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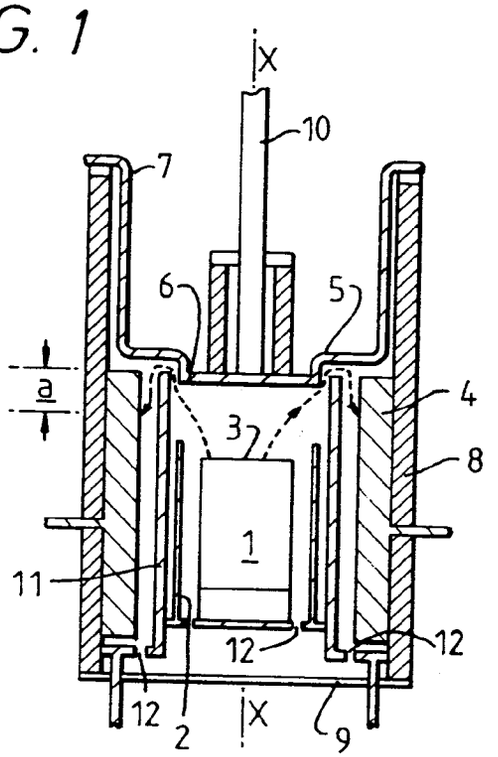
(54) Thyratrons.

(57) A thyratron includes an anode 4 arranged coaxially with a cathode 1 and a control grid 5. During conduction, a folded discharge path, represented by broken lines, is established between the anode and cathode, having overlapping part over an axial distance a. This configuration gives a low inductance device and hence reduces switching times.

FIG. 1



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This invention relates to thyratrons.

A thyratron is a device used for switching large currents. It includes a cathode and an anode with at least one control grid between them, the electrodes being contained within an envelope of ceramic or glass which also contains a gas, typically hydrogen. In use, when a voltage is applied between the anode and the cathode and hold-off is required, biasing potentials are applied to the control grid or grids to prevent gas breakdown. When it is wished to switch current through the device, the potentials on the grids are controlled so as to allow breakdown of the gas and a discharge path, which may also be termed a conduction path, is established between the cathode and the anode.

The present invention arose from an attempt to provide an improved thyratron.

According to the invention there is provided a thyratron comprising a cathode arranged coaxially with an anode about an axis having a shielding member between them and arranged such that, during conduction through the thyratron, a discharge path is established between the cathode and anode which is folded so that portions of the path overlap in the axial direction.

A thyratron which employs the invention may be capable of relatively fast switching because the folded discharge path offers a low inductance configuration. This also enables impedance matching into circuits to be optimised. The symmetrical configuration provided by a coaxial arrangement enables particularly low inductance to be achieved and also results in a compact device.

The amount of overlap may extend over only a relatively small fraction of the total discharge path but a lower inductance may be achieved when a greater overlap exists.

A thyratron in accordance with the invention may also be capable of conducting current pulses of relatively long duration. In a conventional thyratron, gas molecules tend to migrate during conduction to the anode end of the thyratron and this effect may result in quenching of current through the switch before the end of the pulse.

The folded discharge path of the present invention facilitates circulation of the gas molecules through the thyratron and thus the risk of quenching is reduced. The gas molecules follow the direction of the discharge path and, by providing apertures or other openings to allow the gas molecules to continue in that direction past the anode, they may be directed to return towards the cathode region.

It is preferred that the discharge path is folded, through an angle of approximately 180°. Thus, in the region of overlap, the direction of current is completely reversed to give low inductance, However, useful reduction of inductance may be achieved where the angle through which the discharge path is folded is less than 180°, providing that there is some overlap in the axial direction.

At large currents, a pinch effect occurs in which the magnetic field associated with current flow draws charge carriers together and thus restricts the conduction capability of the device. A folded discharge path, especially where the discharge path takes the form of a sheet conduction, tends to oppose this pinch effect, allowing larger currents to be conducted through the thyratron.

Use of the invention facilitates designs in which one or more control grids have surfaces external to the gas tight envelope or which may be readily accessed from outside the thyratron. Cooling of the grid or grids may be then implemented by flowing gas or liquid over the external surfaces.

In one embodiment of the invention, a control grid is arranged between the anode and cathode and spaced from them in a longitudinal axial direction and with a surface substantially normal to the longitudinal axis. The grid may comprise a circular disc arranged along the axis of the device and include a component surrounding the disc so that together they define an annular aperture between them. In a conventional thyratron, the first grid generally has a plurality of slots separated by webs to support the inner disc of the grid. In this embodiment of the present invention, the aperture is able to be a complete annulus around the central disc as there is no need for supporting struts. This presents a larger aperture area for a given disc size and aperture width and permits uniform conduction to be achieved through the slot without interference from other parts of the grid structure.

