GASEOUS DISCHARGE DEVICE

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Filed Mar. 24, 1959, Ser. No. 801,556

5 Claims. (Cl. 313—36)

This invention relates to a gaseous discharge device having means for cooling two of its electrodes. It has particular reference to a supporting structure for the anode and the insulating grid which prevents sputtering on the envelope and thereby prevents inter-electrode leakage and field distortion.

The discharge device hereinafter described operates on voltages up to 50,000 volts and passes current pulses of the order of 5000 amperes. The structure involved in such a device must be carefully positioned to withstand the applied voltages and must also be arranged for heat dissipation so that the electrodes which carry the heavy currents will not be subjected to excessive temperatures.

The present invention is an improvement over the discharge devices described in Patent 2,797,348, issued to W. W. Watrous, Jr., June 25, 1957, and U.S. Patent 2,739,262, issued to the same inventor on March 20, 1956.

One of the objects of this invention is to provide an improved gaseous discharge device which avoids one or more of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to cool both the anode and the control grid by a single air stream drawn by a single exhaust blower.

Another object of the invention is to prevent metallic films from forming on the inside surface of the envelope by the sputtering action of the discharge. Such deposits cause inter-electrode leakage and voltage breakdown due to the distortion of the electric field.

Another object of the invention is to prevent buckling of the anode when heated.

Another object of the invention is to provide a structure which to a large extent is self-jigging and capable of assembly by furnace brazing techniques.

Another object of the invention is to provide a supporting structure for both the anode and the grid which permits a flange seal through the envelope thereby increasing heat radiation and providing for more current flow to the electrodes.

The invention includes a gaseous discharge device within a gas tight envelope containing an anode, a cathode, and a control grid. The anode is secured to a metal support which terminates in a flange sealed to a cylindrical insulator which forms a portion of the envelope. The control grid is mounted on another supporting structure in parallel relationship to the anode and is connected to another flange which is sealed between cylindrical insulators which form another portion of the envelope.

One of the features of the invention includes supporting means for the anode and grid which define an annular space presenting a bent passageway between the portion of the insulator envelope and the space between the anode disc and the grid, thereby preventing the sputtering of solid material onto the inside surface of the envelope. The ratio of the axial to radial spacing can be such as to prevent arcing occurrences near the envelope wall.

Another feature of the invention includes an insulating cap secured to a tubular anode terminal which is joined to the anode. The cap extends substantially parallel to a portion of the envelope and defines an annular space for the passage of cooling air which first passes over a series of fins fastened to the grid flange, then flows along a series of radial fins connected between the anode terminal and the inner surface of the anode, and then is drawn through a tubular anode terminal into an exhaust blower.

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 side view of the discharge device, with some parts in section, showing the internal details of the grid anode, and cathode structures and showing means for cooling the anode by connection air currents.

Fig. 2 is a cross sectional view of the upper part of the discharge device showing the insulating cap and the grid and anode fins which permits forced air cooling.

Fig. 3 is an enlarged cross sectional view of the grid assembly, showing how the components may be simultaneously assembled by brazing in an oven without the use of locating jigs.

Fig. 4 is a plan view of the control grid showing the radial openings.

Referring now to the figures, the discharge device includes an envelope 10 which may be made of suitable material such as ceramic or glass. The envelope is constructed in two parts and is joined by a flange 11 which is part of the supporting structure of the grid. At the lower end of the envelope a base 12 is secured, having the usual conductive pins (not shown) for connection to an external circuit.

The lower portion of the discharge device is occupied by a cylindrical cathode 13 of a type described in U.S. Patent 2,650,997, issued to W. W. Watrous, Jr. on September 1, 1953. This cathode is heated by helical resistance units (not shown) and the emissive material is deposited on the inside surface of a cylindrical support. The top portion 14 of the cathode is open for the escape of electrons and above this opening are two cathode baffles 15 and 16. Baffle 15 is secured to a cylindrical support 17 which is attached to cathode 13 by an annular flange 18. Baffle 16 is arranged in a series of three discs which are concentrically aligned with the opening in baffle 15 and prevent emissive material from moving in a straight line from any portion of the emitting surface to a grid electrode 20. The cathode baffles also reduce the amount of cathode heating energy transferred to the grid structure.

The control grid is composed of several components, one being the grid electrode 20 and another being a grid baffle 21 having an axial hole 22. Baffle 21 and the control grid 20 are generally brazed together and to the supporting cup 23 with which flange 11 is integral. Flange 11 is sealed between two portions of the envelope. The grid structure also includes a vertical cylinder portion 24 and a separate larger cylinder 25 which fits inside the envelope. Cylinders 24 and 25 may have a plurality of holes in corresponding relationship so that the discharge adjoining the anode structure 27 may be viewed exterior of the device.

The anode supporting structure includes a reentrant cylinder 28 and a flange 30, the lower portion of cylinder 28 being formed to parallel the grid structure and present a bent annular space between the discharge space below anode 27 and the inner surface of the envelope 10 which might otherwise be subjected to a metallic deposit by sputtered material from the space between the anode and grid. If sputtered or evaporated material is deposited on the envelope surface it not only causes inter-electrode leakage but also alters the electric field between
the anode and control grid and causes arcing between these electrodes.

