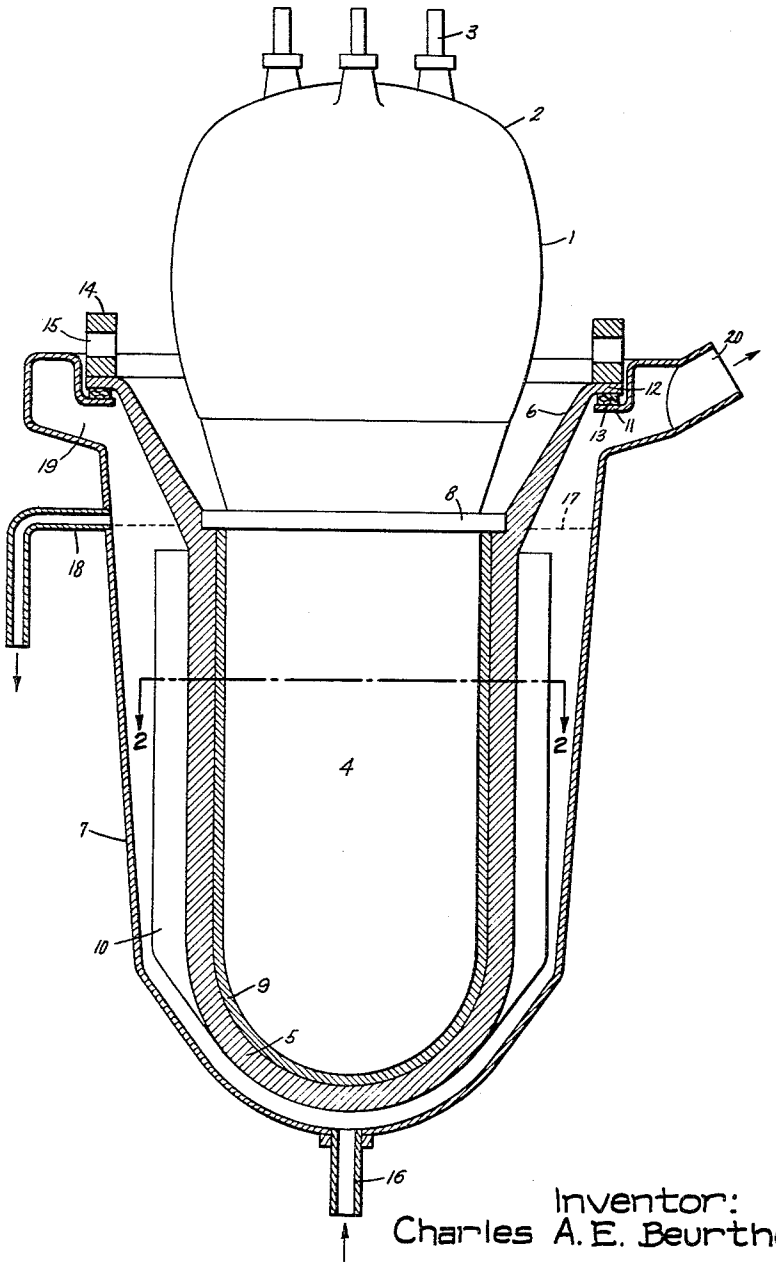
May 3, 1960 C. A. E. BEURTHERET 2,935,305

ELECTRIC DISCHARGE DEVICE COOLING SYSTEM

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Fig. 1.



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ELECTRIC DISCHARGE DEVICE COOLING SYSTEM

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Fig. 2.

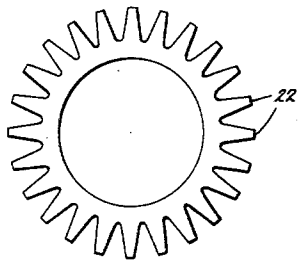


Fig. 4.

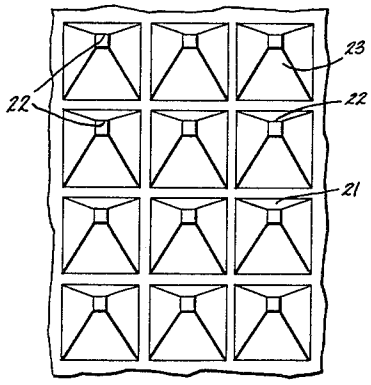


Fig. 3.

