June 13, 1967 W. R. AIKEN 3,325,724

VOLTAGE STABILIZER EMPLOYING A PHOTOSENSITIVE RESISTANCE ELEMENT

Filed July 27, 1964 2 Sheets-Sheet 1

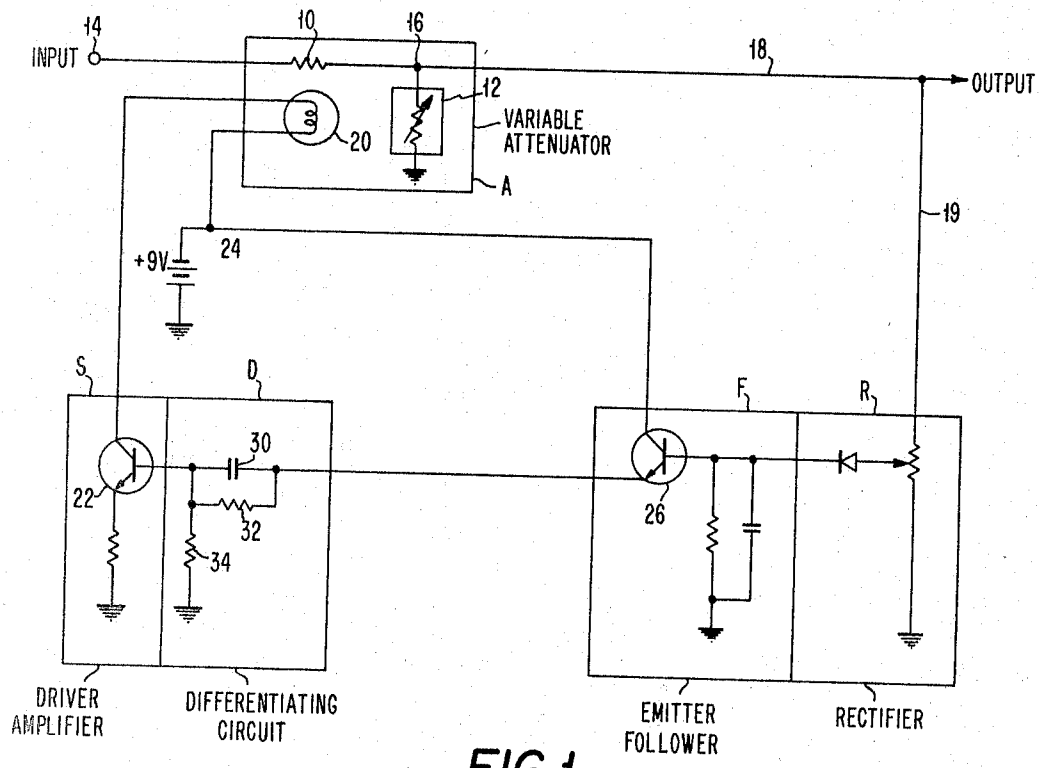

FIG. 1

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FIG. 2A INCOMMING SIGNAL

FIG. 2B RECTIFIED SIGNAL VOLTAGE

FIG. 2C DIFFERENTIATED VOLTAGE CHANGE

FIG. 2D DC VOLTAGE CHANGE

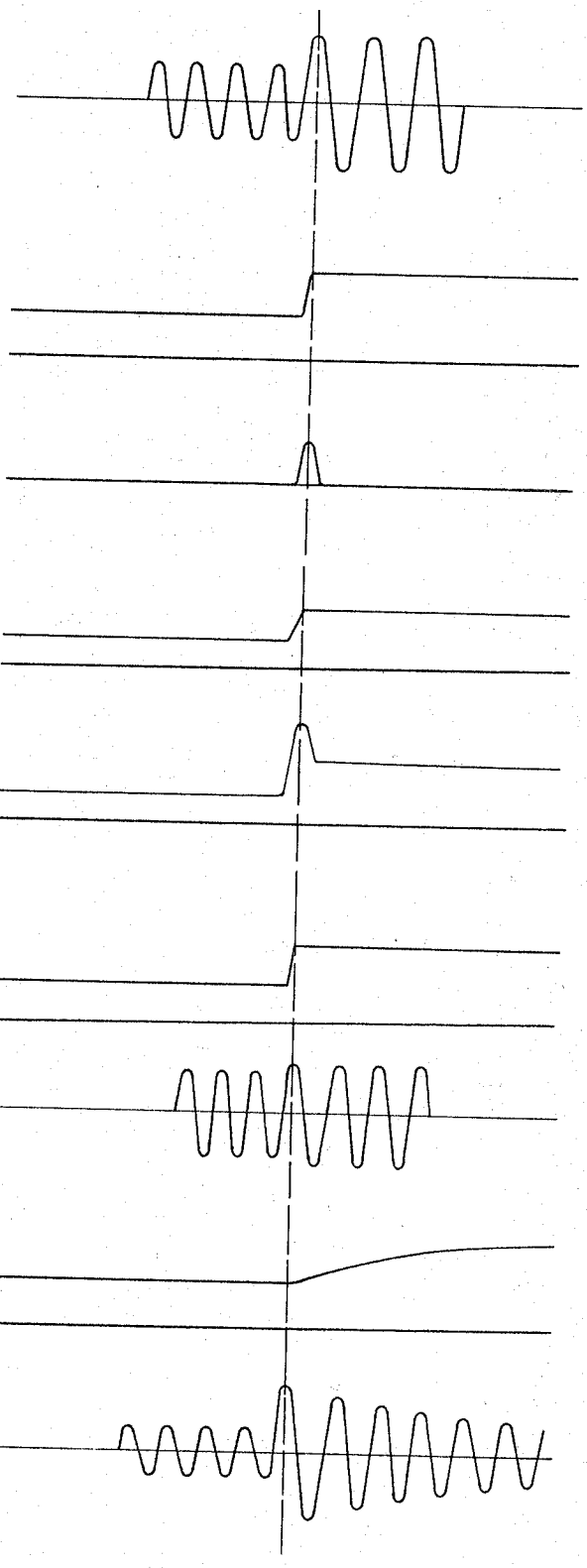
FIG. 2E COMPOSITE VOLTAGE CHANGE

FIG. 2F LIGHT INTENSITY ACCORDING TO THE INVENTION

FIG. 2G RESULTANT OUTPUT SIGNAL

FIG. 2H LIGHT INTENSITY WITHOUT THE INVENTION

FIG. 2I OUTPUT SIGNAL WITHOUT THE INVENTION



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VOLTAGE STABILIZER EMPLOYING A PHOTOSENSITIVE RESISTANCE ELEMENT

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1 Claim. (Cl. 323—21)

The present invention relates to voltage stabilizers, i.e., circuits which operate to supply a steady output voltage irrespective of variations in the voltage supplied to the circuits. More particularly, the present invention relates to voltage stabilizer circuits which employ photosensitive resistor elements that are controlled by a source of light whose degree of illumination is determined by, and varies with, the signal voltage passed through the circuit. The changes in the degree of illumination of the lamp produced in this manner, in turn change the resistance of the photosensitive element of the circuit in such a manner as to maintain the output voltage of the circuit stable in spite of changes in the input voltage of the signal.

The problem with arrangements of this type is that the response of the source of light to changes in the voltage of the signal passed through the circuit and/or the response of the photosensitive element to changes in the illumination is often too slow, and as a result thereof the level of the output voltage of such circuits rises or drops briefly to a noticeable extent whenever the size of the input voltage varies, before it supplies a steady output voltage of the desired magnitude.

It is an object of my invention to provide a voltage stabilizing circuit of the type employing a photosensitive element in combination with a source of light, that provides a truly uniform output voltage in spite of rapid and/or substantial changes in the size of the input voltage.

Another object of the invention is to provide a voltage stabilizer circuit, of the type referred to, that operates successfully to provide a stable output voltage, without requiring expensive types of photosentitive resistor elements or expensive lamps, and which will operate at voltages that permit the use of transistors of the low cost variety.

These and other objects of the invention will be apparent from the following description of the accompanying drawings which illustrate a preferred embodiment thereof and wherein

FIGURE 1 is a block diagram illustrating the principles of my invention and showing in the individual blocks exemplary circuit elements of a preferred embodiment of the invention; and

FIGURES 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H and 2I are graphs illustrating the performance of the stabilizer circuit represented by FIGURE 1.

