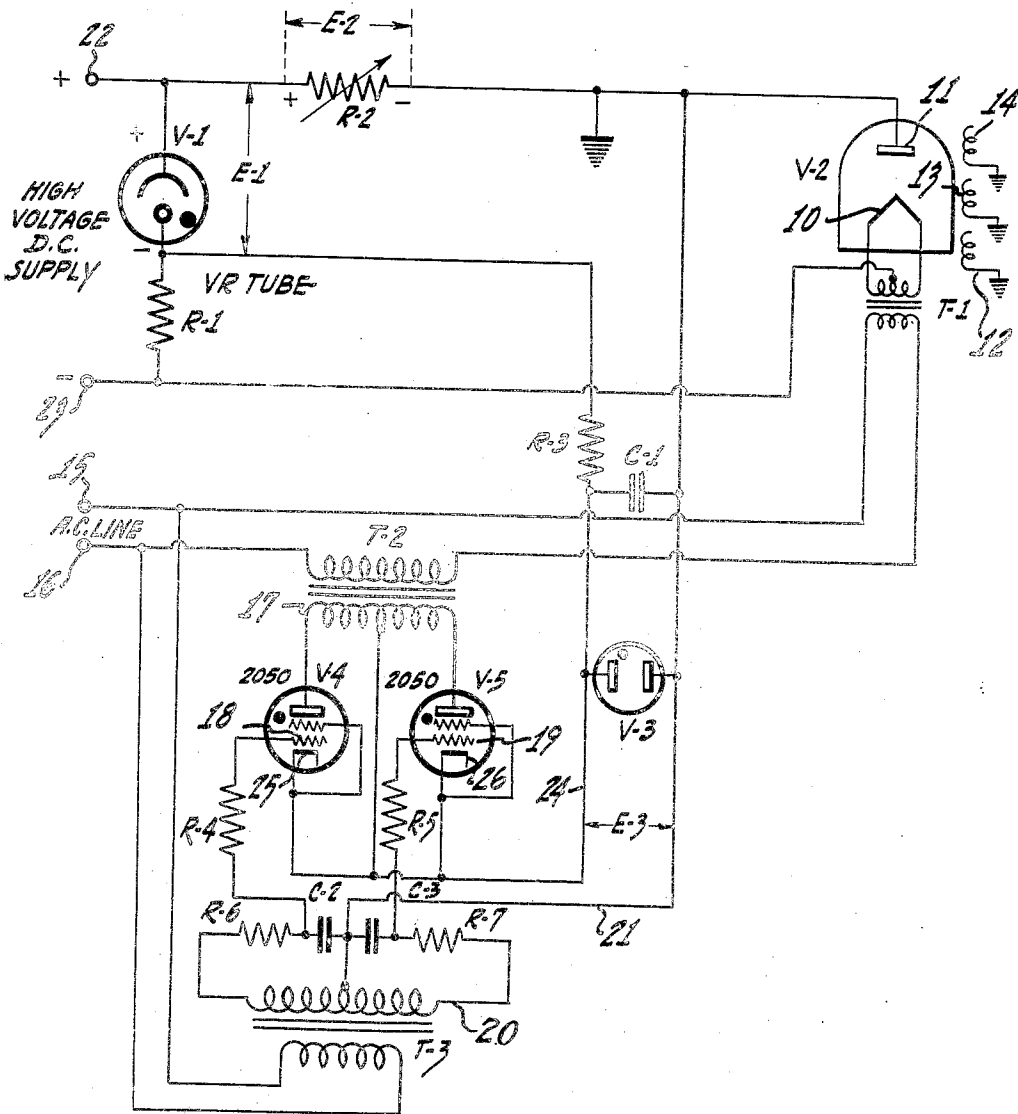


Aug. 15, 1950

S. H. BUDER ET AL
REGULATING DEVICE

Filed June 12, 1946

2,519,173



INVENTORS
Spurgeon H. Buder
& William H. Eichelberger

BY *CDuska*
ATTORNEY

UNITED STATES PATENT OFFICE

2,519,173

REGULATING DEVICE

Spurgeon H. Buder, Merchantville, N. J., and
William H. Eichelberger, Denver, Colo., assign-
ors to Radio Corporation of America, a corpo-
ration of Delaware

Application June 12, 1946, Serial No. 676,167

5 Claims. (Cl. 315-197)

1

This invention relates to regulating devices of the type which are suitable for regulating the cathode heating current of an electron discharge element so as to maintain a current of constant value in the output of such element.