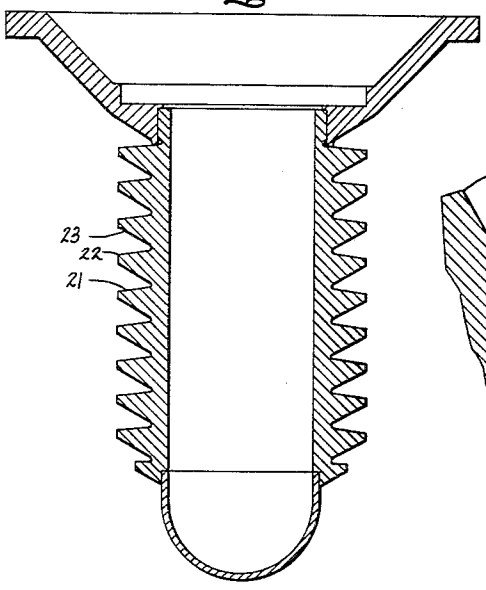
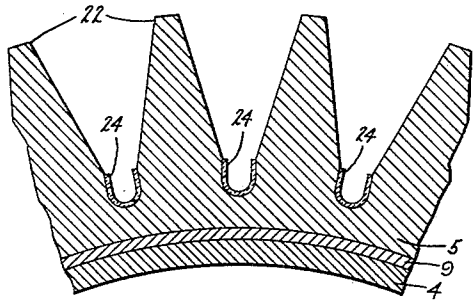


Fig. 5.



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ELECTRIC DISCHARGE DEVICE COOLING SYSTEM

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Fig. 6.

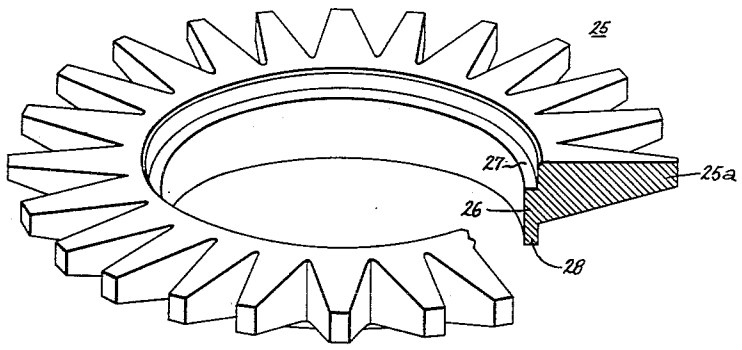


Fig. 7.

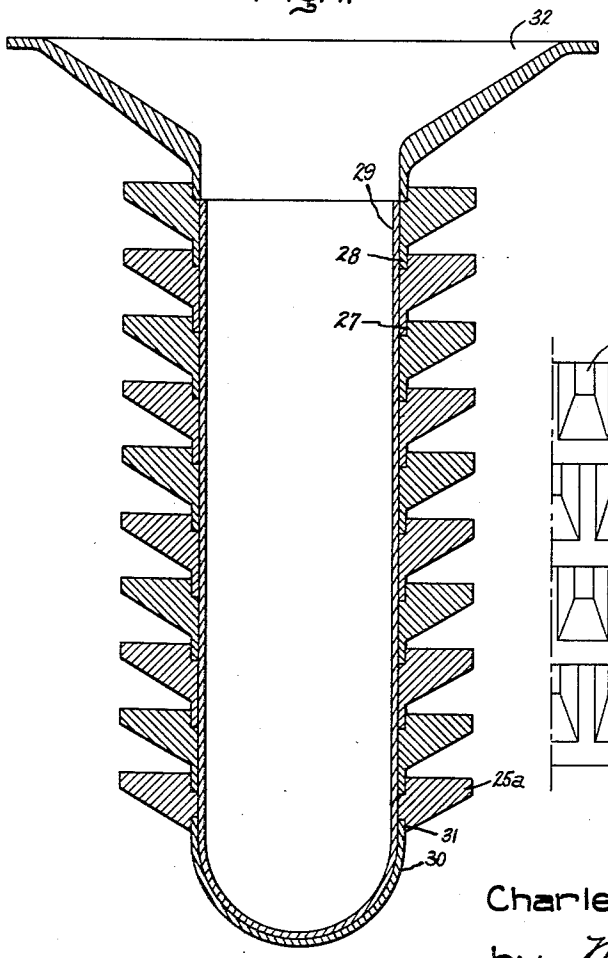
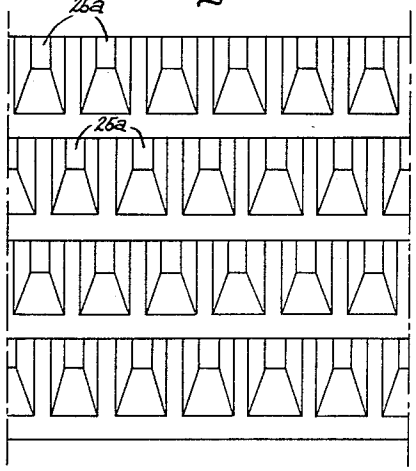


