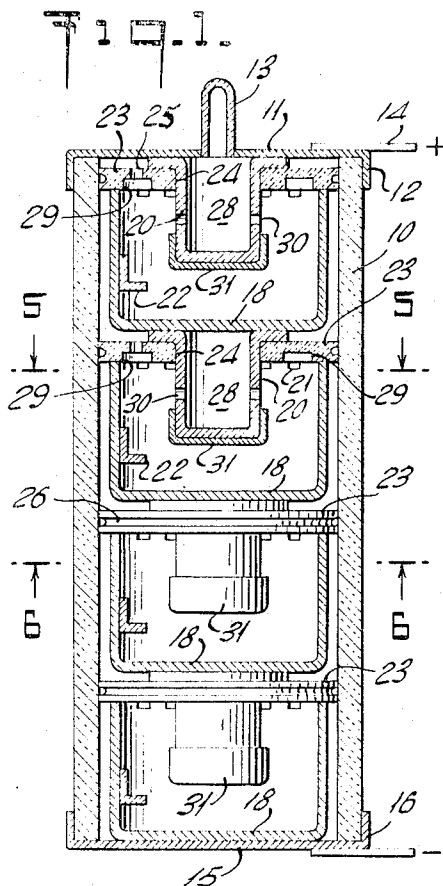
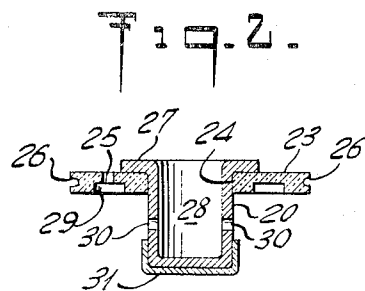
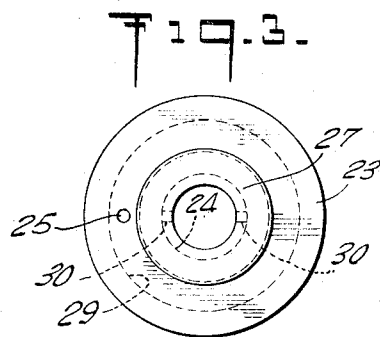
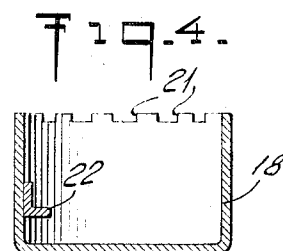
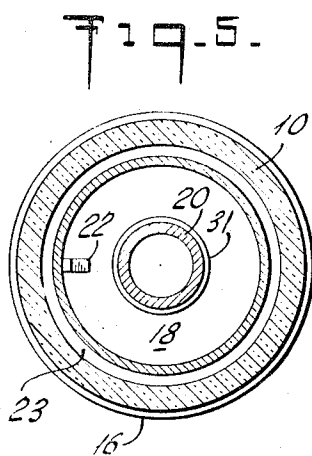
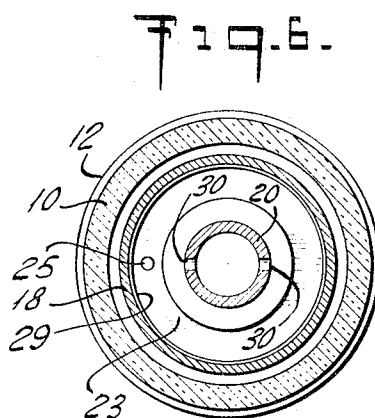


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VOLTAGE REGULATOR TUBE WITH INTEGRAL
PLURAL SERIES DISCHARGE DEVICES
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VOLTAGE REGULATOR TUBE WITH INTEGRAL PLURAL SERIES DISCHARGE DEVICES

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This invention relates to a voltage regulator tube for high voltage and comprises a plurality of electrical discharge units housed within a single envelope. The invention has particular reference to a voltage regulator gas discharge device which includes a plurality of smaller units stacked one on top of the other within a cylindrical insulating envelope. All the discharge devices have gas connecting means so that the unit may be exhausted and sealed in a single operation.

