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LOW PRESSURE GAS FILLED THERMIONIC VALVE

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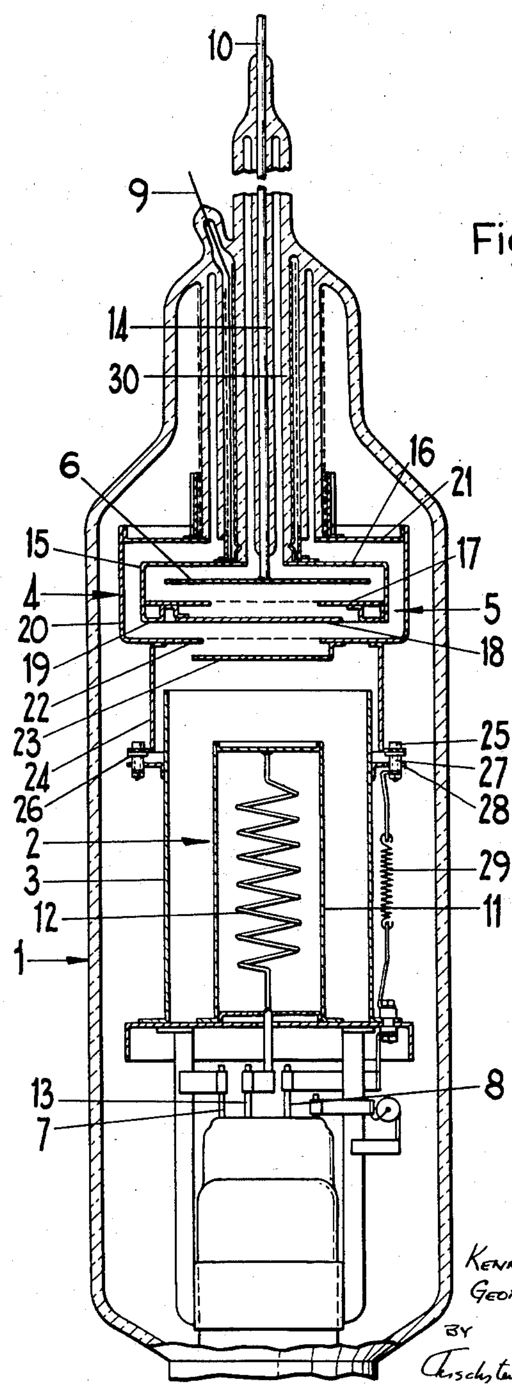

Fig. 1.

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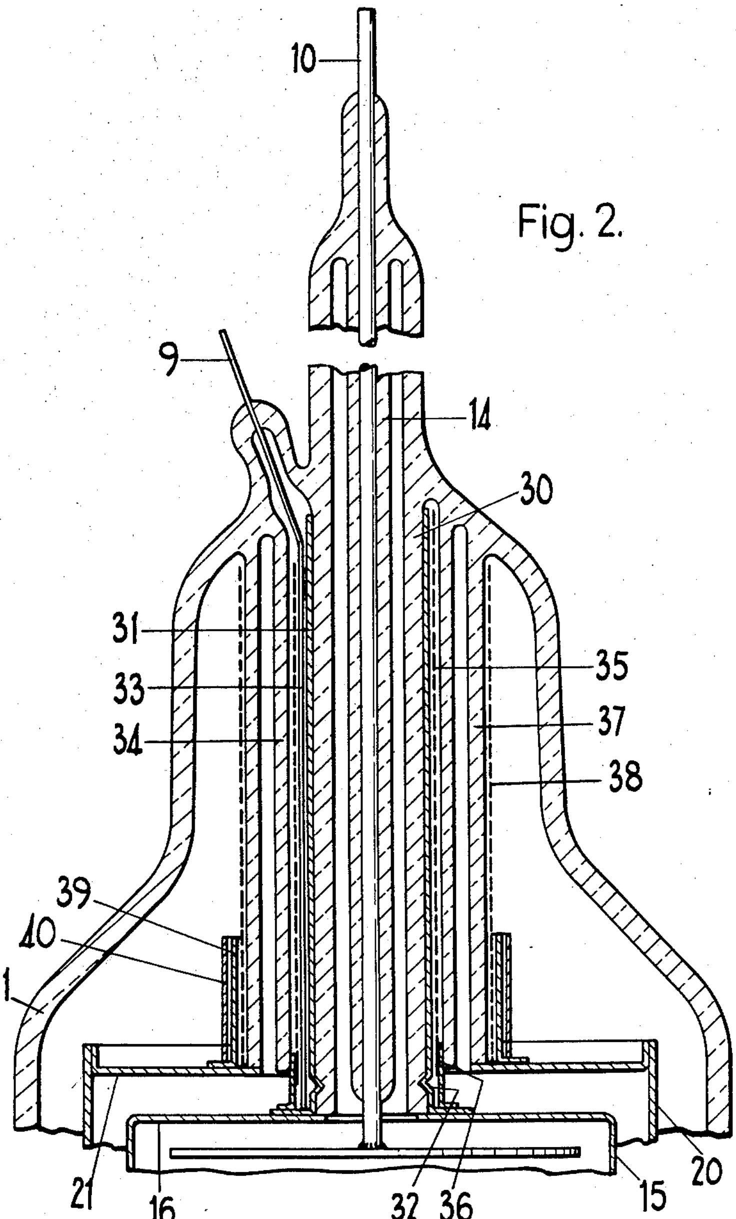