Fig. 8.



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Fig. 9.

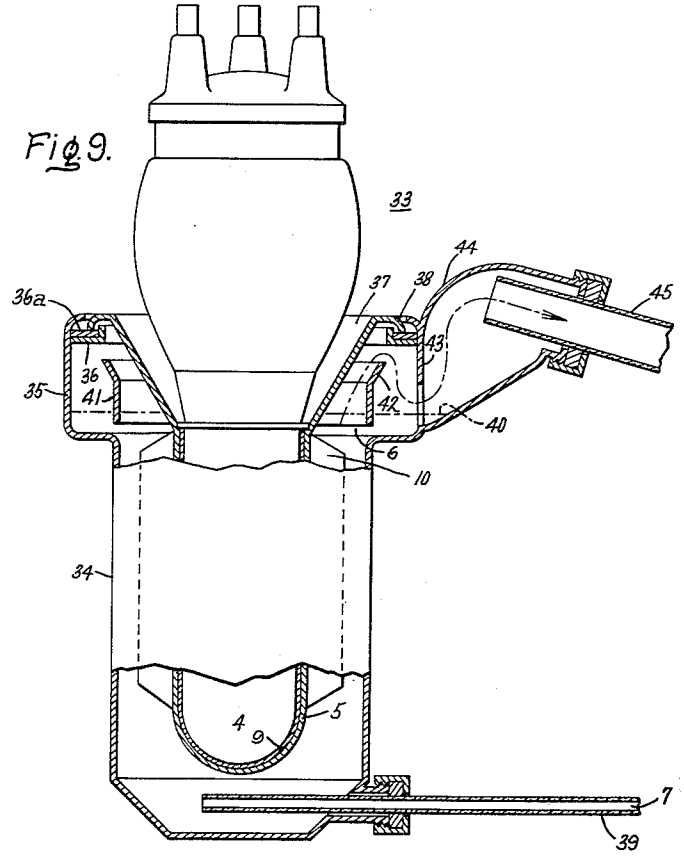
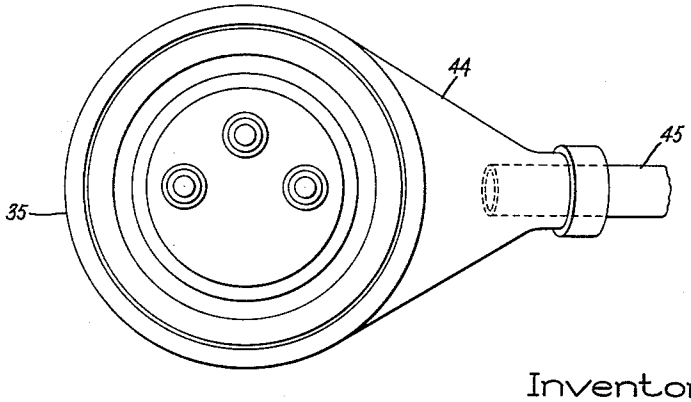


Fig. 10.



