Sept. 29, 1953

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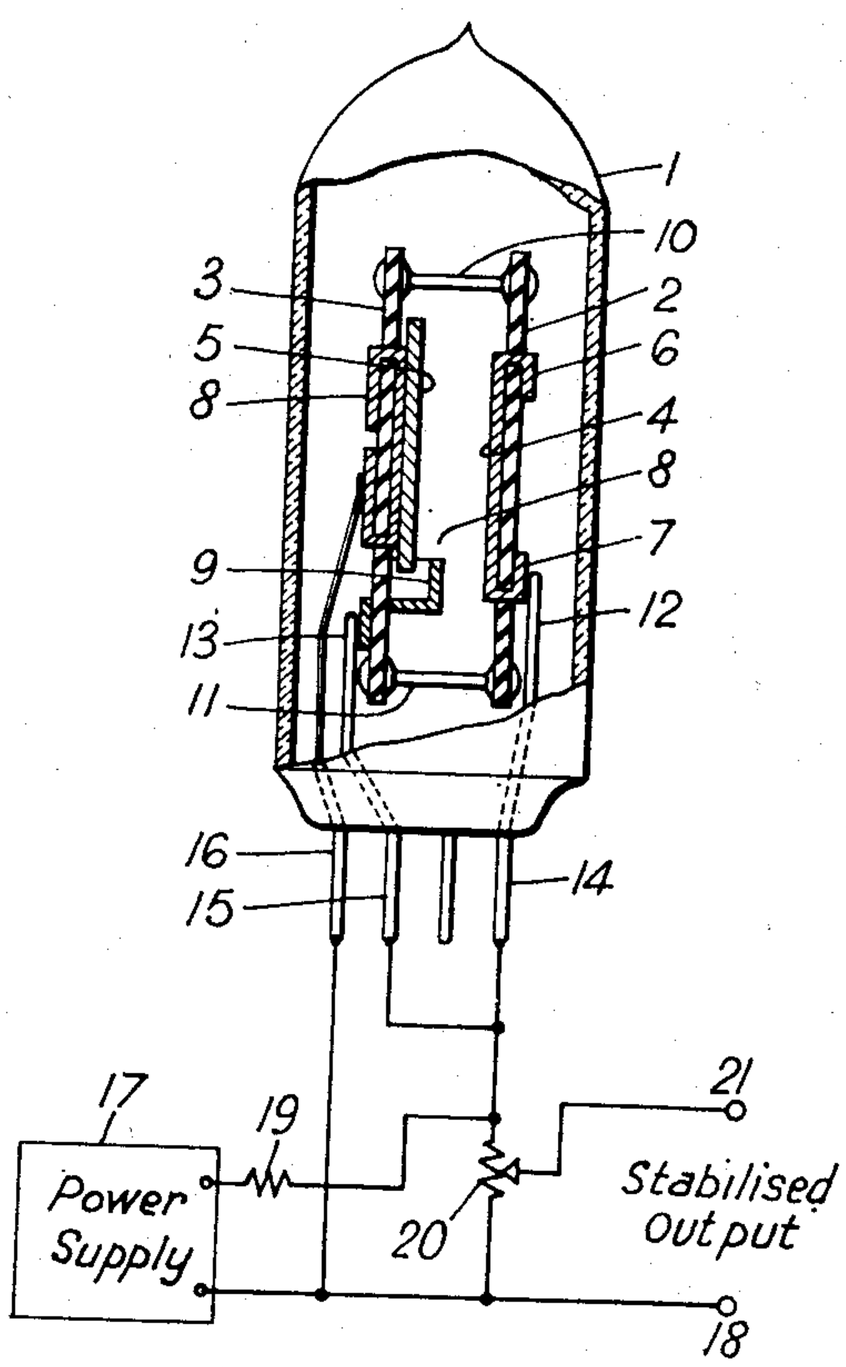
2,654,044

ELECTRIC DISCHARGE TUBE

Filed Dec. 8, 1951



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Patented Sept. 29, 1953

2,654,044

UNITED STATES PATENT OFFICE

2,654,044

ELECTRIC DISCHARGE TUBE

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Application December 8, 1951, Serial No. 260,741
In Great Britain December 22, 1950

3 Claims. (Cl. 313—197)

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The present invention relates to D. C. voltage stabiliser arrangements using the glow discharge between cold cathode electrodes in a gaseous atmosphere as the voltage stabilising element.

The use of cold cathode glow discharge tubes as voltage stabiliser elements depends upon the fact that if two electrodes be placed within a gaseous atmosphere and if a certain critical voltage known as the striking voltage be applied between the electrodes, a discharge will occur with formation of a space charge between the electrodes rendered visible by a glow adjacent the cathode, the voltage between the electrodes then dropping to a value considerably less than the striking voltage provided the current be limited so that the whole of the available cathode surface be not covered with glow; this is the so-called "normal" glow discharge. If the voltage be reduced below a critical value known as the maintaining voltage, the discharge is extinguished. The discharge current-voltage characteristic in the normal discharge tends to be flat, the voltage not rising much above the maintaining voltage until the whole of the cathode surface is covered with glow when the cathode is said to be saturated and "abnormal" discharge commences with rise of voltage with increase of current. The maintaining voltage of a discharge gap depends upon the materials of the electrodes, the gas filling and upon the electrode geometry. Thus, if the anode were to be in the form of a rod normal to a plane cathode, as the discharge current increased those portions of the cathode immediately adjacent the anode would then become saturated, while those portions further away would remain unsaturated. The interelectrode voltage would therefore tend to increase with increasing current, even though the discharge over the cathode surface as a whole could not be said to be abnormal. In order to cater for a wide current range for a small voltage variation, anode and cathode electrodes should therefore preferably be parallel.