Fig. 2.

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LOW PRESSURE GAS FILLED THERMIONIC VALVE

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6 Claims. (Cl. 313—186)

This invention relates to low pressure thyratrons.

In such valves it is often desirable that the maximum hold-off voltage should be as high as possible consistent with the use of a relatively high pressure for the gas filling. By maximum hold-off voltage is meant the maximum potential difference which may be applied between the anode and cathode of the thyratron which makes the anode more positive with respect to the cathode without causing a discharge to occur. The value of the hold-off voltage is limited by the occurrence of spark breakdown between the anode and another electrode. The occurrence of this breakdown is governed by two factors, Paschen's law and electronic field emission. Paschen's law states that the voltage at which breakdown occurs between two electrodes is a function of the product M of the pressure of the gas between the electrodes and the length of the electric lines of force between the electrodes. This function passes through a minimum value at a particular value of the product M; the present invention is concerned only with thyratrons having low pressure gas fillings, that is to say, those in which discharges occur under conditions such that the value of the product M is lower than that corresponding to the minimum value of the breakdown voltage referred to above. (It is to be understood that in this specification the term "gas" includes a vapour.) It will be apparent that in such thyratrons, to obtain high hold-off voltages for a given gas pressure, the electric lines of force should be as short as possible between the electrodes between which breakdown may occur.

It is known in a thyratron to surround the anode by the control electrode, the cathode being situated outside the latter, so as to restrict effectively the length of the lines of force beween the anode and the control electrode and hence raise the maximum hold-off voltage for a given gas pressure. By reducing the electrode spacing the lines of force can be shortened, but should the spacing become too close electronic field emission will occur, independently of the value of the gas pressure, and spark breakdown will take place. The requirements of high maximum hold-off voltage and relatively high gas pressure are therefore to some extent mutually incompatible.

It is an object of this invention to provide a low pressure thyratron in which an improved balance between these two requirements may be obtained.

According to this invention there is provided a low pressure thyratron in which the anode is disposed within and surrounded by the control electrode, the cathode being situated outside the control electrode and at least one further electrode being interposed between the anode and the control electrode so as to surround the anode.

It will be understood that the extent to which the electrodes surround the anode is limited by the requirement that the discharge must pass from the cathode to the anode and by the need for leads to pass from the various electrodes out of the thyratron.

According to a feature of this invention the thyratron is associated with means whereby potentials may be applied to the anode, the further electrode or electrodes and the control electrode in such a manner that the potential or potentials of said further electrode or electrodes is or are intermediate between the potentials of the anode and control electrode, the potential differences across the consecutive discharge gaps between the anode and the control electrode being substantially equal.