In one advantageous embodiment of the invention the anode may itself form part of the gas tight envelope to facilitate cooling of the anode or may have portions which extend through the envelope for cooling purposes.

The invention may be employed with other forms of thyratron. For example, a hollow anode may be used to enable current to be conducted bi-directionally or the thyratron may be double ended having two cylindrical cathodes between which an anode is located. In another type of double-ended thyratron, two electrodes are employed both of which are capable of acting as either a cathode or an anode depending on the direction of current flow through the device. Each electrode includes, say, thermionic material and is associated with a heater element for operation as a cathode and also presents a surface suitable for anode operation.

Some ways in which the invention may be performed are now described by way of example with reference to the accompanying drawings in which:

Figures 1, 2, 3, 4 and 5 schematically illustrate in longitudinal section respective different thyratrons in accordance with the invention.

With reference to Figure 1, a thyratron in accor-

dance with the invention includes a cathode 1 surrounded by a heat shield 2 and having a front, upwardly facing, surface 3 (as shown) from which electrons are emitted during operation of the thyratron. The thyratron also includes a hollow cylindrical anode 4 arranged coaxially around the cathode 1 about the longitudinal axis X-X of the thyratron. The anode 4 has a greater axial length than the cathode 1 which is co-extensive with it. A single control grid 5 comprises a disc shaped central portion 6 which faces the electron emissive surface 3 of the cathode 1 and is substantially normal to the longitudinal axis X-X. The grid 5 also has an upwardly extending wall 7 and forms part of the gas tight envelope of the device together with a cylindrical ceramic wall 8 and an end plate 9. Connection to the grid 5 is made via a lead 10. Cooling fluid is arranged to flow over the external surface of the grid 5.

A cylindrical baffle 11 is interposed in the region between the heat shield 2 and the anode 4 and is maintained at cathode potential during operation of the device.

During operation, a biasing potential is applied to the grid 5 via lead 10 such that when a voltage is applied between the cathode 1 and the anode 4, there is no gas breakdown, and hence there is no conduction through the thyratron. When the thyratron is to be triggered into conduction, a trigger pulse is applied to the grid 5 permitting breakdown of the gas and causing a discharge path to be established between the cathode 1 and the anode 4.

The configuration of the thyratron is such that the discharge path is folded through approximately 180° so as to present an overlapping portion, having an axial length a, as shown by the broken lines.

The thyratron includes apertures 12 in the cathode support as shown. During conduction gas circulates within the device following the conduction path from the cathode 1 to the anode 4 and then passes through the apertures 12 and back to the cathode region to enable conduction to be sustained for the full duration of an applied current pulse.

With reference to Figure 2, another thyratron in accordance with the invention is similar to that described with reference to Figure 1 above. However, this thyratron includes two control grids 13 and 14 to provide greater control over the conduction process, the potentials applied to the control grids being controlled in a similar manner to those of a conventional thyratron. The discharge path between the cathode 17 and anode 15 is represented by broken lines. The anode includes an extended portion 16 which is outwardly extensive in a radial direction to give an external surface over which coolant may be flowed. The connections to the anode 15 and to the cathode 17 are located relatively close together, being spaced apart by distance b. This is a low inductance arrangement which facilitating impedance matching into circuits.

With reference to Figure 3, another thyratron having a folded discharge path includes a hollow anode 18 which encloses a volume 19 of gas. During conduction through the thyratron, a plasma is built up in the volume 19. If an inverse voltage is applied momentarily across the thyratron, some reverse conduction is therefore possible reducing or eliminating damage which might otherwise be inflicted on the anode surfaces.

With reference to Figure 4, a thyratron in accordance with the invention is double ended having two cylindrical cathodes 20 and 21 between which an anode 22 is located. The thyratron is of a coaxial cylindrical configuration and the respective discharge paths established between each cathode 20 and 21 and the anode 22 both include portions which are folded back on themselves to present a low inductance device.

With reference to Figure 5, another thyratron has a coaxially arranged anode 23 and cathode 24, with a cylindrical baffle 25 between them and a control grid 26. In this device the anode 23 is located inside the hollow cathode 24 and the baffle 25 also acts as a cathode heat shield.

Claims

1. A thyratron comprising a cathode (1,17,20,21,24) arranged coaxially with an anode (4,15,18,22,23) about an axis having a shielding member (2,11,25) between them and arranged such that, during conduction through the thyratron, a discharge path is established between the cathode and anode which is folded so that portions of the path overlap in the axial direction.

2. A thyratron as claimed in claim 1 wherein the anode (4) is cylindrical and arranged outside the cathode (1).

3. A thyratron as claimed in claim 1 wherein the cathode (21, 24) is cylindrical and arranged outside the anode (22, 23).

