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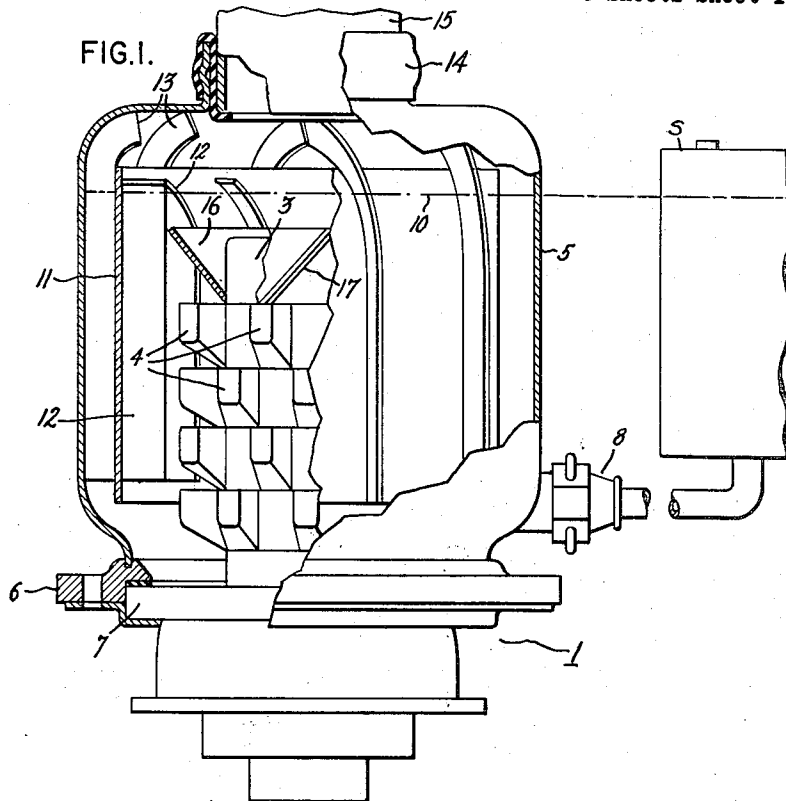
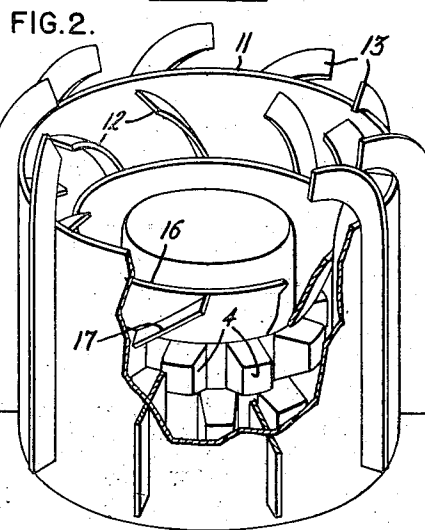
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2,969,957