In the operation of various types of equipments including an electron discharge element, it is desirable that the cathode heating current of the element be so regulated that the output current is maintained within very narrow limits, or substantially constant irrespective of variation in the operating voltages of the device. Thus in the case of a lens coating equipment wherein the coating is hardened by bombardment with an electron gun, for example, the requirement that the lens coating be uniformly treated makes it necessary that the current and scanning speed of the cathode ray of the electron gun be maintained constant throughout the bombarding of the coating on the lens surface.

In accordance with the present invention, the first requirement, namely that of keeping the current constant, is achieved by a regulating device which includes (1) a variable impedance means connected in the cathode heating circuit of the electron gun, (2) a pair of push-pull electron tubes of the gaseous conduction type connected to control the impedance of the impedance means, and (3) means for applying to the control grids of the electron tubes a bias potential which is the resultant of a potential having a constant value and a potential having a value which is proportional to the output current of the electron gun.

Under these conditions, there are applied to the control grids of the tubes (1) an alternating potential which has a predetermined phase relation with that applied to the impedance device and the cathode heating circuit of the electron gun, and (2) unidirectional bias potential which is proportional to slight variations of the output current of the gun so that the impedance of the impedance means connected in the cathode heating circuit increases when the output current of the gun tends to increase and vice versa.

This action results from the well known fact that the current conduction of a gaseous discharge tube (sometimes designated as a "Thyratron") may be started at any desired point in the positive half cycle of its anode voltage by varying the bias potential of its control grid relative to its cathode. Thus the part of the positive half during which the triode conducts de-

2

termines the value of its anode current and of the impedance of the impedance device which is connected in its anode circuit.

Important objects of the invention are the provision of an improved regulating device and method of operation for maintaining a constant value in the output current of an electron gun, and the provision of an improved regulating device which functions to vary the impedance of a cathode heating circuit in accordance with the value of a unidirectional potential dependent on the electron emission of such cathode.

The invention will be better understood from the following description considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

The single figure of the drawing is a wiring diagram of a regulating device connected and arranged in accordance with the present invention.

This figure shows an electron gun V-2 which includes a cathode 10, an anode 11, a focus coil 12, a high speed sweep deflection coil 13 and a low speed sweep deflection coil 14. Heating current is supplied to the cathode 10 from the alternating potential input terminals 15-16 through a transformer T-1 and a variable impedance device which includes a transformer T-2 and a pair of gaseous conduction electron discharge elements V-4 and V-5 which have their anodes connected in push-pull relation to the secondary winding 17 of the transformer T-2, the primary winding of this transformer being connected in series with the heating circuit of the cathode 10.

Alternating potential derived from the terminals 15-16 is applied to the control grids 18 and 19 of the electron discharge elements V-4 and V-5 through a transformer T-3 which has its secondary winding 20 shunted by the resistors R-6 and R-7 and the capacitors C-2 and C-3 so that a push-pull potential is applied to the grids 18 and 19 through the resistors R-4 and R-5. The neutral lead 21 of the secondary winding 20 is connected to the anode 11 of the gun V-2 which is grounded.

Operating potential is applied between the cathode 10 and the anode 11 of the electron gun V-2 from a pair of terminals 22-23 through a resistor R-2 which is adjustable to produce a voltage E-2. This voltage is balanced against that of a constant voltage device V-1 which is connected between the terminals 22 and 23

3

through a resistor R—1 and functions to produce a constant voltage E—1.

The resultant difference voltage E—3 of the voltages E—1 and E—2 is applied between the neutral lead 21 and the cathode return lead 24 of the devices V—4 and V—5 so that the cathodes 25 and 26 are maintained at a bias potential dependent on the value of the voltage E—3. Rapid fluctuations in this voltage are smoothed out by a filter R—3 and C—1, and the discharge device V—3 functions to limit the voltage that can be applied to the cathodes 25 and 26 under abnormal conditions.

If the voltage E—2 is small compared to E—1, the voltage E—3 from the cathode lead 24 to the grid return lead 21 is more positive thus causing a wider angle of current flow in the devices V—4 and V—5, lowering the impedance of the transformer T—2, increasing the temperature of the cathode 10 and increasing the current of the gun V—2. Likewise if E—2 is large compared to E—1, the grids of the devices V—4 and V—5 are made more negative with respect to their cathodes, thus limiting the flow of their currents to a smaller part of the cycle, increasing the impedance of the transformer T—2 and decreasing the current of the gun V—2.