The stabilizer arrangement of my invention comprises a variable volume changer of the type employing a photosensitive resistor element. In FIGURE 1 said volume changer is represented by the block A and is in fact a variable attenuator formed by a voltage divider network consisting of a fixed resistor **10** and the photosensitive resistor element **12** connected in series between the signal input means **14** and ground. The voltage developed across the photosensitive element **12** is taken off the junction point **16** of the resistors **10** and **12** and appears as the output signal in line **18**. The size of the voltage appearing in the output line depends upon the relative values of the two series-connected resistors **10** and **12** and will be large if the value of resistor element **12** is large compared with resistor **10**, or small if the value of resistor element **12** is small as compared with resistor **10**. To vary the resistance value of resistor element **12** it is exposed to illumination from an adjacently positioned electric lamp **20** so that the resistance value of the photosensitive resistor element **12** is inversely proportional to the degree of illumination of the lamp. To stabilize the voltage output of the voltage divider net work **10/12**, the degree of illumination of the lamp is controlled by the signal that passes through said network such that the lamp burns brighter and therefore reduces the resistance value of the element **12** and hence the voltage developed across said element when the signal delivered to the attenuator becomes stronger and vice versa, i.e., the lamp dims when the signal applied to the attenuator becomes weaker, and as a result thereof the value of resistor element **12** increases and the output voltage developed across said element increases correspondingly.

In conventional stabilizer circuits of the type here under consideration the power circuit of the source of light usually contains a current-flow controlling element, and a rectified control voltage derived from the signal passed through the stabilizer circuit is applied to said control element to change the current flow in the power circuit of the light source so as to produce such a change in the brightness of the light source as will compensate for the changes in the voltage of the input signal and return the output of the stabilizer circuit to its intended level. In accordance with the invention I apply an additional control voltage to the control element in the power circuit of the light source whenever the volume of the input signal changes, to over- or under-voltage the light source, as the case may be, and thus increase its rate of change of light output. I apply said additional control voltage to said control element only for the brief period necessary to adjust the output of the light source to the level required to provide the proper compensation for the change in the voltage of the applied signal. By the time said additional control voltage disappears, the conventionally developed control voltage maintains the output of the light source at the proper compensating level. In practice I accomplish this by applying the conventionally developed control voltage through a differentiating circuit as well as through a D.C. circuit to the control element in the power circuit of the light source. The output of a differentiating circuit is proportional to the rate of change of the applied signal. It provides, therefore, a sudden control voltage of brief duration which disappears by the time the conventionally applied control voltage would ordinarily have changed the operation of the element in the required manner. From now on the conventionally applied control voltage continues to hold the control element at the voltage level to which it was rapidly raised or lowered, as the case may be, by the output of the differentiator circuit.

In the embodiment of the invention illustrated in FIGURE 1 the current flow through the lamp **20** is regulated by a driver stage represented by the block S which may be a transistor **22** whose emitter and collector are connected between the source of power **24** and ground. The flow of power through the lamp and hence its degree of illumination depend upon the size of a control voltage applied to the base electrode of the transistor. To control the flow of power through the lamp in the proper manner whenever the volume of the signal applied to the attenuator A changes, a part of the alternating voltage appearing in the output line **18** of the attenuator is rectified in the rectifier represented by the block R.

The rectified voltage is applied to the base of a transistor **26** connected to operate as an emitter follower, to control the flow of current from the source of D.C. **24** through said transistor. Any current flowing through the transistor **26** under control of the varying D.C. voltages supplied by the rectifier R, is applied to the base of transistor **22** in driver stage S transistor through a resistor **32** and through a differentiating circuit composed of a capacitor **30** connected parallel to resistor **32** and grounded

jointly with resistor **32** through a resistor **34**, as shown in block D.

Operation

When the volume of a signal applied to the input of attenuator A rises abruptly, the output voltage of said attenuator in output line **18** rises likewise. Part of the output signal is tapped off along line **19** and rectified in rectifier R. The output of rectifier R is applied to the emitter follower F (which would be unnecessary if an expensive high impedance transistor were used in the power circuit of the lamp **20**). The D.C. voltage rise supplied by the emitter of transistor **26** is applied to the base of transistor **22** through the parallel paths provided by the differentiating circuits **30**, **34** and the resistor **32** to control the flow of current in the power circuit of the lamp **20**. The capacitor **30** passes the voltage rise fully to the base of transistor **22** and increases the conductivity of said transistor abruptly for the brief duration of its change. At the same time the rise in the flow of D.C. current through transistor **26** is applied to the base of control transistor **22** through resistor **32** at a reduced value determined by the size of resistors **32** and **34**; and while the sudden voltage rise applied to the base of transistor through capacitor **30** disappears momentarily, the rise in the control voltage applied to said base through resistor **32** and across resistor **34** remains in force as a steady control voltage until the output of rectifier R changes as a result of renewed changes in the level of the signal applied to the input line **14** of attenuator A.

