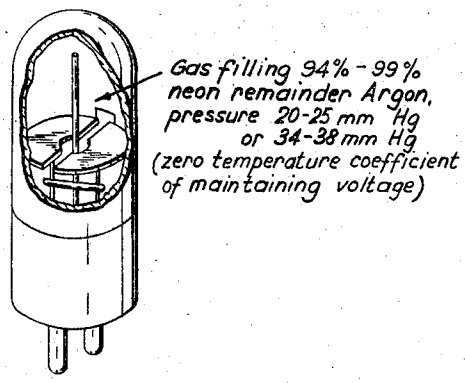
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ELECTRIC GASEOUS DISCHARGE TUBES

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Fig. 1



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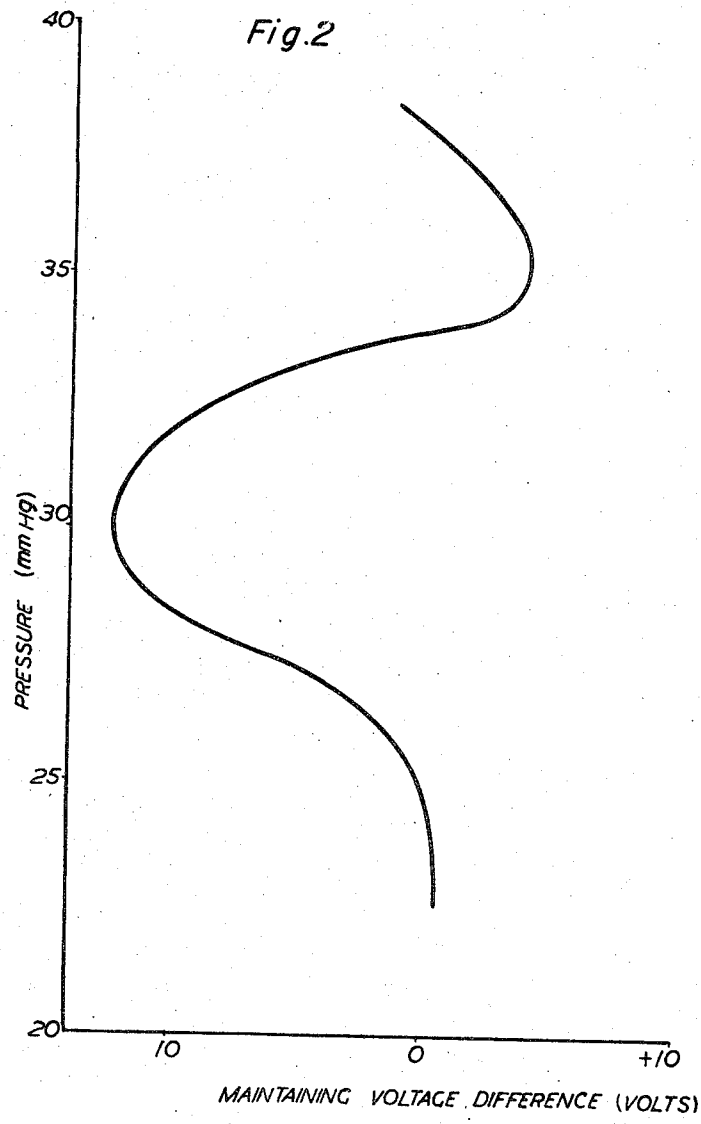
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ELECTRIC GASEOUS DISCHARGE TUBES

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Fig.2



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2,874,324

ELECTRIC GASEOUS DISCHARGE TUBES

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Claims priority, application Great Britain July 23, 1952

1 Claim. (Cl. 313—185)

The present invention relates to cold cathode gas-filled electric discharge tubes, particularly such as are used to provide a reference voltage in stabilised power supplies and the like.

Cold cathode electric glow discharge tubes are characterised in that when once an anode-cathode voltage of sufficient magnitude, depending upon the gas pressure and the anode-cathode separation, is applied to the tube, glow discharge occurs and may be maintained at a considerably lower voltage, referred to as the maintaining voltage of the tube. Over a wide range of discharge current the maintaining voltage may vary but slightly, the discharge being said to be "normal" and being characterised by the fact that the cathode glow does not completely cover the whole of the available cathode surface. At higher discharge currents, when the glow completely covers the cathode, the anode-cathode voltage rises rapidly with increase of current, the discharge being said to be "abnormal." For some time past use has been made of this property of the cold cathode discharge tubes to stabilise the output voltage in mains supply stabilizers and the like. As implied above, however, the maintaining voltage, even in the region of normal discharge is not entirely independent of current, and a given voltage drop across the tube is obtainable only at a specified value of discharge current. Under such limitations, the cold cathode glow discharge tube is widely used as a source of reference voltage. Improvements in tube design have now reached the point where very stable voltages may be obtained provided the tube is run in a temperature controlled enclosure, it being found that a major source of voltage variation is due to a temperature coefficient of maintaining voltage.