ELECTRIC DISCHARGE DEVICE COOLING SYSTEMS

Filed Jan. 10, 1956

3 Sheets-Sheet 1



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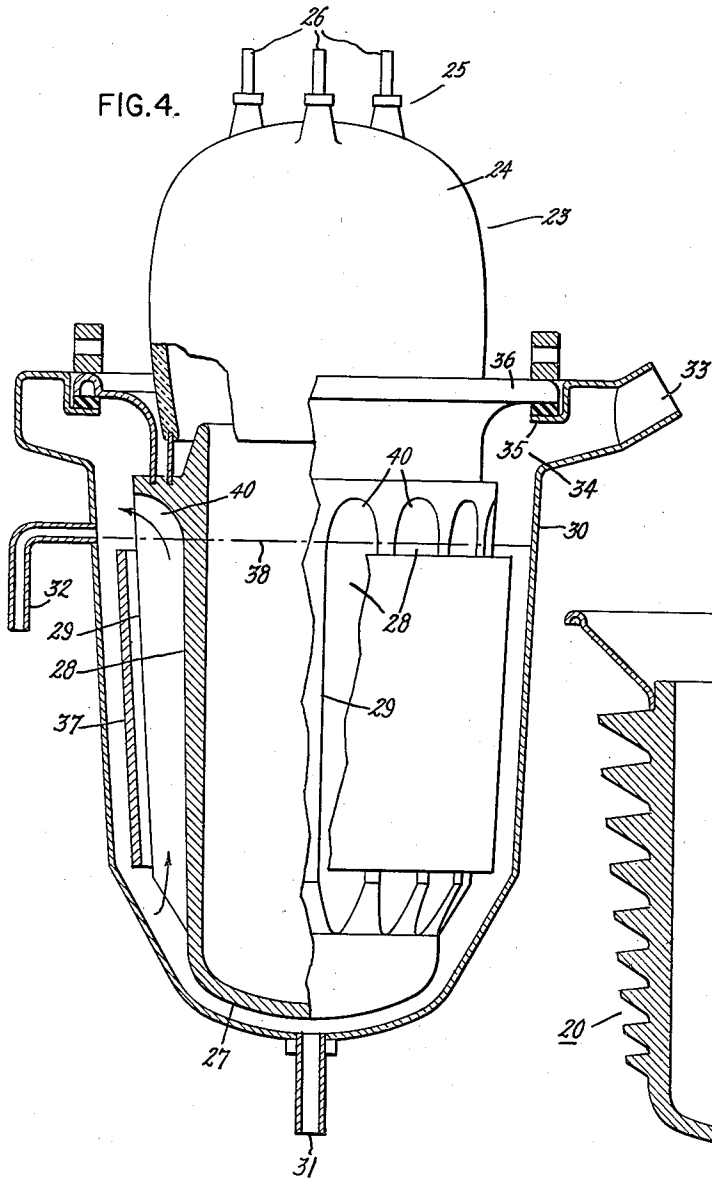
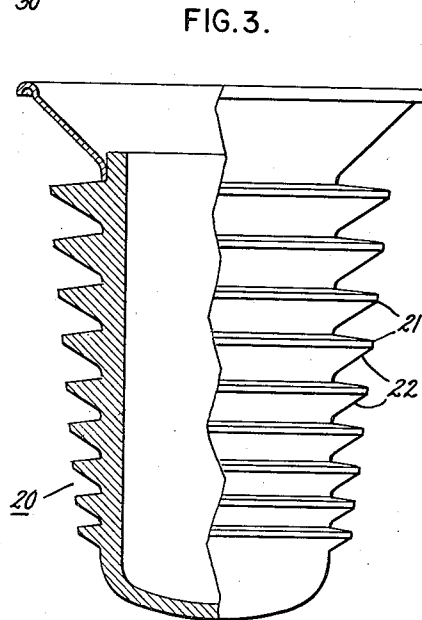
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ELECTRIC DISCHARGE DEVICE COOLING SYSTEMS

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3 Sheets-Sheet 2



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2,969,957

ELECTRIC DISCHARGE DEVICE COOLING SYSTEMS

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13 Claims. (Cl. 257—250)

The present invention relates generally to vapor cooling apparatus for electric discharge devices. More particularly, the present invention constitutes a further development of an improvement on the vapor cooling systems described and claimed in my co-pending applications Serial Nos. 232,188 and 273,813, filed June 18, 1951, and February 28, 1952, respectively, now Patent Nos. 2,935,305 and 2,935,306, granted May 3, 1960, respectively.

In the above-identified co-pending applications the advantages of vapor cooling as compared with liquid cooling are pointed out and suitable radiator or anode cooling structures and associated evaporators or boilers are described and claimed. The primary object of the present invention is to provide new and improved means adapted for increasing the operating efficiency of vapor cooling apparatus.

Another object of the present invention is to reduce appreciably the size of vapor cooling arrangements and the amount of coolant required to effect satisfactory cooling thereby.

Another object of the present invention is to simplify vapor cooling apparatus and necessary associated coolant supply systems.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

In carrying out the objects of the present invention, I have provided a vapor cooled structure including a heat radiator adapted for being surrounded by liquid coolant and an enclosing jacket. Provided in the jacket between the walls thereof and the radiator is a deflection system effective for imparting an ascending motion to coolant immediately adjacent the radiator and a descending motion in the space immediately adjacent the walls of the jacket. Further, I have provided a radiator structure which, in addition to providing heat conduction to the coolant, is effective for determining the direction of movement of the coolant immediately adjacent thereto. Still further, I have provided a radiator structure whereby the ascending liquid immediately adjacent the radiator is adapted for increased turbulence.