Voltage regulator tubes comprising an anode and a cathode in a rarefied gas have been employed for some time as voltage regulators in many types of circuits. In prior applications each envelope contained only a single diode discharge device and, when such devices were used in high voltage circuits, a large number of separate units were required, resulting in extensive wiring, sockets for each device, and the occupation of considerable space. The present invention stores a number of discharge devices in a single envelope and thereby can reduce the space required for the circuit and components. The collection of diodes has many other advantages. The separate discharge units are easy to fabricate and may be stacked one on top of the other without extensive welding or brazing operations. Also, a single filling of rarefied gas is all that is necessary to process such a unit. Other advantages will be described later.

One of the objects of this invention is to provide an improved high voltage regulator tube which avoids one or more of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to provide a compact structure for voltage regulator discharge units which are contained within a single sealed envelope.

Another object of the invention is to confine the sputtering of solid materials within the discharge units to portions which will not cause leakage paths between two discharge electrodes.

Another object of the invention is to provide a structure which permits cascading of a plurality of discharge devices in a nested array within a single envelope so that all the discharge devices may be exhausted, processed, and sealed in a single series of operations.

The invention includes a voltage regulator discharge device which includes a single cylindrical sealed envelope enclosing a gas at reduced pressure and a plurality of discharge devices arranged in a linear array within the envelope. Each of the discharge devices includes a cup-shaped cathode having an outside cylindrical surface which is adjacent to the inside surface of the envelope. Each discharge device also includes a cup-shaped anode positioned within the cathode in axial alignment and separated from the cathode by an insulating spacer in the form of a disc washer. The washer edge rests upon the edge of the cathode and the edge of the washer hole supports the anode.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

FIG. 1 is a cross sectional view of the discharge device taken along its axis and showing four discharge units in a single envelope.

FIG. 2 is a cross sectional view of the anode and the insulating washer.

FIG. 3 is a top view of the anode and washer shown in FIG. 2.

FIG. 4 is a cross sectional view of the cathode.

FIG. 5 is a cross sectional view of the tube shown in FIG. 1 and is taken along line 5-5 of that figure.

FIG. 6 is a cross sectional view of the tube shown in FIG. 1 and is taken along line 6-6 of that figure.

Referring now to the figures, the discharge units are housed within a cylindrical insulating tube 10 which may be of glass but is preferably made of ceramic. The insulator is sealed at the anode end by a flat terminal disc 11 having a turned-over edge 12 which is brazed to the insulator to form a gas-tight joint. At the center of the terminal disc 11 an exhaust tube 13 is positioned for connecting to a pump for the exhausting and filling operations. The tube is finally sealed by pinching off this tubulation. A terminal connecting lug 14 may be added to the terminal disc for connection to an external circuit.

The other end of the tube is sealed by a similar terminal disc 15 having a turned-over edge 16 which is brazed to the ceramic cylinder and a connecting strip 17 for connection to an external circuit.

Inside the tube are shown four discharge units, each unit including a cup-shaped cathode 18 and a smaller cup-shaped anode 20. The cathode is formed with cut-out channels 21 at its upper edge to permit the free flow of gas into or out of the cathode chamber. The cathode also contains a small bracket 22 welded to the inside surface of the cathode cup and extending a short distance into the cathode space. This is a discharge starting device and is well-known in the art.

An insulator disc 23 rests on top of the cathode cup and is formed with an axial hole 24 and a smaller hole 25 positioned at one side of the central hole for the free flow of gas from the cathode space into the space over the disc. An annular groove 29 is also formed in the lower face of the insulator disc to reduce the leakage along the surface of the insulator between the anode and cathode. This groove presents side portions which are not subject to cathode sputtering deposits.