Since the circuit of the devices V—4 and V—5 is arranged to change from a firing angle of zero to 180 degrees when the voltage E—3 varies over a few volts, the current of the gun V—2 is stabilized at such a value that E—1 and E—2 are approximately equal. The magnitude of the gun current required to fulfill this condition may be varied by adjustment of the resistor R—2. As the voltage E—3 is the resultant difference of two relatively large voltages E—1 and E—2, a small change in gun current produces a relatively large change in the voltage E—3 so that the gun current is substantially independent of line voltage (and condition of cathode), the reference voltage E—1 being maintained at a constant value by the voltage regulator V—1.

The present invention is thus characterized by the provision of means whereby a potential proportional to the output current of an electron discharge device is compared with a constant potential to derive a resultant potential by which the cathode heating current of such device is regulated to maintain its output current at a constant value determined by the adjustment of the regulating device.

We claim as our invention:

1. In a device for regulating the output current of an electron discharge device having a cathode coupled to be heated to a source of heating current, the combination of means for producing opposed unidirectional potentials one of which has a constant value and the other of which has a value proportional to said output current, a variable impedance connected between said cathode and said source of heating current, means to control the value of said variable impedance, and means to continuously impress the resultant of said opposed potentials upon said control means to vary the value of said variable impedance and the heating current supplied to said cathode in accordance with fluctuations in said resultant potentials.

2. In a device for regulating the output current of an electron discharge device having a cathode coupled to be heated to a source of heating current, the combination of means for producing opposed unidirectional potentials one of which

4

has a constant value and the other of which has a value proportional to said output current, means for smoothing out rapid fluctuations in the resultant of said opposed potentials, a variable impedance connected between said cathode and said source of heating current, means to control the value of said variable impedance, and means to continuously impress said smoothed out resultant potential upon said control means to vary the value of said variable impedance and the heating current supplied to said cathode in accordance with fluctuations in said resultant potential.

3. In a device for regulating the output current of an electron discharge device having a cathode coupled to be heated to a source of heating current, the combination of means for producing opposed unidirectional potentials one of which has a constant value and the other of which has a value proportional to said output current, means for smoothing out rapid fluctuations from the resultant of said potentials, a discharge device upon which said resultant potential is impressed for providing a shunt path under abnormal operating conditions of said device, a variable impedance connected between said cathode and said source of heating current, means to control the value of said variable impedance, and means to continuously impress said smoothed-out resultant potential upon said control means to vary the value of said variable impedance and the heating current supplied to said cathode in accordance with fluctuations in said resultant potential.

4. In a device for regulating the output current of an electron discharge device having a cathode coupled to be heated to a source of heating current, the combination of means for producing opposed potentials one of which has a constant value and the other of which has a value proportional to said output current, a transformer having a primary winding connected between said cathode of said discharge device and said source of heating current and a secondary winding, a pair of gaseous conduction electron discharge tubes, each having a grid, cathode and anode electrodes, said gaseous discharge tubes being push-pull connected to said secondary winding, and means for applying between the cathodes and control grids of said gaseous conduction tubes a potential which is the resultant of said opposed potentials to vary the current drawn by said gaseous conduction tubes proportionally to said resultant potential to vary the impedance of said transformer primary to cause heating current variations in opposition to variations in said output current.

5. In a device for regulating the output current of an electron discharge device having a cathode coupled to be heated to a source of heating current, the combination of means for producing opposed potentials one of which has a constant value and the other of which has a value proportional to said output current, a pair of gaseous conduction electron discharge tubes each having a cathode, an anode, and a control grid, a transformer having a primary winding connected between said source of heating current and said cathode of said discharge device and a secondary winding, said pair of gaseous conduction electron discharge tubes being push-pull connected to said secondary winding, means for applying between the cathodes and control grids of said gaseous conduction tubes a push-pull alternating current biasing potential, and means for applying between

5
said gaseous conduction tubes, cathodes and control grids a potential which is the resultant of said opposed potentials to vary the current drawn by said gaseous conduction tubes proportionally to said resultant potential to vary the impedance of said transformer primary to cause heating current variations in opposition to variations in said output current.

SPURGEON H. BUDER.

WILLIAM H. EICHELBERGER. 10

6
REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,319,378	Weisglass -----	May 18, 1943
2,408,091	Olesen -----	Sept. 24, 1946