For a better understanding of my invention reference may be had to the accompanying drawing in which:

Figure 1 is a partially broken-away elevational view of an electric discharge device cooling system constructed in accordance with a preferred embodiment of my invention;

Figure 2 is a partially broken-away perspective view of the deflection system shown in Figure 1;

Figure 3 is a partially sectionalized elevational view of a modified form of radiator construction;

Figure 4 is a partially sectionalized elevational view of an electric discharge device cooling system constructed in accordance with a modified form of my invention; and

Figure 5 is a partially broken-away elevational view

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of an electric discharge device incorporating a modified form of radiator construction.

Referring to Figure 1 of the drawing, I have shown my invention incorporated in a system adapted for vapor cooling an electric discharge device generally designated 1 and including an upturned tubular or cylindrical anode forming a part of the envelope structure of the device. The discharge device includes the usual internal electrodes and mutually insulated electrode contacts. However, these elements need not be further referred to or described in detail herein.

The anode is fitted with a tubular or cylindrical radiator 3 comprising a plurality of outwardly extending substantially massive projections or lugs 4. The radiator 3 is adapted for effecting heat exchange by the vaporization of a liquid coolant, such as water, brought in contact with the surfaces thereof. The projections 4 are adapted for effecting continued turbulence of the coolant immediately adjacent the radiator thereby to avoid collection or accumulation of vapor bubbles on surface portions of the radiator, which bubbles, if permitted to accumulate, would result in hot-spots and unsatisfactory cooling and damage to the structure.

Fitted about the radiator 3 and adapted for maintaining a supply of liquid coolant in heat-exchange relationship therewith is an outer casing or coolant jacket 5. The lower end of the jacket 5 is provided with an annular flange 6 adapted for cooperating with a similar flange 7 provided on the envelope of the discharge device 1 and which may be one of the above-referred-to electrode contacts. By suitable means interposed between these members the lower end of the jacket is sealed thereby to avoid leakage of the coolant.

The coolant is supplied to the interior of the jacket 5 through a suitable inlet generally designated 8; and by means illustrated in Figure 1 and generally designated 9 the coolant supplied to the jacket is adapted for being maintained at a predetermined normal level above the radiator indicated approximately by the dot and dash line designated 10.

As perhaps better seen in Figure 2 there is provided in the jacket 5 a coaxial tubular element or cylinder 11 which surrounds the anode. The cylinder 11 is spaced from both the jacket and radiator and divides the interior volume of the jacket into two concentric annular spaces. As seen in Figure 1, the cylinder 11 is of such linear dimension that the lower edge thereof is spaced from the bottom of the jacket and the upper edge extends or projects a relatively short distance above the normal level of the coolant at rest.

The cylinder 11 carries two sets of blades or deflection elements 12 and 13 mounted, respectively, inside and outside the cylinder. The blades 12 and 13 are straight and parallel to the axis of the device throughout the lower parts thereof, which are normally immersed in the coolant, while the upper parts of the two sets of blades are inclined or bent approximately in helices with the pitches directed respectively in opposite directions. That is, the lower portions of the inner set of blades are substantially straight and extend below the level of the coolant for substantially the full length of the cylinder 11 in the region or space between the cylinder and radiator and the upper portions of the inner blades are arcuate or bent in one direction and disposed below the upper edge of the cylinder or in the upper part of the region between the cylinder and radiator. The outer set of blades is similar in that the lower portions are straight and extend into the coolant in the region between the jacket and cylinder. However, the upper portions of these blades extend above and inwardly over the upper edge of the cylinder 11 and are bent or inclined oppositely relative to the corresponding portions on the inner

set. Preferably the arcuate portions of the outer set of blades extend up to the upper end of the jacket 5, this upper end of the jacket 5 being adapted for acting as a vapor dome or collector. Connected to the dome portion of the jacket 5 by means of a suitable stuffing box or gasket 14 is an outlet conduit 15 adapted for permitting the escape of vapor from the jacket and conducting such vapor to suitable condensing means (not shown).

In operation of the structure described to this point, the coolant in the jacket 5 is maintained at substantially the predetermined normal level 10 by the mentioned suitable means (not shown) admitting such coolant into the jacket through the inlet 8. In the jacket the coolant is raised in temperature to the boiling point upon contact with the radiator, thus reducing the temperature of the latter to slightly above 100° centigrade and effecting satisfactory dissipation of the energy loss resulting from heating of the anode during operation of the anode discharge device 1. Undesirous accumulation of vapor bubbles on the various surfaces of the radiator is avoided by the particular construction of the exterior of the radiator including the massive projections or lugs 4.