The present applicants have conducted investigations with a view to controlling the temperature coefficient of maintaining voltage in glow discharge tubes used as sources of reference voltage. They have found that the value of this temperature coefficient, with a given gas-filling, may be critically dependent upon the amount of gas present, i. e. upon the gas pressure.

In accordance with one aspect of the present invention there is provided a cold cathode gas-filled electric discharge tube in which the pressure of the gas-filling is regulated so that under given operating conditions of normal discharge the temperature coefficient of anode-cathode voltage is substantially zero.

Rather than to make measurements of the actual temperature coefficient involved it has been found that the difference between the anode-cathode voltage for a given cathode current immediately after switching on and after thermal equilibrium has been attained provides a sufficient measure of the temperature coefficient, although other factors may contribute towards the voltage difference obtained.

According to another aspect of the present invention, therefore, there is provided a cold cathode gas-filled electric glow discharge tube in which the pressure of the gas-filling is adjusted to a value at which there is substantially no difference between the anode-cathode voltage for a given cathode current immediately after switching on and after thermal equilibrium between the tube and its surroundings has been attained.

The invention will be more fully described with reference to the accompanying drawings which show, in Fig. 1 a particular type of tube, and in Fig. 2 a graph of the variation with pressure of the difference in maintaining voltage immediately after switching on and at a given time later.

The tube to which the drawing relates was a voltage reference tube having an anode and a cathode activated by cerium-mischmetal, the tube geometry being such that with a gas filling of 97% neon and 3% argon normal glow discharge was obtained for cathode currents up to 40 milliamperes. At a pressure of 30 mm. of mercury and ambient temperature of 20° C., the tube had a maintaining voltage of 79 volts at 40 ma. current. The temperature coefficient of maintaining voltage, however, was found to be considerable.

Experiments were made with different batches of tube, each batch being filled with the same gas and to a different pressure and at the same temperature. The maintaining voltage was measured at 40 ma. discharge current immediately after establishing glow discharge and again at the same current, after a lapse of one minute. The variation between tubes of a given batch was very small, but the differences between the two readings of maintaining voltage varied markedly between different batches and was found to lie on a curve which is reproduced in the drawing. In this graph filling gas pressure in millimeters of mercury at 20° C. is plotted against the maintaining voltage difference. It will be seen that below 25 mm. of pressure the voltage difference is very small, it becomes a negative maximum at 30 mm. pressure, becomes zero again at 34 mm. pressure goes to a positive maximum and then returns to zero at 38 mm. pressure. Subsidiary tests proved that the actual temperature coefficient of maintaining voltage followed a similar trend to that of the voltage difference plotted on the graph, and that the latter, therefore, could be taken as a sufficient measure of the variation of the temperature coefficient.

In the type of tube to which the accompanying graph relates a high degree of stability of maintaining voltage may be obtained when the filling pressure lies between 20 and 25 mm. mercury, or is adjusted to 34 mm. or to 38 mm. At the latter two points, of course the actual pressure is somewhat more critical. On the other hand, if desired, the filling pressure may be adjusted to provide some other given positive or negative temperature coefficient.

Our experiments indicate that substantially similar qualitative results to those described above may be obtained when the gas mixture varies between 94 and 99% neon, the remainder being argon and also for a neon helium argon mixture in the ratio of 80:20:1 while

analogous results are to be expected with other gas mixtures.

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:

A voltage stabilizer electric discharge tube of the cold cathode type comprising an envelope containing a gas filling of 97% neon and 3% argon at a pressure of 25±2 millimeters of mercury, an anode and a cathode activated with cerium mischmetal said anode spaced from said cathode a given distance, said distance being such that the anode-cathode maintaining voltage over a glow discharge current range of 5 ma. to 40 ma. lies between 70 and 80 volts, the variation of voltage with current being less than 7 volts.

References Cited in the file of this patent

UNITED STATES PATENTS

1,749,423	Fenton	Mar. 4, 1930
1,834,251	Moore	Dec. 1, 1931
1,965,585	Foulke	July 10, 1934
2,507,696	Depp	May 16, 1950
2,728,005	Victoreen	Dec. 20, 1955