As a rapidly rising control voltage is applied to the base of transistor **22** through capacitor **30**, the conductivity of the transistor **22** is rapidly increased so that the current flow in the power circuit of lamp **20** increases rapidly and would increase beyond the level required for compensating for the increase in the volume of the applied signal, were it not of such brief duration; and by the time the control voltage applied through capacitor **30** has disappeared, the steady bias voltage applied through resistor **32** and developed across resistor **34** maintains the illumination of lamp **20** at the brightness required to reduce the resistance value of the photosensitive resistance element **12** to the extent necessary for maintaining the output volume of the attenuator A steadily at its predetermined level.

By proper choice of the voltage provided by transistor **26** and by proper choice of the values of capacitor **30** and resistors **32** and **34**, it is therefore possible to provide for such rapid variations of appropriate magnitude in the current flow through lamp **20** with changes in the volume of a received signal, as will not only compensate for inherent slowness in the response of relatively inexpensive lamps to changes in current flow, but also for inherent slowness in the response of relatively inexpensive photosensitive resistance elements to changes in illumination.

Having reference to FIGURES 2A to 2I, the graph shown in FIGURE 2A represents an incoming signal and indicates a sudden increase in the volume of the incoming signal. FIGURE 2B represents the corresponding change in the control voltage derived by rectifying part of the signal derived from the output side of the attenuator, as provided in the emitter circuit of transistor **26**. FIGURE 2C represents the brief voltage surge applied to the base of the driver transistor **22** through capacitor **30** and FIGURE 2D represents the control voltage supplied to the base of transistor **22** through resistor **32**. FIGURE 2E represents the composite voltage applied to the base of the driver transistor **22** through both the differentiating circuit **30**, **34** and the D.C. circuit **32**. The resultant change of current flow in the power circuit of the lamp **20** and the consequent change in the illumination provided by the lamp are represented in FIGURE 2F. In contradistinction, FIGURE 2H represents the more gradual change in the illumination of the lamp **20** provided when the variations in the rectified output signal are applied directly to the base of the driver transistor **22**. FIGURE 2H shows an increase in the illumination of lamp **20** that is far too gradual to insure proper stabilization of the output signal. With the pronounced change in the illumination provided by lamp **20** as achieved by the arrangement of the present invention, it is now possible to maintain the volume of a signal as even and uniform as illustrated in FIGURE 2G in spite of pronounced and rapidly occurring changes in the strength of the input signal, which would formerly have produced an output signal such as illustrated in FIGURE 2I.

While I have illustrated my invention with the aid of an exemplary embodiment thereof, it will be understood that the invention is not limited to the specific volume changer, rectifier and control means for the power circuit of the light source shown and described by way of example, which may be departed from without departing from the scope and spirit of the invention. Thus, it will be understood by those skilled in the art that the principles of my invention may be employed to stabilize the output of volume changers other than the specific attenuator shown and described, and the control voltage derived from the signal passing through the volume changer may be taken off at the input side or at an intermediate point of its path through the volume changer rather than the output side thereof.

I claim:

A voltage stabilizer circuit comprising a volume changer including a photosensitive resistor element and a light source arranged to illuminate said resistor element and having a power circuit including a transistor having an emitter and a collector electrode connected into said power circuit, means for applying a signal to said volume changer, means for rectifying a part of the signal applied to the volume changer, and means including a differentiating circuit and a direct current circuit for applying the rectified signal to the base electrode of said transistor.

References Cited

UNITED STATES PATENTS

2,158,193	5/1939	Morse	250—205 X
2,866,151	12/1958	Applin et al.	
3,171,032	2/1965	Holt	250—205 X
3,200,329	8/1965	Haisty	323—21 X
3,248,642	4/1966	Rothschild	323—21

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