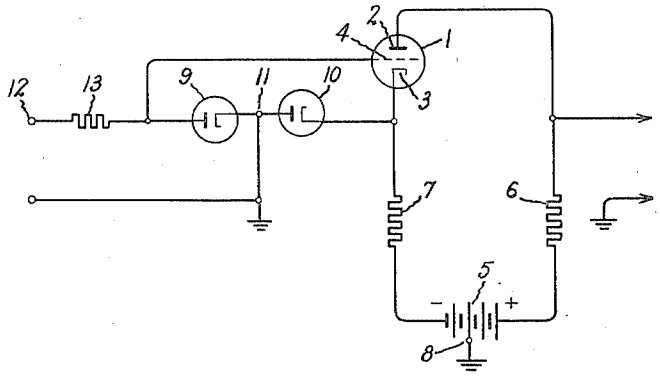
May 30, 1950 D. J. MYNALL 2,509,742

VOLTAGE LIMITING CIRCUIT

Filed Oct. 15, 1947



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Patented May 30, 1950 2,509,742

UNITED STATES PATENT OFFICE

2,509,742

VOLTAGE LIMITING CIRCUIT

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Application October 15, 1947, Serial No. 780,056
In Great Britain October 16, 1946

2 Claims. (Cl. 178—44)

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My invention relates to circuit arrangements employing electron discharge devices capable of operating over only a narrow range of input voltage level and ignoring all variations of input voltage which lie outside the range, the output voltage meanwhile remaining at either the higher or lower limit. The arrangement thus forms a voltage limiting circuit.

Such voltage limiting circuits have heretofore frequently been characterized by a marked difference of output resistance when the output voltage level is at the upper and lower limits of operating range. This change in output resistance is often undesirable when the action of the circuit following the limiter is affected by the value of the output resistance of the limiter.

The object of the present invention is to provide a limiting amplifier in which the output resistance varies but slightly as its output voltage moves from one limit to the other.

In a voltage limiting amplifying circuit comprising an electron discharge device having three or more electrodes including a cathode, an anode, and a control electrode, according to the invention, two unidirectional conducting paths are connected in series for the same direction of current flow between the control electrode and the cathode, the common connection between the two paths being maintained at a fixed potential. The arrangement is such that one of the paths becomes conducting when the input voltage level exceeds a predetermined upper limit, thereby holding the control electrode at a limited positive value with respect to the fixed potential. The other path becomes conducting when the input voltage level is below a predetermined negative limit, thereby holding the cathode at a negative potential with respect to the point of fixed potential and positive with respect to the control electrode, thus maintaining the valve non-conducting.

The two unidirectional conducting paths are preferably constituted by two thermionic diodes connected in series between the control electrodes and the cathode of an electron discharge amplifying device. The anode of one diode is connected to the control electrode of the device and the cathode of the other diode, to the cathode of the device. The intermediate point connecting the cathode of one diode to the anode of the other diode is maintained at a point of fixed potential, preferably ground.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention

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itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood from the following description taken in connection with the accompanying drawings in which the single figure represents an embodiment of my invention.

Referring to the drawing, the voltage limiter there shown comprises an electron discharge device 1 having an anode 2, a cathode 3, and a control electrode 4. The anode 2 is connected to the positive terminal of a battery 5 through an anode resistance 6. The cathode 3 is connected to the negative terminal of the battery 5 through a cathode resistance 7. An intermediate point 8 of the battery 5 is connected to ground, as indicated. Between the cathode 3 and the control electrode 4 are connected two unidirectionally conducting devices 9, 10. The devices 9, 10 are illustrated as diodes, device 9 having its anode connected to the control electrode 4 and device 10 having its cathode connected to the cathode 3. While unilateral devices 9 and 10 are illustrated as diodes, other rectifying devices, such as a contact rectifier for example, may be employed if the rectifier characteristic is similar to that of a diode. The cathode of the device 9 and the anode of device 10 are connected together at a point 11 which, in turn, is connected to ground. The anode of device 9 is connected to an input terminal 12 through a resistance 13. The other input terminal may be connected to ground as illustrated. Output terminals for the limiter amplifier may be connected, respectively to the anode 2 and to ground, as indicated.