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United States Patent Office

2,935,305

Patented May 3, 1960

2,935,305

ELECTRIC DISCHARGE DEVICE COOLING SYSTEM

Charles A. E. Beurtheret, Paris, France, assignor to General Electric Company, a corporation of New York

Application June 18, 1951, Serial No. 232,188

Claims priority, application France July 7, 1950

3 Claims. (Cl. 257—250)

The present invention relates to improved electric discharge device cooling with particular reference to the design of the exterior or heat-transfer surface of the anode, forming part of the tube envelope, and a surrounding jacket therefor. The present invention relates particularly to systems of the type utilizing the latent heat of vaporization of the cooling liquid in their operation.

In the fluid cooling systems for electric discharge devices employed commercially prior to my invention, the cooling fluid, which is usually water, is circulated over the exterior surface of the anode and is confined by a suitable water jacket. It has been common practice to utilize pumps of sufficient capacity to provide a relatively high velocity of the cooling water and thereby to avoid any possibility of the formation of steam pockets or thin layers of vapor over the anode surface which tend to remain stationary and cause localized overheating and sometime destruction of the anode. In accordance with an important aspect of my invention, the exterior surface of the anode and the surrounding jacket are designed to promote the continual movement or bubbling away of the steam produced on the anode surface and the amount of liquid provided is such that the actual production of steam is contemplated in the operation of the device thus making use of the large heat absorbing capacity due to the large latent heat of vaporization of the cooling water. While it has been suggested that the latent heat of vaporization be employed for cooling electric discharge devices, there have been prior to my invention no commercially acceptable designs for the electric discharge device itself including the anode and the cooperating jacket to form an evaporator which results in satisfactory cooling without destruction of the device. In accordance with another important aspect of my invention, the region in which the steam or vapor is formed is controlled by the use of heat insulation of selected portions of the anode in order to provide for a better distribution of the cooling liquid and a better liberation of the steam after the heat transfer progresses.

Further objects and advantages of my invention will become apparent as the following description proceeds, reference being had to the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is an elevational view of an electric discharge device including the surrounding jacket for the external anode embodying my invention; Fig. 2 is a sectional view taken along the lines 2—2 of Fig. 1 showing a cross section of the anode; Fig. 3 is an elevational view in section showing a modified form of the external surface of the anode; Fig. 4 is a development of the surface of a portion of the modification shown in Fig. 3; Fig. 5 is a modification of the anode construction shown in Figs. 1 and 2 showing the use of insulating material for controlling the heat transfer characteristic of the anode surface; Fig. 6 is a perspective view partially in section of a single annular element from which the cooling structure for an anode of my invention may be assembled; Fig. 7 shows an anode cooling assembly made up of a plurality of the members shown in Fig. 6; Fig. 8 is a development of a part of the surface of the anode shown in Fig. 7; Fig. 9 is an elevational view in section of a modified form of cooling jacket; and Fig. 10 is a plan view of the tube and jacket shown in Fig. 9.

Referring now to Fig. 1 of the drawing, I have shown my invention embodied in an electric discharge device which is, in general, of known construction and comprises an envelope made up of a glass bulb portion 1, a header portion 2 through which the terminals 3 for the filament and grid are sealed. The envelope is completed by a cylindrical anode 4 sealed to the other end of the bulb portion 1. In accordance with usual practice this anode may be formed of copper which is not only a good conductor of electricity but also a metal having good heat transfer characteristics. The external heat transfer surface or radiator for the anode is provided by a structure which is formed separately but which for heat transfer purposes is an integral part of the anode. This radiator includes a generally cylindrical member 5 having an internal shape conforming generally to the external surface of the anode 4 and provided at its upper end with an outwardly flared portion 6 which cooperates with the surrounding cooling jacket 7 to provide a support for the discharge device. As illustrated, the radiator member 5 cooperates with a flange 8 formed on the anode and the space 9 between the anode and the radiator is filled with a low melting point solder to, in effect, render the radiator and the exterior surface of the anode an integral unit as far as heat transfer is concerned. On the exterior surface of the radiator cylinder 5 are provided a plurality of longitudinally extending relatively massive ribs or fins 10 of tapered cross section.

As illustrated, the upper end of the jacket is provided with a suitable opening for receiving the electric discharge device and this opening is surrounded by an inwardly directed flange 11 on which a cooperating outwardly directed flange 12 at the upper end of the flared portion 6 of the radiator rests. A suitable gasket 13 is interposed between the flanges 11 and 12. As will be readily understood by those skilled in the art, suitable quick-detachable clamping means may be provided for clamping the tube and radiator within the jacket, if desired. If the system operates at only slight pressure, the weight of the discharge device and radiator may be sufficient to effect the desired seal at the gasket 13.