4. A thyratron as claimed in claim 1, 2 or 3 wherein the portions of the discharge path overlap in a direction normal to an electron emitting surface of the cathode.

5. A thyratron as claimed in any preceding claim wherein the discharge path is folded through an angle of approximately 180°.

6. A thyratron as claimed in any preceding claim and including a control grid (5, 13) having a planar surface (6) which is substantially parallel to the electron emitting surface (3) of the cathode.

7. A thyratron as claimed in any preceding claim and including a control grid (5, 14) having a surface which is external to a gas tight envelope of the thyratron.

8. A thyratron as claimed in any preceding claim wherein the anode (18) encloses a volume (19) in which a plasma is retained during operation of the thyratron.

9. A thyratron as claimed in any preceding claim wherein the anode (15) has a surface (16) external to the thyratron.

10. A thyratron as claimed in any preceding claim and including a second cathode (20, 21) arranged coaxially with the anode (22), a discharge path between the second cathode and the anode being folded so as to present an overlap in the axial direction.

11. A thyratron as claimed in any preceding claim wherein a electrode support structure within the thyratron includes a electrode support structure within the thyratron includes apertures (12) for circulation of gas therethrough.

FIG. 1

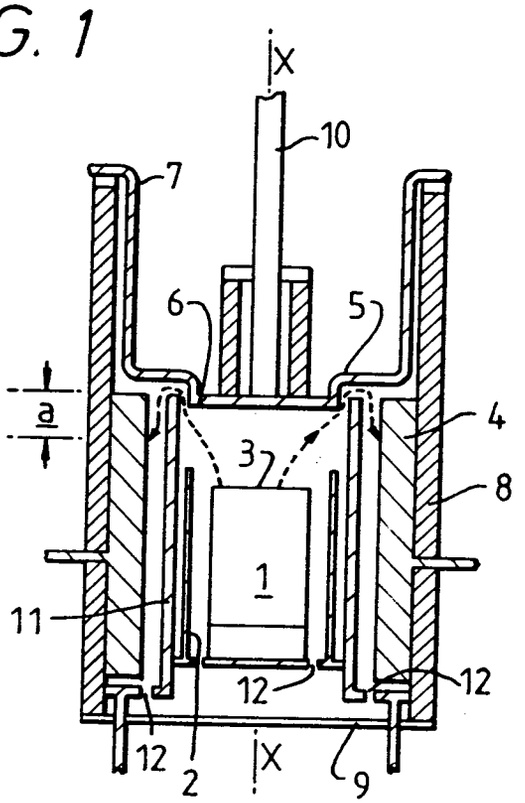


FIG. 2

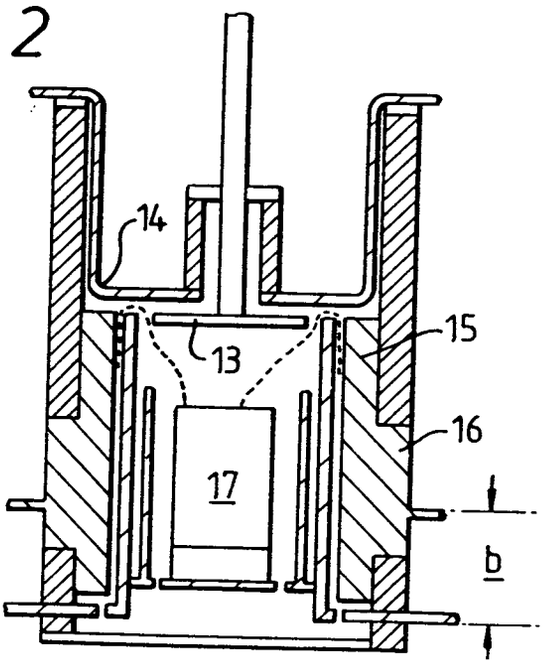


FIG. 3

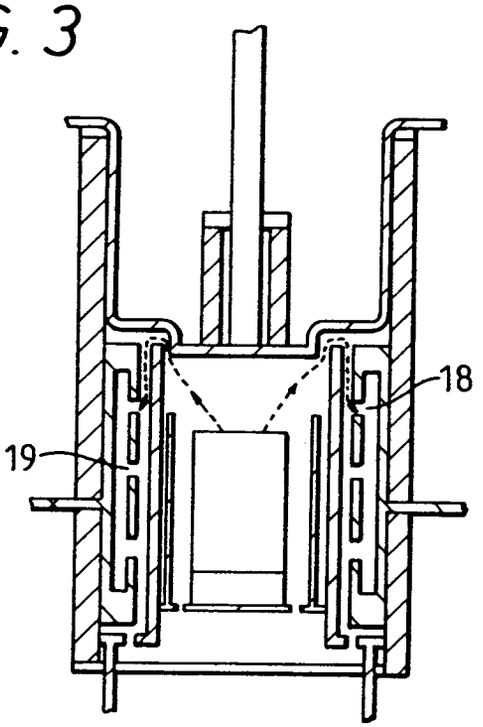


FIG. 4

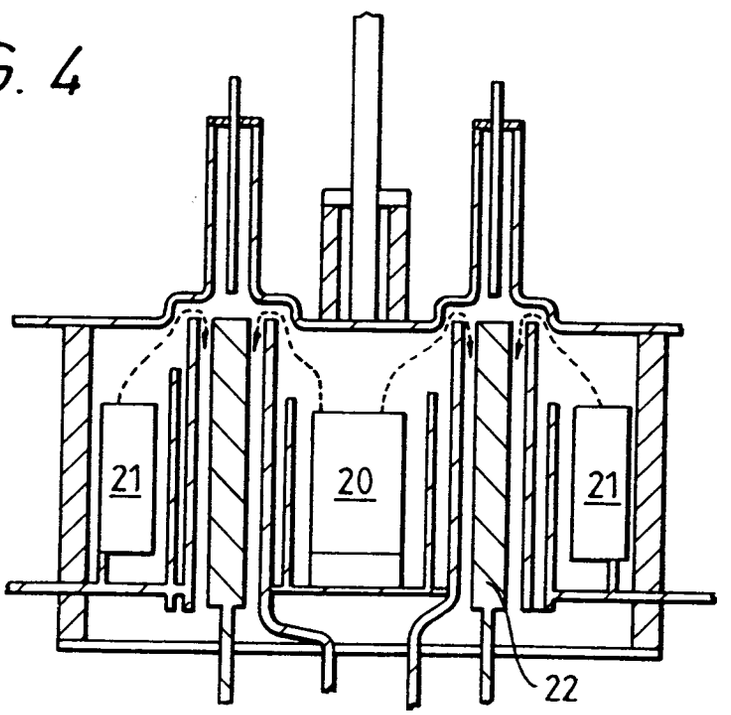
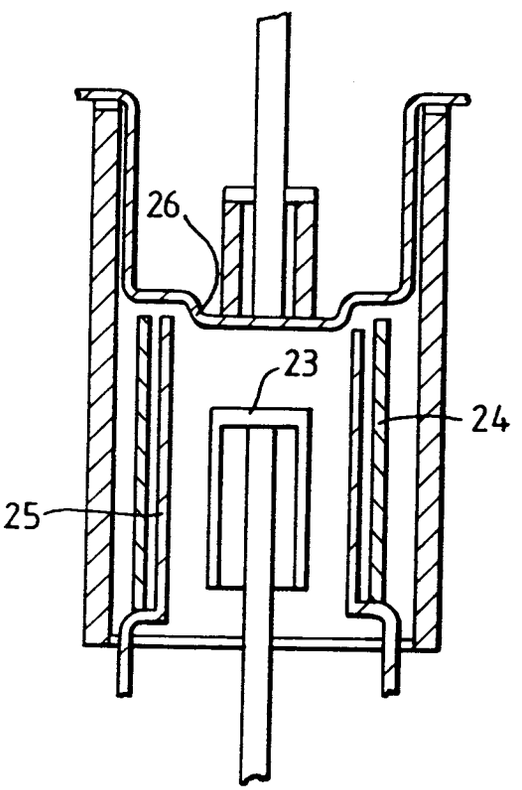


FIG. 5



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 30 7255

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 259 993 (ENGLISH ELECTRIC VALVE COMPANY LIMITED) * abstract; figures 2-4,8 * * column 3, line 15 - line 19 * * column 4, line 44 - line 50 * * column 5, line 18 - line 43 *	1-3,10	H01J17/50
A	US-A-4 668 896 (BYRON ET AL.) * column 3, line 21 - line 40; figure 3 *	1,6	
A	CANADIAN JOURNAL OF PHYSICS vol. 50, no. 12, 15 June 1972, OTTAWA CA pages 1337 - 1345 R. J. ARMSTRONG 'Some Observations on Arc Potentials in Hydrogen Thyratron Pulse Discharges' * figure 1 *	1	
A	JOURNAL OF APPLIED PHYSICS vol. 61, no. 8, 15 April 1987, NEW YORK US pages 2784 - 2794 M. J. KUSHNER 'Application of a particle simulation to modeling commutation in a linear thyratron' * figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 DECEMBER 1992	MARTIN Y VICENTE M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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