It should be noted that the inner surface of the reentrant portion of the anode structure 30—28 is actually part of the outer surface of the envelope and for this reason the reentrant portion forms a single piece of some material, such as Kovar, which can be sealed easily to the glass cylinder 10. The single piece of Kovar insures that there will be no gas leakage past any welded joints but the Kovar material is not well suited for an anode cathode, and for this reason a disc of molybdenum 31 is bonded to the inside of the Kovar at the surface where the discharge occurs. The molybdenum has a high melting point and is well adapted to sustain a gaseous discharge with a minimum of sputtering. However, the temperature coefficient of thermal expansion of molybdenum is not the same as that of Kovar, therefore when this combination is subjected to a heating-cooling cycle, it is liable to buckle or bend and perhaps short circuit to the grid. In order to obtain the anode in its desired shape, a second disc of molybdenum 32 is bonded to the upper side of the anode and thereby presents a three ply anode structure which does not buckle or bend when heated and cooled.

In order to cool the anode and to increase its current carrying capacity, a tubular anode terminal 33 serving also as a heat conveyor is joined to the top surface of the anode assembly 27. The anode terminal is tubular in form and includes a plurality of vertical slots 34 or other apertures adjacent to the top surface of the anode. In one form of the discharge device a convection type radiator is provided consisting of a plurality of cooling fins 35 mounted beyond the upper surface of flange 30. Since the anode assembly 27 is heated to a temperature which is considerably higher than room temperature, most of the heat energy developed at the anode is conducted by the anode terminal 33 to the radiator fins 35 and dissipated to the atmosphere. Additional cooling action is realized by the chimney action since the conveyor vent rises, drawing cool air from the outside into the space adjacent to cylinder 28 and circulating this air through slots 34.

The alternate arrangement shown in Fig. 2 includes all of the internal structures shown in Fig. 1 but omits the heat radiator 35 and substitutes an insulating cup 36 which contains an axial hole 37 and is bolted to the anode terminal 33. Cup 36 extends downwardly in substantial parallel relationship to the exterior surface of envelope 10 and terminates at a position adjacent to flange 11 of the control electrode. The cup is secured to the anode terminal 33 by a flange 35e and a series of bolts. Connection to the anode source of potential is made by a conducting lug 45. An insulator tube or pipe 46 leads to an exhaust blower which pulls the air through the cooling system.

In order to increase the heat dissipation from the anode 31 and its supporting structure, a series of radial fins 29 may be brazed or otherwise joined to the top surface of the anode disc and the anode conductor 33. These cooling fins are not always necessary but they increase the cooling effect and raise the allowable current carrying capacity of the anode.

The control grid does not get as hot as the anode but, to prevent grid emission, it should also be cooled. To this end, a plurality of heat conductive fins 38 are brazed or otherwise secured to flange 11, these fins extending from the flange to the inside surface of the insulating cup 36. For ease in assembly, a circular band 39 is joined to all the fins 38 and maintains them in their correct position.

In order to maintain a flow of air past the grid and anode cooling fins and through the tubular anode terminal 33, a blower or exhaust fan (not shown) is connected to the exhaust pipe 46 and, during the operation of the device a stream of air is drawn up past the grid fins 38, downwardly past the anode cooling fins 29, and up through the anode terminal pipe 33. This flow of air cools the anode structure and permits operation at increased power output levels.

The sectional drawing shown in Fig. 3 illustrates the method of assembling the various parts that go to make up the grid structure. The main supporting structure 23 is formed of a hollow tube 24 which receives a depressed portion of the grid baffle 21. During assembly a thin washer of copper 40 is placed between support 23 and the baffle 21. The grid partition 20 fits within the cylindrical walls of the baffle 24 and, when assembled, is positioned on another washer 41 which may be of copper or other suitable alloy for brazing the components. Band 25 is also secured to cup 24 with a sliding engagement to member 23. The assembly as shown is heated in a furnace to a brazing temperature so that all four parts are permanently joined. It should be noted that no additional jig is required to maintain the parts in their correct relationship.

The plan view of the grid 20 (Fig. 4) shows how the radial slots 42 are arranged in the grid to permit the passage of electrons when the device is first fired. It is obvious that other sizes and types of openings can be used.

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 those determined from the scope of the appended claims.

I claim:

1. A gaseous discharge device comprising an envelope containing an anode, a cathode, and a control grid, said anode secured to a metal support terminal in a first flange sealed to a cylindrical insulator forming a portion of the envelope, said anode connected to a hollow cylindrical anode terminal having a plurality of openings adjacent to the anode surface for the passage of cooling fluid, said control grid mounted in parallel relationship with the anode and connected to a second flange which is sealed between cylindrical insulators forming a portion of the envelope, and a shield secured to the hollow cylindrical anode terminal and extending substantially parallel to a portion of the envelope to said second flange, said shield and said portion of the envelope defining an annular space for the passage of cooling fluid.

2. A gaseous discharge device as set forth in claim 1 wherein said second flange is secured to a plurality of heat conducting fins, said fins mounted adjacent to said annular space.

3. A gaseous discharge device as set forth in claim 1 wherein said control grid, an associated baffle plate, and the support means therefor fit within each other and thereby permit joining in a furnace without the use of auxiliary positioning jigs.

4. A control grid for a gaseous discharge device comprising a first disc having a central hole for the passage of an electrical discharge, said second disc having a plurality of radial slots also for the passage of an electrical discharge, said first disc formed with an annular ridge for receiving a supporting ring and also formed with a tubular wall for positioning said second disc.

5. A control grid as set forth in claim 4 wherein said components are joined together by brazing material.

References Cited in the file of this patent

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