

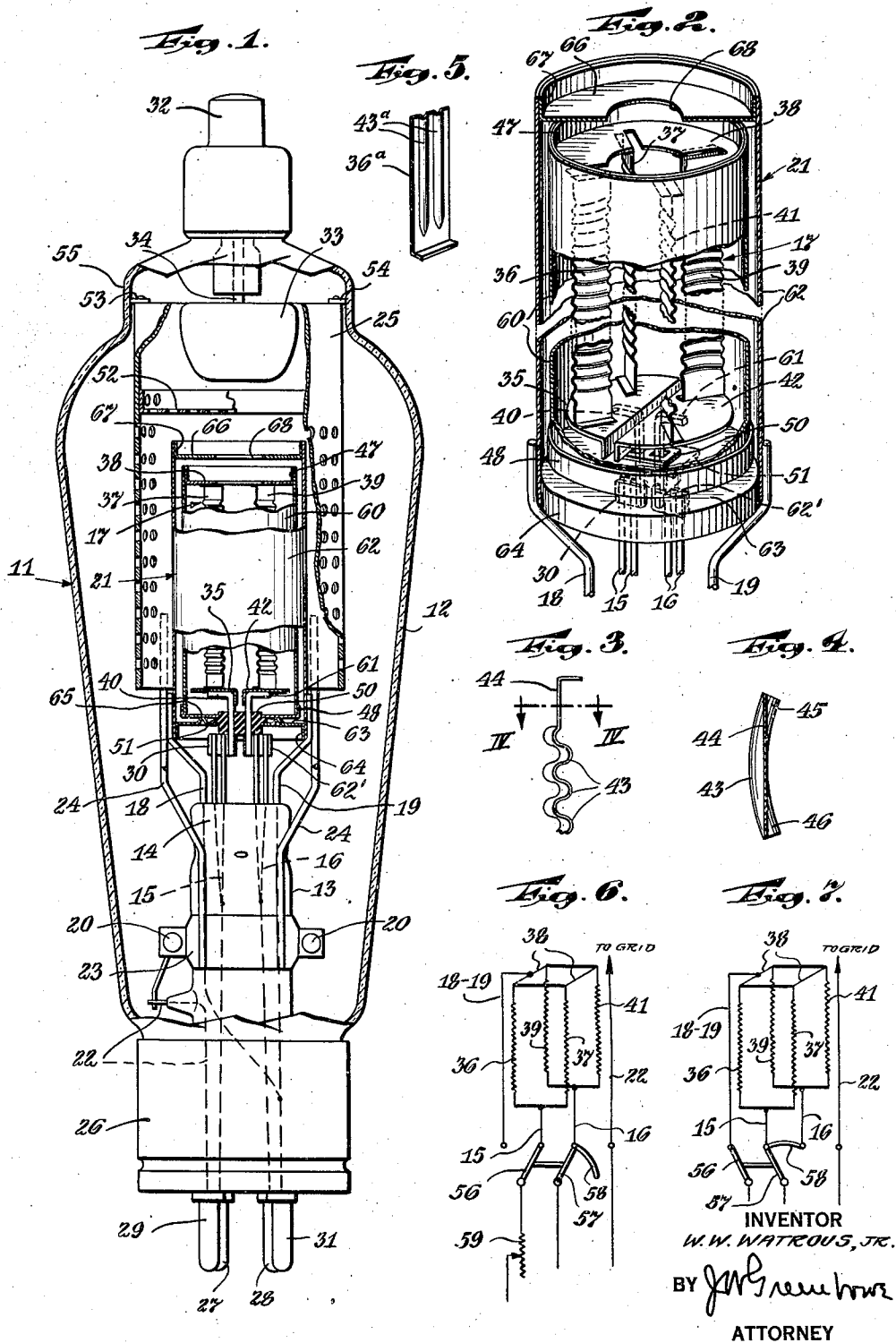
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DISCHARGE DEVICE AND CATHODE THEREFOR

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DISCHARGE DEVICE AND CATHODE
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This invention relates to cathodes, and more particularly to such for use in connection with discharge devices.