It is a commonly observed phenomenon in glow discharge tubes and is particularly liable to occur in tubes having planar electrodes, that the glow tends not to remain stationary over the cathode surface, but wanders in position; such fluctuation in position of the cathode glow we have found to be a main cause of fluctuations in voltage in gas discharge tubes designed for use as voltage stabilisers.

According to the present invention there is provided a D. C. voltage stabiliser arrangement comprising a pair of extended electrodes enclosed

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within a gas filled envelope and defining a cold cathode glow discharge gap between substantially parallel surfaces and an auxiliary electrode connected to the anode electrode of the said gap projecting into the said gap parallel to the cathode electrode and at a distance therefrom substantially equal to the length of the cathode fall of potential for discharge between the said cathode and the main anode, the discharge surfaces of all the said electrodes being of clean metal, the discharge current-voltage characteristics of the said auxiliary gap being such that it serves as a starting gap for the discharge at the main gap and during consequent operation stabilises the position of the cathode glow.

An embodiment of the invention will now be described with reference to the accompanying drawings which shows a cold cathode gas filled discharge tube according to the invention in part section and the circuit connection thereto.

The electrodes of the stabiliser tube according to this embodiment of the invention are housed within a glass envelope **1** such as is used for small radio valves. The electrode assembly comprises a pair of mica sheets **2** and **3** upon which are mounted, respectively, an anode **4** and a cathode **5** of pure nickel. The anode **4** is formed of strip material bent to pass through apertures in the sheet **2**, the end of the strip being clamped over as shown at **6** and **7**. The cathode **5** is welded to a strip **8** secured to the mica sheet **3** in similar manner to that in which anode **4** is secured to the sheet **2**; there is thus a small clearance between the rear edges of the cathode and the mica sheet **3**, this clearance being arranged to be shorter than the length of the cathode fall of potential during normal discharge between cathode **5** and anode **4**, thus preventing the discharge from spreading round the edges of the cathode and also avoiding irregular operation of the tube due to cathode material being sputtered on to the mica plate **3**. An auxiliary electrode **9** is secured to the mica sheet **3** and is formed so as to provide a box like enclosure about the end of the cathode. The mica sheets **2** and **3** are held together by means of two pairs of pins **10** and **11** to which the sheets are riveted. The electrode assembly is supported upon rods **12** and **13** welded respectively to the rear of the anode **4** and auxiliary electrode **9** and to respective pins **14** and **15** sealed through the base of the envelope. The pin **16** is shown connected to the cathode **5**.

In operation to provide a stabilised E. M. F. the negative side of the power supply **17** is connected to the cathode pin **16** and to output terminal **18**.

The positive terminal of the power supply is connected to anode pin 14, a current limiting resistance 19 being shown inserted in series. The pin joined to the auxiliary electrode 9 is connected directly to anode pin 14 and a potentiometer 20 is inserted between cathode and anode. The stabilised E. M. F. is taken from terminals 18 and 21 which are connected, respectively, to the cathode pin 16 and to the slider of the potentiometer 20. If current is to be drawn from the supply at a constant voltage, as opposed to a constant E. M. F., potentiometer 20 is omitted and terminal 21 is connected direct to the anode pin 14.

The auxiliary electrode 9 not only provides a starting gap for the tube, but during its subsequent operation the presence of the continued discharge between cathode 5 and auxiliary electrode 9 assures that for all values of the main discharge gap current within the design range the cathode glow is continuous from the edge of the auxiliary electrode and so is unable to alter its position to any observable extent.

A typical tube as described above is dimensioned as follows:

Main gap, anode 4—cathode 5, 3.0 mm.
Auxiliary gap length, auxiliary electrode 9—cathode 5, 0.3 mm.
Gas filling hydrogen at 15 mm. pressure.

With these dimensions the striking voltage varies from tube to tube between 375 v. nominal and 400 volts maximum. The tube supplies a discharge current through potentiometer 20 of from 2–4 ma. The slider of potentiometer 20 being adjusted to provide the required E. M. F. between terminals 18 and 22. For any given current value within the above range, the voltage across potentiometer 20 varies from tube to tube above a nominal value of 312 volts by not more than ± 5 volts. In any single tube, after ageing, the voltage across potentiometer 20 does not vary by more than 1.0 volt at any current within the above range.

While the principles of the invention have been described above in connection with specific embodiments and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

1. A D. C. voltage stabiliser arrangement comprising a pair of extended electrodes enclosed within a gas filled envelope and defining a cold cathode glow discharge gap between substantially parallel surfaces and an auxiliary electrode connected to the anode electrode of the said gap projecting into the said gap parallel to the cathode electrode and at a distance therefrom substantially equal to the length of the cathode fall of potential for discharge between the said cathode and the main anode, the discharge surfaces of all the said electrodes being of clean metal, the discharge current-voltage characteristics of the said auxiliary gap being such that it serves as a starting gap for the discharge at the main gap and during consequent operation stabilises the position of the cathode glow.

2. A D. C. voltage stabiliser arrangement according to claim 1 in which the discharge surfaces of the said anode, cathode and auxiliary electrodes are planar, the anode electrode being mounted on a first sheet of insulating material, the cathode and auxiliary electrode being mounted on a second opposed sheet of insulating material, the auxiliary electrode being shaped to form a container open at one end projecting from the second sheet of insulating material with cathode electrode projecting into the said open end, the length of the auxiliary gap so formed being substantially equal to, the length of the cathode fall of potential for normal glow discharge across the main gap between the said cathode and anode electrodes.

3. A D. C. voltage stabiliser arrangement according to claim 2 in which the edges and adjacent under surface of the said cathode electrode are spaced from the said second sheet of insulating material by a distance less than the length of the cathode fall of potential for normal glow discharge at these surfaces.

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No references cited.