In the operation of the circuit described, if the input terminal 12 is, for example, raised to a high positive potential, current flows through resistor 13 and diode 9 to ground. Resistor 13 is made sufficiently large in value to insure that the current through the diode 9 is not excessive and the potential of the anode of diode 9 is thus slightly positive with respect to ground. The control electrode 4 of discharge device 1, being connected to the anode of the diode 9, is therefore held substantially at ground potential under this condition of operation. The cathode of device 1 establishes itself through a normal cathode follower action at a potential slightly more positive than that of the control electrode 4. This action has two effects: (1) the cathode of diode 10 is maintained positive with respect to its anode so that diode 10 does not conduct, and (2) the current flow in the electron discharge device 1 has a value which is substantially independent

of the value of the input voltage so long as the input voltage remains high enough to maintain diode 9 conducting.

If, on the other hand, the potential of the input terminal 12 is lowered to a negative value considerably lower than ground, diode 9 ceases to conduct and the cathode 3 of device 1 tends to become lower in potential. This permits the diode 10 to conduct and maintains the cathode of the device 1 at a potential somewhat lower than under the previously described operation, but still considerably above the potential of the control electrode 4. In this fashion, the anode-cathode current of device 1 is reduced to zero and remains at zero independent of variations of the input level, provided that the input voltage remains low enough.

Between the two extreme conditions described above is an intermediate region in which variations in the output correspond with those in the input voltage.

The resistance value of the anode and cathode resistors 6, 7 is such as to insure that the device 1 does not at any time tend to pass grid current. When the device 1 is not passing anode current, the output resistance is equal to the value of the anode resistance 6. However, when the device is passing its limiting value of current, the output resistance is slightly lower than the value of resistor 6, since resistor 6 is effectively shunted by a resistance which is approximately equal to $(\mu+1)$ times the value of cathode resistor 7 (where μ is the amplification factor of the device 1). However, since this effective resistance may be designed to be much greater than the anode resistor 6, the output resistance may be considered as practically constant.

It may sometimes be an advantage to use in the above described limiter circuit a pentode type of electron discharge device in place of the triode, indicated in the drawing as the device 1, thus taking advantage of the shorter grid base and higher amplification factor of the pentode. Such change, however, does not affect materially the operation of the circuit, but only involves an additional connection between the screen grid of the pentode to a positive source of potential.

While the diodes 9 and 10 have been shown as constituting separate units, it may likewise be found convenient to use a multiple device, such as a multiple diode, for the two diodes 9 and 10 or any other suitable combination.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto, since various modifications may be made in the circuit arrangement and in the instrumentalities employed therein, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electronic voltage limiting circuit comprising an electron discharge device having an anode, a cathode and a control electrode, a pair of diodes connected in series between said control electrode and said cathode, one of said diodes having its anode connected to said control electrode and the other of said diodes having its cathode connected to the cathode of said device, a pair of input terminals connected respectively to the mid-point of said serially connected diodes and to said control electrode through a resistance, said mid-point being connected to a point of fixed potential, respective resistances connected to the anode and the cathode of said device, and an output terminal connected to the anode of said device.

2. In an electronic voltage limiter circuit, the combination comprising an electron discharge device having an anode, a cathode and a control electrode, a pair of input terminals, a source of input voltage connected between said terminals, one of said terminals being a point of fixed potential, means for establishing two unidirectionally conducting paths between said terminals comprising a pair of rectifiers connected in series between said control electrode and said cathode, said rectifiers having unlike poles connected together and to said point of fixed potential, said other input terminal being connected to said control electrode and the other pole of a first of said rectifiers, the remaining pole of the second of said rectifiers being connected to said cathode, said rectifiers being so poled that when the potential of said other terminal is greater than said fixed potential said first rectifier is rendered conductive, the other of said rectifiers being rendered conductive when the potential of said other terminal is less than said fixed potential.

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