The vapor resulting from the just-described cooling naturally rises in the space or region between the cylinder 11 and radiator and between the straight portions of the inner set of blades 12. At the upper portions of the blades 12 the bend or curvature thereof effects a rotary movement of the ascending vapor, which corresponds in degree generally with the degree of vapor output. The coolant or water entrained by the ascending vapor is subjected to the same rotary motion as the vapor and is thereby forced with considerable centrifugal force against the inside wall of the cylinder 11 along which it also rises until it is centrifuged at a substantial velocity over the upper edge of the cylinder. Then it contacts the curved upper portions of the outer set of blades 12. These upper portions of the outer set of blades, inasmuch as they are inclined in a direction opposite the upper portions of the inner blades directs the centrifuged liquid downward. At this stage the liquid still possesses a high velocity and descends substantially rapidly in the relatively narrow annular space or region between the cylinder 11 and the jacket 5. This action results in a more rapid ascent or circulation of the coolant from the bottom of the jacket upward between the cylinder and radiator or in the region which is immediately adjacent the radiator. Inside the cylinder 11 and below the arcuate portions of the blade 12 the coolant is guided by the vertical or straight portions of the blades which prevent the water from maintaining in this lower zone any rotary motion about the axis of the anode. Such rotary motion would be parasitic and if permitted would have the undesirable effect of causing the coolant in this lower zone to move away from the radiator by centrifugal forces. Thus, it will be seen that the system described to this point is effective for establishing circulation of the coolant at a velocity which minimizes any tendency toward vapor collection or accumulation on the anode radiator and in the system described such velocity increases with the heat dissipation, the energy required to maintain the coolant circulation being supplied by the kinetic energy of the vapor.

In order to enhance the operation of the just-described device, I have further included in the vapor deflection system an inverted frusto-conical element 16 supported on the upper end of the radiator 3 and adapted for directing or forcing the ascending vaporizing coolant into the space controlled by the curved upper portions of the inner set of blades 12. Additionally, on the outer surface of the frusto-conical member 16 is suitably supported a plurality of circumferentially spaced supplementary blades or baffles 17 inclined in the same direction as the curved upper portions of the inner set of blades 12. The blades 17, like the curved upper portions of the inner blades 12, impart rotary motion to the

rising vapor and liquid for directing it in a suitable manner toward the oppositely inclined upper portions of the outer set of blades 13.

It will be seen that the deflection system described with reference to Figures 1 and 2 permits a reduction in the size of the projections 4 of the anode radiator which may be in the order of half of that which would be necessary in a vaporizer not provided with the water circulating means of the present invention. Thus, the overall dimensions of the system may be reduced. Additionally, it will be seen that in some vapor cooling systems the coolant circulating arrangement of the present invention will make possible the complete elimination of the radiator projections 4 inasmuch as the coolant circulation as affected by the structure of the present invention will be sufficient for avoiding vapor collection on the surface of an anode. Still further, the upper portion of the described system serves as a vapor separator which permits only a negligible loss of vapor coolant through the conduit 15 and this lost vapor is substantially free of entrained liquid. Thus, less coolant is required for satisfactory operation of the present system.

In some structures or systems where extremely high heat dissipation is required, the anode radiator 3 including discrete circumferentially spaced projections or lugs may be replaced by a radiator structure such as that illustrated in Figure 3 and generally designated 20, thereby to provide the structure illustrated in Figure 5. This radiator structure 20, whether it has the opening therein at the top as in Figure 3, or at the bottom, as in Figure 5, comprises a plurality of superposed solid circular or annular fins 21, of decreasing diameter in the direction from which the vaporizing coolant will be rising. Additionally, the fins 21 are each formed with a frusto-conical under surface 22 adapted for extending inclined in respect to rising vapor bubbles. This construction provides for increased turbulence of the coolant whereby a wiping action is afforded for minimizing any tendency toward vapor collection on the anode. The radiator structure of Figure 3 is illustrated as one appropriately machined from a single piece of material and having a closed lower end. This particular type of radiator is generally employed in tube structures wherein the anode is adapted for extending downwardly. It will be seen, however, that the radiator 20 is adaptable for use on inverted anodes such as the anode 2 illustrated in Figure 1, in which case the upper end of the radiator would be closed and the lower end would be appropriately opened for insertion of the anode in the manner shown in Figure 5. It will be seen further that while the radiator 20 is illustrated as machined from a single piece of material it could be suitably constructed by stacking a plurality of individual formed annular fins 21.