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One arrangement in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a longitudinal sectional representation of a hydrogen filled thyratron; and

Figure 2 is an enlarged sectional representation of part of the thyratron.

Referring to Figure 1, the thyratron has a sealed glass envelope 1, filled with hydrogen, in which is mounted an electrode structure including a thermionic cathode generally designated 2 partially surrounded by a heat shield 3, a control electrode generally designated 4, an auxiliary anode generally designated 5, and a main anode 6, these electrodes being respectively provided with leads 7, 8, 9 and 10 sealed through the envelope 1. The cathode 2 has a cylindrical emissive portion 11 and is provided with a heater 12 having one end connected to the cathode 2 and the other end connected to a separate lead 13 sealed through the envelope 1.

The main anode 6 consists of a molybdenum disc 4.16 centimetres in diameter disposed perpendicular to the axis of the cathode 2. To the centre of the disc 6 is welded the anode lead 10, which is sheathed over the major portion of its length by a coaxial cylindrical glass sheath 14 of 4 millimetres outer diameter, the sheath 14 uniting with the envelope 1 in the region where the lead 10 is sealed through the envelope 1.

The main anode 6 is disposed within and surrounded by the auxiliary anode 5 which consists of a cylindrical nickel box 15 of internal diameter 4.86 centimetres and internal length 7 millimetres, the plane ends 16 and 17 of the box 15 being disposed parallel to the main anode 6 and each being spaced 3.3 millimetres from it. The central portion of the plane end 17 is perforated, and a disc-like baffle 18 of 31 millimetres diameter is connected to the box 15 spaced 3 millimetres from the plane end 17, the baffle 18 screening substantially completely the main anode 6 from the control electrode 4 and the cathode 2. An annular flange 19 is attached to the box 15 and forms a longitudinal extension to it, the annulus lying in the same plane as the disc 18 and being concentric with it and spaced apart from it by 5 millimetres.

Surrounding the auxiliary anode 5 is the control electrode 4 consisting of a cylindrical nickel box 20 of internal diameter 5.64 centimetres and internal length 1.82 centimetres, the boxes 15 and 20 being disposed coaxially. The plane ends 21 and 22 of the box 20 are respectively parallel to the plane ends 16 and 17 of the box 15, the plane end 21 being spaced 3.5 millimetres from the plane end 16 and the plane end 22 being spaced 3.5 millimetres from the baffle 18. The plane end 22 is perforated, and a disc like baffle 23 of 2.975 centimetres diameter is connected to the box 20 so as to be spaced 3.5 millimetres from the plane end 22, the baffle 23 screening substantially completely the control electrode 4 and the baffle 18 from the cathode 2. A cylindrical nickel sleeve 24 is attached to the plane end 22 and surrounds part of the cathode heat shield 3, the sleeve 24 being held off by means of insulating supports 26 and 27 from an annular flange 28 which is rigidly secured to the heat shield 3; the control grid lead 8 is connected to the control electrode 4 via a spring connector 29 one end of which is electrically connected to the sleeve 24 via a bolt 25 which is insulated from the flange 28.

Referring now to Figure 2 of the accompanying drawings, a circular aperture 7.5 millimetres in diameter is formed concentrically in the plane end 16 of the box 15, the main anode lead 10 passing through the centre of this aperture. A cylindrical glass sleeve 30 of inner diameter 6 millimetres and 1.9 millimetres thickness is disposed coaxial with the main anode lead 10 and unites at one end with the envelope 1, the other end being contiguous with the plane end 16. A cylindrical nickel sleeve 31 is welded at one end to the plane end 16 and closely surrounds the glass sleeve 30 extending longitudinally to the region where the glass sleeve 30 unites with the envelope 1. A circumferential ridge 32, formed in the nickel sleeve 31, fits into a corresponding groove formed in the glass sleeve 30, this arrangement serving to support the auxiliary anode 5 in the required position. A tungsten wire 33 is welded at one end to the plane end 16, extends close to the nickel sleeve 31, and is welded at the other end to the auxiliary anode lead 9.