Also to facilitate removal of the discharge device and radiator, suitable lugs 14 are provided on the flange 12 and these lugs are provided with openings 15 for the reception of suitable lifting hooks or handles (not shown). Water is supplied to the outer jacket 7 by a suitable inlet conduit 16. Inasmuch as in the system employed by applicant and utilizing the heat of vaporization of the fluid for cooling it is not necessary that the water be circulated. For this reason, the supply line is for the purpose of supplying sufficient liquid to maintain the desired level which in the particular embodiment illustrated is designated by numeral 17. This level may be maintained in any desirable way and in the particular embodiment illustrated an overflow pipe 18 is provided for this purpose.

Steam produced during operation of an electric discharge device bubbles upwardly in the space between the radiator and the outer jacket and particularly in the channels or flues provided between the ribs 10 and between the ends of the ribs and the jacket 7 and collects in the enlarged upper portion or header 19 of the jacket 7. The steam is led from the header 19 through an opening 20 which as will be readily understood may be connected to a suitable condensing apparatus (not shown).

It is an important aspect of the present invention that

the fins are designed to assist in the movement of any steam that is formed upwardly from the radiator to the header at the top of the jacket and prevent the accumulation of vapor pockets on the hot surface of the anode. As shown in Fig. 2, the fins are of relatively heavy cross section at the surface of the anode and taper outwardly. The movement of the steam bubbles upwardly may be still further facilitated by machining the radiator or outer anode surface as illustrated in Fig. 3 to provide a plurality of upwardly sloping surfaces. The projections thus formed increase the turbulence produced and provide a considerable heat transfer area. As a result there are no pockets or ledges under which this vapor is apt to accumulate with resulting production of localized heating of the anode. As illustrated, the annular grooves **21** through the ribs provide a plurality of projections **22** having upwardly sloping surfaces **23** on their lower edges. It will be understood that the construction shown in Fig. 3 is either soldered to the anode as described in connection with Fig. 1 or may be formed integrally as a part of the anode as desired.

In Fig. 4 is shown a development of a portion of the surface of an anode constructed in accordance with the modification of Fig. 3. As will be seen from this figure, the lower surfaces **23** of the projections slope upwardly to a marked degree and the upper surfaces of the projections may also slope downwardly a little if desired. While in the particular embodiment illustrated in Fig. 4 the projections in vertically adjacent rows are in alignment, it will be apparent that they may be staggered, if desired, to increase the turbulence produced by the release of the steam bubbles produced on the surfaces of the projections.

In Fig. 5 I have shown a modification of my invention which is in general similar to that shown in Fig. 1 and corresponding parts have been designated by the same reference numerals. In the modification shown in Fig. 5, the area at the base of the fins is provided with an insulating lining **24** to slow up the heat transfer in this region and thus insure that the cooling liquid remains in a liquid state in this area limiting the formation of steam to the surfaces of the ribs removed from the outer anode or radiator surface. The release of the steam formed from the surface of the ribs is readily accomplished and the operation of the device is characterized by the uniform cooling of the anode surface.

In Figs. 6, 7 and 8 I have illustrated a modification of my invention in accordance with which the exterior surface of the anode or the radiator, as the case may be, is assembled from a plurality of similar rings **25** which are machined to form inner collars **26** provided at the upper edge thereof with a recess **27** and at the lower edge thereof with a projecting flange **28** which may be received in the corresponding recess **27** of an adjacent ring. Each of the rings is machined to provide a plurality of radial projections **25***a* of triangular or trapezoidal cross section in a plane extending through the axis of the circular ring. In Fig. 7 I have shown a radiator made up of a plurality of these rings **25** and assembled on a cylindrical tube **29** which may be the anode proper or if desired it may be a separate supporting cylinder which is soldered to the anode as illustrated in Fig. 1. A suitable end cap **30** is provided at the lower end and fits within a recess **31** which is formed on the lower ring of the assembly in place of the flange **28**. A flared supporting flange **32** may be joined to the upper end of the assembly to render the radiator assembly in general similar to that shown in connection with Fig. 1. A development of the anode surface formed in this manner is shown in Fig. 8 in which the teeth of adjacent rings are circumferentially displaced to increase the turbulence caused by the release of steam bubbles.