The primary object of my invention, generally considered, is to provide an improved form of directly-heated cathode for electrical discharge devices.

Another object of my invention is to provide a directly-heated type of cathode operating in a heat-shielded enclosure and so arranged that the intermediate or central portion of the cathode is presented to the anode, in order to minimize operating variations due to phase changes resulting from cathode energization by alternating current.

A further object of my invention is to provide a directly-heated cathode structure which has a very small thermal mass.

A still further object of my invention is to provide a directly-heated cathode structure which allows for high heating efficiency, and at the same time has sufficient space, in the region adjacent to the electron emissive surface, to provide a multiplicity of paths, greater than the mean free path, for ionization.

An additional object of my invention is to provide a cathode structure in which the mass thereof is low but which is nevertheless relatively rigid. Another object of my invention is to provide a cathode structure the operating voltage for which is readily changeable to predetermined values.

Other objects and advantages of the invention, relating to the particular arrangement and construction of the various parts, will become apparent as the description proceeds.

Referring to the drawing:

Fig. 1 is an elevational view, with parts broken away, of a thyatron embodying my invention.

Fig. 2 is a perspective view, on an enlarged scale, of the shield and cathode structure of the thyatron illustrated in Fig. 1.

Fig. 3 is a longitudinal sectional view of one of the corrugated cathode elements.

Fig. 4 is a transverse sectional view on the line IV—IV of Fig. 3, in the direction of the arrows.

Fig. 5 is a fragmentary perspective view of a corrugated cathode element, showing a modification.

Fig. 6 is a diagram showing how the cathode elements are connected for operation at relatively high voltage.

Fig. 7 is a diagram showing how the cathode elements are connected for operation at relatively low voltage.

Referring to the drawing in detail, like parts being designated by like reference characters, and first considering the embodiment of my invention illustrated in Figs. 1 to 4, inclusive, there is shown a thyatron 11 consisting of a vitreous or glass envelope 12, preferably containing inert gas at a desired pressure, closed at one end by a flare tube 13, having a press 14 through which pass lead-in conductors 15 and 16 (shown double) for the cathode, generally designated as 17. By making provision for the necessary insulation between the electrodes, the insulating envelope 12 may be replaced by one of metal. The press also receives supporting lead wires 18 and 19 (which unite outside of the press 14) for the cathode shield 21, shown double cylindrical in the present embodiment.

Through a side of the flare tube 13, passes a lead-in conductor 22 uniting with a collar 23 which is clamped to embrace the flare tube 13, as by means of bolts or the like 20, and from which extend supporting lead wires 24 to the grid 25. The thyatron is based as indicated at 26, said lead-in conductors 15, 16, 22 and 18—19 connecting, respectively, with contacts 27, 28, 29, and 31 of said base. The other end of the lamp is provided with a contact cap 32 to which an electrode 33, adapted to function as an anode, is connected, as by means of lead-in conductor 34.

In general, the cathode 17 consists of one or more filaments of special configuration, the present embodiment being illustrated specifically in Figs. 1, 2, 3, and 4, located radially in the interior of the heat-shielding device 21. In the form of construction illustrated in these figures, it is proposed that current flow from the lead-in conductors 15 through connector 30 and lead 40, (desirably square in section and which passes through correspondingly shaped hole in insulating bushing 50 in the bottom walls of the shield 21), to half disk 35, then divide, one-half continuing through each filament 36 and 37, across the top circular, apertured, and slotted connector disc 38, (which is outwardly flanged for connecting with and partly closing the outer or upper end of the inner heat-shielding cylinder 60) one-half also continuing through each filament 39 and 41, uniting at half disk 42, and passing out of the envelope along lead 61, desirably square in section, through corresponding hole in bushing 50, and connector 62', and out along lead-in conductors 16. It will thus be seen that the uppermost portion of the cathode structure is electrically midway between the inlet and outlet leads

and, therefore, always at an operating voltage midway between that of said leads.