Disc 23 is also formed with an annular groove 26 in its edge for holding brazing material prior to the sealing operation. The brazing material (generally a wire) is put into groove 26 and the internal surface of cylinder 10 is metalized adjoining the final position of the groove when all components have been assembled. The brazing operations may be done in a number of ways but it has been found convenient to first braze the stack of discharge devices together, then insert the assembly into the cylinder, put on the terminal discs and place the entire unit into a furnace and heat to brazing temperature. When this is done, the edges of all insulator discs are brazed to the inside surface of the cylinder and there is no chance for a gaseous discharge to form directly between the upper and lower terminal discs 11 and 15.

The anode cup 20 is formed with an upper flange 27 which rests on top of the insulator disc. When the components are assembled, flange 27 is clamped between the bottom of the adjoining cathode cup 18 and the top of the adjoining disc 23. The flange 27 may be brazed to the insulator disc but this is not necessary. In order to connect the inside space 28 to the other spaces within the envelope, one or two holes 30 are formed in the anode cup. At the bottom portion of the anode cup a coating 31 of radioactive material is deposited. This coating permits easier starting of the discharge and makes the starting voltage more uniform. It has been found that silver foil alloyed with americium is a dependable source of radioactivity and withstands the brazing temperatures.

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The assembly and exhausting procedures have been described above. When the device is used as a voltage regulator the action is more uniform than that of four separate discharge devices because the gas pressure within the discharge devices is the same.

From the above description it will be obvious that the present invention provides a high voltage gas discharge regulator which saves considerable space, is cheaper to manufacture, and provides improved performance. While the drawing shows only four discharge devices, it is obvious that any number may be assembled.

The foregoing disclosure and drawings are merely illustrative of the principles of this invention and are not to be interpreted in a limiting sense. The only limitations are to be determined from the scope of the appended claims.

I claim:

1. A voltage regulator discharge device comprising; a single cylindrical sealed envelope enclosing gas at reduced pressure and a plurality of discharge devices arranged in linear axial array; each of said discharge devices including a cup-shaped cathode, a cup-shaped anode positioned within the cathode in axial alignment therewith, and an insulating spacer in the form of a disc washer making contact with the edge of the cathode and supporting the anode within a central cavity; said cathode having an outside cylindrical surface positioned adjacent to the inside surface of the envelope, said insulating disc washer and said anode both having holes for the passage of gas.

2. A voltage regulator discharge device comprising; a single cylindrical sealed envelope enclosing gas at a reduced pressure and a plurality of discharge devices arranged in linear array; said cylinder terminated by metal end discs sealed to the cylinder edges and forming electrical connectors for the device; each of said discharge devices including a cup-shaped cathode, a cup-shaped anode, and an insulating spacer in the form of a disc

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washer for supporting the anode in axial alignment within the cathode; said insulating disc washer and said anode both having holes for the passage of gas.

3. A voltage regulator discharge device comprising; a single cylindrical sealed envelope enclosing an ionizable gas at a reduced pressure and a plurality of discharge devices arranged in linear axial array; each of said discharge devices including a cup-shaped cathode, a cup-shaped anode positioned within the cathode in axial alignment therewith, and an insulating spacer in the form of a disc washer making contact with the edge of the cathode and supporting the anode within a central cavity; said cathode having an outside cylindrical surface positioned adjacent to the inside surface of the envelope, said insulating disc washer and said anode both having holes for the passage of gas, said anodes each formed with a turned-over flange for supporting the anodes in the insulator cavity and for making electrical contact with the adjoining cathode.

4. A discharge device as claimed in claim 3 wherein each cathode cup is formed with edge grooves for the passage of gas.

5. A discharge device as claimed in claim 3 wherein each of said anodes is provided with a layer of radioactive material on its outside lower surface for ionizing the gas between the anode and cathode.

6. A discharge device as claimed in claim 3 wherein each of said insulator discs is formed with an annular groove which is positioned adjoining to the inside surface of the envelope, said groove being filled with brazing material for contact with said envelope surface.

7. A discharge device as claimed in claim 3 wherein the envelope is ceramic and the ends discs are brazed to the envelope ends to create a gas tight seal.

No references cited.

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