In Figs. 9 and 10 I have shown a modified form of radiator which may be used with any of the anode constructions previously described for the purposes of carrying out my invention. The radiator is in general similar to that shown in Fig. 1 except that in Figs. 9 and 10 the electric discharge device **33** and cooling radiator is shown in outline only. The cooling jacket is in the form of a cylinder **34** having an enlarged cylindrical or header portion **35** at its upper end provided with an inwardly directed flange **36** for the reception of the sealing gasket **36***a*. The outwardly and upwardly flared portion of the radiator **37** is provided with a downwardly directed flange **38** which rests upon the gasket to seal the electric discharge device to the surrounding jacket. As previously indicated, these parts may be held together by suitable quick-detachable clamping means (not shown) if desired. The inlet for the cooling liquid is provided by a pipe of insulating material **39** extending through a stuffing box in the lower end of the jacket **34**. As illustrated, the pipe extends a substantial distance beyond the inner wall of the jacket to provide the required insulating path in the liquid and at the same time minimizing the length of the pipe exterior of the jacket.

At the upper end of the jacket and above the normal level of the liquid illustrated, for example, at **40**, is provided a circular baffle **41** with an outwardly directed flange **42** corresponding generally to the slope of the mounting flange of the radiator. This baffle, together with a downwardly projecting baffle **43** at the outlet, assists in separating the entrained liquid from the steam which rises from the surface of the water. The outlet **44** as shown is of large cross-section and tapers to a circular cross-section which receives an insulating outlet conduit **45**.

In the preceding description various constructions for carrying out my invention have been described. It is a characteristic of the constructions employed that they provide for a natural agitation of the liquid and movement of the vapor formed to the upper surface so that no localized heating and dangerously hot spots result, thus rendering it possible to utilize the anode of the tube, its radiator and its surrounding jacket essentially as an evaporator without any damage to the tube itself. The amount of liquid required, where the liquid is water, as compared to conventional cooling systems is in the order of $\frac{1}{20}$ to $\frac{1}{50}$. In a station employing a large number of transmitting tubes, this factor alone is a large item. If processed water is used and recirculated, there is a large volume of water required and the power required for circulating it is substantial. In some locations tap water is circulated through the tube and not recirculated and in these cases the conservation of water alone amounts to a large saving.

While for the most part water has been referred to as the cooling liquid, it is obvious that other liquids having acceptable temperatures of vaporization may be employed.

While I have illustrated and described a number of modifications as illustrating my invention, it will be apparent to those skilled in the art that further changes and modifications may be made without departing from my invention in its broader aspects, and I aim, therefore, in the appended claims to cover all such changes and modifications as may fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Cooling means for cooling an electric discharge device by vaporization of a cooling liquid, said electric discharge device comprising a generally cylindrical anode forming a part of the envelope wall of the device, a jacket surrounding said anode and cooperating therewith to provide an evaporator, said jacket including a vapor collecting portion at the upper end thereof above the level of liquid maintained in the jacket, a vapor outlet communicating with said vapor collector portion and baffle means supported within said vapor collecting portion in the vapor path between the liquid in said jacket and said vapor outlet.

2. A heat exchanger for a cylindrical wall of an electric discharge device comprising a plurality of similar metal rings each having a cylindrical inner collar and a plurality of radially extending projections on the outer surface thereof, said rings being assembled in contiguous axial relationship to form an elongated cylinder and an outwardly flared flange joined to the upper end of said structure for supporting said heat exchanger.

3. Cooling means for cooling an electric discharge device by vaporization of a cooling liquid, said electric discharge device comprising a generally cylindrical anode constituting a part of the envelope wall of the device, a plurality of individually massive radially elongated portions projecting outwardly from said anode, a jacket surrounding said anode and cooperating therewith to provide an evaporator, said jacket including a vapor collecting

portion at the upper end thereof above the level of liquid maintained in the jacket, a vapor outlet communicating with said vapor collecting portion, and baffle means supported within said vapor collecting portion in the vapor path between the liquid in said jacket and said vapor outlet.

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