Therefore, even when heating the filaments with alternating current of a relatively high potential, the cathode region around the area bordered by the top disc 38 and adjacent portions of the filaments 36, 37, 39 and 41 is always substantially unipotential, that is, it does not even vary appreciably as the phase of the heating current changes. Thus, regardless of said heating current, the field conditions at the "mouth" of the cathode, or opening 68 are constant, so that ionization sufficient to cause breakdown will occur at a uniform value of anode potential.

Low cathode mass with mechanical rigidity is obtained by employing a thin (of the order of a few mils) cathode base material of suitable composition, such as nickel, and forming it in such a way that increased area and reasonable rigidity and resistance to warping are obtained. A preferred construction is shown fragmentarily in detail in Figs. 3 and 4, and another is shown as an alternative in perspective, fragmentarily and in detail in Fig. 5, like the cathode element 36 in Fig. 2, and designated 36^a. The cathode elements when finished are, of course, coated with suitable electron-emissive material, such as the oxides of barium and strontium.

Specifically, each filament of the cathode is desirably formed with transverse corrugations 43, each of which is in turn bent, as shown most clearly in Fig. 4, as it extends from side to side, so that its intermediate portion is to one side of the plane of the flat end portions 44 of each filament, and its end portions 45 and 46 lie on the other side of said plane. This is equivalent to corrugating each filament both ways, that is, longitudinally and transversely, insofar as rigidifying the same is concerned.

It will also be understood, that although I have shown the small corrugations 43 extending between the near sides of the cathode plates, yet if desired said corrugations 43^a may extend between the far sides, or longitudinally rather than transversely of each plate, in this case desirably terminating short of the ends, as shown in Fig. 5, so as to leave flat end portions for attachment to the members 35, 38 and 42, which attachment may be effected by welding or soldering, as in the first embodiment.

The intermediate attaching member 38 is secured to the upper or outer end portion of the inner hollow cylinder 60, as by welding or soldering a peripheral flange 47 to the upper edge portion thereof (Figs. 1 and 2). The lower edge of said cylinder 60 is desirably connected in a similar manner to a closure member 48, spaced from the lower wall of the outer heat-shielding hollow cylinder 62 by the peripheral flange 51 of the insulating bushing 50 through which the leads 40 and 61 pass.

The hollow outer cylinder 62, of heat-shielding device 21, encloses the hollow inner cylinder 60, as illustrated most clearly in Figs. 1 and 2, with just a convenient gas space therebetween. It is directly connected to end support by the leads 18 and 19, which are soldered or otherwise suitably connected thereto, and closed at its lower end by bottom plate 63, provided with an outer peripheral flange 64 soldered or otherwise suitably connected to its lower edge portion. The plate 63 serves to support the insulating bushing 50 and the inner cylinder 60, as by dimples or upwardly extending corrugated portions 65, desirably spot welded or otherwise metallicly con-

nected to the lower surface of the closure plate 48 of said cylinder 60, thereby making a good electrical connection therewith.

The upper end of the outer cylinder 62 is partly closed by circular plate 66 provided with outstanding peripheral flange 67 soldered or otherwise suitably secured to the outer edge portion of said cylinder. The plate 66 may be provided with a central circular aperture 68, or cathode "mouth" corresponding in size with the central aperture in the plate 38, to allow for the escape of electrons. All parts of the shielding cylinders, including the circular end closure plates, are desirably formed of polished nickel, or other similar metal, for conserving the heat radiated by the cathode elements during operation of the device.