A coaxial cylindrical glass sleeve 34, of inner diameter 1.45 centimetres and outer diameter 1.75 centimetres, units at one end with the envelope 1, the other end being coplanar with the outer surface of the plane end 21 of the box 20. A coaxial cylindrical nickel gauze sleeve 35 is contiguous with the inner surface of the glass sleeve 34 and is supported by a short cylindrical nickel sleeve 36 which is welded at one end to the plane end 16.

A circular aperture 2.05 centimetres in diameter is formed concentrically in the plane end 21 of the box 20. A coaxial cylindrical glass sleeve 37, of 2.05 centimetres inner diameter and 2.35 centimetres outer diameter, unites at one end with the envelope 1, the other end being contiguous with the plane end 21. A coaxial cylindrical nickel gauze sleeve 38 is contiguous with the outer surface of the glass sleeve 37, extending from the plane end 21 to the region where the glass sleeve 37 unites with the envelope 1. A coaxial longitudinally split cylindrical nickel sleeve 39 intimately surrounds the gauze sleeve 38 and is welded at one end to the plane end 21. A nickel clamping collar 40 surrounds the coaxial assembly and is provided with a nut and bolt (not shown) whereby the collar 40 clamps together the split sleeve 39, the gauze 38 and the glass sleeve 37, thus ensuring the correct disposition of the control electrode 4 with respect to the other electrodes.

It will be appreciated that the provision and disposition of the nickel sleeves 31, 35, 38 and 39 and the accurate dimensioning of the glass sleeves 30, 34 and 37 reduce the lengths of the lines of force between neighbouring electrodes and their leads and thus reduce the possibility of long path discharge breakdown, as well as ensuring adequate insulation of all high voltage leads and the avoidance of large gas filled cavities. It is desirable that the glass used for the sleeves 30, 34 and 37 and for the sheath 14 should have a high resistance to thermal shock and a high dielectric strength.

In operation of a thyratron of the kind described above, the anode voltage applied to the thyratron is distributed by means of a resistive potentiometer connected between the main anode 6 and the cathode 2 and having a tapping connected to the auxiliary anode 5, the control electrode 4 being maintained substantially at cathode potential. In this way, whilst the total anode voltage applied to the thyratron may be 50 kilovolts the potential difference between the main and auxiliary anodes 6 and 5 and between the auxiliary anode 5 and the control electrode 4 is only 25 kilovolts, this potential difference not being sufficient to cause breakdown with the electrode spacings described above when the thyratron is filled with hydrogen at a pressure of 0.5 millimetre of mercury.

We claim:

1. A low pressure thyratron comprising a sealed envelope having a low pressure gas filling, and an electrode system disposed within, and provided with leads sealed through, the envelope, said electrode system incorporating a control electrode, an anode disposed within and three-dimensionally surrounded by the control electrode, a cathode situated outside the control electrode, and at least one further electrode interposed between the control electrode and the anode, said further electrode being three-dimensionally surrounded by the control electrode and three-dimensionally surrounding the anode, all of said four electrodes being electrically insulated from one another.

2. A low pressure thyratron according to claim 1 wherein means is included to apply potential to the anode, to each further electrode and to the control electrode in such a manner that the potential of each further electrode is intermediate the potentials of the anode and the control electrode, the potential difference across consecutive discharge gaps between the anode and the control electrode being substantially equal.

3. A low pressure thyratron according to claim 1, in which there are provided at least one metallic and at least one non-metallic screen for each of the leads to the anode and each further electrode.

4. A low pressure thyratron according to claim 3, in which the non-metallic screens consist of glass having a high resistance to thermal shock and a high dielectric strength.

5. A low pressure thyratron according to claim 3, in which the metallic screens consist of nickel.

6. A low pressure thyratron according to claim 3, in which the gas filling is hydrogen at a pressure of the order of 0.5 millimeter of mercury and in which the spacings between consecutive electrodes from the control electrode to the anode are of the order of 3.5 millimeters.

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