The grid 25 is formed generally as a hollow cylinder carrying a transverse foraminous wall 52 which functions as the grid proper with respect to the anode 33. The upper end of the grid 25 is braced by connected tab members 53 and 54 which are adjusted so to snugly fit within the dome or constricted portion 55 of the envelopes 12. The grid 25 is desirably formed of sheet metal, nickel for example, provided with a coating of carbon or other material which is low in electron emissivity and high in heat-radiating power. Although the cylindrical portion of the grid 25 is also shown foraminous, it will be understood that this is not necessary as the grid cylinder is equally efficacious when unperforated.

The wiring diagram for the arrangement shown in Figs. 1 and 2 is illustrated in Fig. 6. That is, when it is desired to operate the cathode at a relatively high voltage, current passes through a switch member 56, leads 15 (connector 30, lead 40, shown in Figs. 1 and 2), dividing to pass through cathode elements 36 and 37, then after passing through the top connection 38, continuing through cathode elements 39 and 41, and returning through (lead 61, connector 62', shown in Figs. 1 and 2) leads 16, and switch element 57.

If it is desired to operate the cathode at half voltage, it is only necessary to tie the leads 15 and 16 together, as indicated by switch member 58, and pass current between this juncture, as one terminal, and the shield member 21, which is electrically connected through the top disk 38, as the other terminal. The current will then double but the power input remains the same. This connection is illustrated in Fig. 7, the current passing through switch element 56 and leads 18 and 19 to the top disk 38, dividing through the four filaments 36, 37, 39 and 41, and finally passing out through return leads 15 and 16 and switch element. In order to use voltages different from the normal voltage which should be applied to the cathode filaments, in accordance with Fig. 6, or the half voltage of Fig. 7, a rheostat 59 (which may be cut out entirely when the supply voltage is correct for the filaments) may be employed in series with the cathode supply, if desired.

The operating voltage can be determined when the tube is being manufactured, thus offering devices with cathodes of two potentials, while using similar cathode parts, or the leads can be brought out from the tube as separate connections and the filament potential selected by the user. With the parallel connection, it will be noted that the equipotential (or intermediate) cathode surfaces are not presented to the anode, (which may be designated as the "random-phasing" advantage) so one advantage of the connection, illustrated in Fig. 6, disappears. How-

ever, in such instance the voltage being only half, the effect of cathode potential phasing is minimized.

From a consideration of the foregoing, it will be seen that although both faces of each cathode section are heat shielded, they are readily accessible to emit electrons. This avoids some difficulties previously encountered due to heat shielding because of space charge effects and the inability of the field from the anode to act upon all parts of the cathode surface.

It will also be seen that I have devised a discharge device and cathode therefor in which the cathode is directly heated, and its effective potential, as compared with the anode is independent of the supply potential phasing. I have likewise provided a cathode with elements of small thermal mass, rigid, and adjustable to one or another voltage, the lead sections which connect directly to the lower plates thereof being desirably non-circular or square, so that they not only tend to maintain their desired positions in the receiving insulator, but present flat upper surfaces for accurate connection with said plates.

Although preferred embodiments of my invention have been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

I claim:

1. An electrode for a discharge device comprising a strip of metal connected for direct heating to electron-emitting temperature by the passage of electric current therethrough, and formed with a rigidifying corrugation extending longitudinally between the pair of remote opposite edges thereof.

2. An electrode for a discharge device comprising a strip of metal connected for direct heating to electron-emitting temperature by the passage of electric current therethrough, and formed with a longitudinally extending corrugation.

3. An electrode for a discharge device comprising a generally straight corrugated strip of metal connected for direct heating to an electron-emitting temperature by the passage of electric current therethrough, and with its corrugations curved as viewed in a transverse section of said strip.

4. An electrode for a discharge device comprising a generally flat strip of metal connected for direct heating to an electron-emitting temperature by the passage of electric current therethrough, and formed with corrugations extending from side to side and curved as viewed in a transverse section of said strip.

5. An electrode comprising a generally flat strip of metal connected for direct heating to an electron-emitting temperature by the passage of electric current therethrough, and formed with corrugations extending at an angle to one another.

6. An electrode for a discharge device comprising a heat-conserving enclosing shield, and a strip of electron-emissive material formed with corrugations, extending parallel to the axis of said shield, and connected for direct heating by the passage of electric current therethrough.

7. An electrode for a discharge device comprising a double heat-conserving enclosing shield of bright metal, and a strip of electron-emissive material formed with corrugations, extending parallel to the axis of said shield, and connected for direct heating by the passage of electric current therethrough.

8. An electrode for a discharge device comprising

ing a plurality of corrugated strips of metal extending in generally the same direction as the axis of said device, means extending transversely of said device and connecting the inner ends of said strips, and means connecting the outer ends of said strips to a source of electric power for energizing said strips to electron-emitting temperature by passage of electric current therethrough.

9. An electrode for a discharge device comprising a heat shield, an insulator mounted in a bottom aperture thereof, a plurality of strips of metal enclosed in said shield and extending in generally the same direction as the axis of said device, means extending transversely of said device and connecting the inner ends of said strips, and means connecting the outer ends of said strips to a source of electric power for energizing said strips to electron-emitting temperature, said means including transversely extending plates, and lead sections square in section, connected to said plates, and passing through corresponding apertures in said insulator.

10. An electrode for a discharge device comprising a generally cylindrical shield disposed axially of an enclosing envelope, a plurality of shield-enclosed corrugated strips of metal extending in generally the same direction as the axis of said shield, means extending transversely of said shield and connecting the inner ends of said strips, and means connecting the outer ends of said strips to a source of electric power for energizing said strips to electron-emitting temperature by passage of electric current therethrough.

11. An electrode for a discharge device comprising a plurality of corrugated strips of metal extending in generally the same direction as the axis of said device, means extending transversely of said device and connecting the inner ends of said strips, and means connecting said transversely extending means and the outer ends of said strips to a source of electric power for energizing said strips to electron-emitting temperature by passage of electric current therethrough.

12. An electrode for a discharge device comprising a generally cylindrical shield disposed axially of an enclosing envelope, a plurality of corrugated strips of metal extending in generally the same direction as the axis of said shield, means extending transversely of said shield and connecting the inner ends of said strips, and means connecting said transversely extending means and the outer ends of said strips to a source of electric power for energizing said strips to electron-emitting temperature by passage of electric current therethrough.

13. A discharge device comprising a vitreous envelope, a flare closing one end of said envelope, a grid supported from said flare and with its other end braced with respect to the opposite end of said envelope, an anode passing through said opposite end for cooperating with said grid, a cathode device disposed within said grid and comprising a corrugated strip of metal, and a heat shield surrounding said strip and enclosed in said grid.

14. An electrode comprising a strip of metal connected for direct heating to an electron-emitting temperature by the passage of electric current therethrough, and curved to cylindrical form about a longitudinally disposed axis and provided with corrugations transverse to said axis.

15. An electrode comprising a strip of metal

connected for direct heating to an electron-emitting temperature by the passage of electric current therethrough, and corrugated longitudinally and transversely.

16. An electrode for a discharge device comprising a plurality of corrugated strips of metal extending in generally the same direction as the axis of said device, means extending transversely to said axis and connecting the inner ends of said strips, a lead extending to each of the outer ends of said strips, and a lead united to the connection between the inner ends of said strips, whereby said electrode may be energized by passing current from one of the first two mentioned leads to the other, or between said first two leads and the third lead.

17. A discharge device comprising a vitreous

envelope, a flare closing one end thereof, a grid supported from said flare and with its other end braced with respect to the opposite end of said envelope, an anode supported on means passing through said opposite end for cooperating with said grid, and a cathode device disposed within said grid and comprising a plurality of strips of metal extending longitudinally from said flare with their remote ends connected, and a pair of leads passing through said flare and respectively connected to the adjacent ends of said strips, and a third lead also passing through said flare and united to said remote ends connection, whereby said cathode is adapted for operation on either of two voltages.

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