Illustrated in Figure 4 is a modified form of my coolant circulating system wherein the deflection of the vapor and entrained coolant is deflected substantially horizontally away from the anode at the upper portion thereof by means of the radiator. More specifically, in Figure 4 is illustrated an electric discharge device generally designated 23 comprising an envelope made up of a glass bulb portion 24, a header portion 25 through which terminals 26 for the filament and grid are sealed. The envelope is completed by a cylindrical anode 27 suitably sealed to the other end of the bulb portion 24.

In accordance with the general practice, the anode may be formed of copper which is not only a good conductor of electricity but is also a metal having high heat transfer characteristics. The outer surface of the anode is formed to include a plurality of flutes or elongated depressions 28. Thus, the outer surface of the anode is adapted for serving as a heat radiator including a plurality of circumferentially spaced longitudinally extending solid fins 29. The fins 29 are preferably of trapezoidal cross-section, which cross-section may be

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constant throughout the lengths of the fins or decreasing downwardly in the manner illustrated.

The anode 27 is adapted for extending downwardly into an outer casing or coolant jacket 30. The jacket 30 includes a coolant inlet 31 at the lower end thereof, an overflow outlet 32 at the upper side portion thereof and a vapor outlet 33 in the upper portion also. Additionally, the jacket 30 is formed to include a vapor collecting portion generally designated 34 and an annular flange 35 adapted for cooperating with a suitable flange 36 carried by the discharge device and adapted for cooperating therewith in a suitable manner to effect a satisfactory vapor-tight seal. Suitably supported in the jacket 30 in a manner not illustrated and adapted for surrounding the radiator in substantially close proximity to the outer portions of the fins 29 is a cylinder 37. The cylinder 37 extends for a major portion of the lengths of the fins 29 and the upper edge of the cylinder is disposed below the normal level of liquid coolant indicated by the dot and dash line designated 38.

The upper portions of the radiator constituting the ends of the flutes 28 comprise incurved or arcuate surfaces designated 40. In the operation of the system illustrated in Figure 4 the liquid coolant is maintained by means not shown at the desired normal level 38 which is below the incurved surfaces 40. Thus when the coolant immediately adjacent or in contact with the fins 29 or the portions of the radiator between such fins is caused to boil the resultant vapor and liquid entrained thereby rises in the region between the radiator and the cylinder 37. Upon leaving the surface of the coolant such vapor and entrained liquid engages the incurved surfaces 40 of the radiator whereby it is deflected and caused to leave the radiator almost horizontally whereby it is directed toward the region between the cylinder 37 and the inner wall of the outer jacket 30. In this manner the coolant is caused to circulate substantially rapidly as by ascending in the region between the radiator and cylinder 37 and descending in the region between the cylinder and outer case, which increased circulation minimizes any tendency toward accumulation of vapor bubbles on the surface of the radiator and thus enhances the efficiency of operation of the system in effecting cooling of the anode.

It will be understood that while my invention is described and illustrated as electric discharge cooling means it is equally applicable in heat transfer structures of other types. For example, it can be incorporated in structure including a heated body of any type including a radiator and wherein it is desired to transfer heat from that body to a liquid heat exchange medium for the purpose of changing the latter to its vaporous stage. In this type of arrangement the structure of the present invention will increase circulation of the liquid medium past the heated body and avoid vapor accumulation on the surface of the radiator of the heated body and thus increase the heat transfer efficiency of the structure.

While I have shown and described specific embodiments of my invention I do not desire my invention to be limited to the particular forms shown and described, and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

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

1. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator, a coolant jacket enclosing said radiator and including an upper vapor collecting portion having a vapor outlet, a hollow straight-walled cylinder in said jacket surrounding said anode and radially spaced from said jacket and from said radiator, said cylinder having both ends completely open for enabling a coolant to circulate freely therethrough, a set of deflection elements including straight portions in the lower part of the region between said cylinder and radiator and arcuate

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ate portions in the upper part of the region between said cylinder and radiator and said arcuate portions being spaced below the upper edge of said cylinder and effective for imparting a rotary motion about the longitudinal axis of said cylinder to vaporizing coolant rising by convection in said upper part of said region thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder to extract said liquid from vaporized coolant, and another set of deflection elements in the region between said cylinder and jacket including arcuate portions disposed above said upper edge of said cylinder and inclined oppositely with respect to said arcuate portions of said first-mentioned set and effective for directing said extracted liquid downwardly into said region between said cylinder and jacket, whereby coolant circulation past said radiator by convection is increased.

2. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator, a coolant jacket enclosing said radiator, a hollow straight-walled cylinder completely open at both ends disposed in said jacket surrounding said anode and spaced radially from both said jacket and said radiator, a set of deflection elements including straight portions in the lower part of the region between said cylinder and radiator and arcuate portions in the upper part of the region between said cylinder and radiator, and said arcuate portions being spaced below the upper edge of said cylinder and effective for imparting a rotary motion about the longitudinal axis of said cylinder to vaporizing coolant in said upper part of said region thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder, means disposed below the upper ends of said deflection elements effective for deflecting vaporizing coolant outwardly from said radiator only in said upper part of said region and into contact with said arcuate portions of said deflection elements, means directing said centrifuged liquid downwardly into the region between said cylinder and jacket, whereby said coolant circulation past said radiator is increased.

3. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator having a plurality of radial protrusions, a coolant jacket enclosing said radiator, a hollow straight cylinder completely open at both ends disposed in said jacket surrounding said anode and spaced radially from said jacket and said radiator, a set of deflection elements including arcuate portions in the upper part of the region between said cylinder and radiator and above said protrusions effective for imparting a rotary motion about the longitudinal axis of said cylinders only to vaporizing coolant in said upper part of said region thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder, an inverted frusto-conical element mounted on said radiator below the upper ends of said deflection elements and above said radiator protrusions and carrying a plurality of circumferentially arranged baffle elements extending in substantially the same direction as said arcuate portions of said deflection elements effective for deflecting vaporizing coolant above said protrusion outwardly from said radiator into contact with said arcuate portions of said deflection elements and means directing said centrifuged liquid downwardly into the region between the cylinder and jacket, whereby coolant circulation past said radiator is increased.

4. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator having a plurality of radial protrusions, a coolant jacket enclosing said radiator, a coolant inlet in the lower end of said jacket admitting coolant directly into said jacket, a straight-walled hollow cylinder completely open at

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both ends disposed in said jacket surrounding said anode and spaced from both said jacket and said radiator, a circumferentially spaced set of deflection elements including substantially straight portions extending longitudinally between said cylinder and radiator and arcuate portions disposed in the upper part of the region between said cylinder and radiator and below the upper end of said cylinder and above said protrusions effective for rotating vaporizing coolant in only said upper part of said region about the longitudinal axis of said cylinder thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder, and another set of circumferentially spaced deflection elements including substantially straight portions extending longitudinally between said cylinder and jacket and arcuate portions extending above said upper edge of said cylinder and inclined oppositely with respect to said arcuate portions of said first-mentioned set effective for directing said centrifuged liquid downwardly into said region between said cylinder and jacket, whereby coolant circulation past said radiator is increased.

5. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator having a surface effecting substantial turbulence of boiling coolant in contact therewith, a coolant jacket enclosing said radiator, means for maintaining a liquid coolant at a predetermined level spaced from the upper end of said jacket, and only a single hollow cylinder in said jacket surrounding said anode and spaced from both said jacket and said radiator, said cylinder being straight and open at both ends and effective for enhancing upward convection currents of coolant between said cylinder and radiator, a circumferentially spaced set of elements including substantially straight portions extending longitudinally between said cylinder and radiator and arcuate portions disposed in the upper part of the region between said cylinder and radiator and below the upper end of said cylinder effective for rotating vaporizing coolant in said upper portion of said region thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder, an inverted frusto-conical element mounted on said radiator and carrying a plurality of circumferentially arranged baffle elements disposed below the upper ends of said arcuate portions of said set of deflection elements and inclined in substantially the same direction as said arcuate portions of said deflection elements effective for directing vaporizing coolant from said radiator into contact with said arcuate portions of said deflection elements, and a second set of circumferentially spaced deflection elements including substantially straight portions extending longitudinally between said cylinder and jacket and arcuate portions extending above said upper edge of said cylinder and inclined oppositely with respect to said arcuate portions of said first-mentioned set effective for directing said centrifuged liquid downwardly in said region between said cylinder and jacket, whereby coolant circulation past said radiator is increased.

6. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator, said radiator comprising a plurality of circumferentially spaced projections and inclined surface portions disposed between said projections at the upper end of said radiator, and a cylinder in said jacket surrounding said radiator and spaced from said jacket and said radiator, said inclined surface portions of said radiator deflecting vaporizing coolant from said radiator over the upper edge of said cylinder toward the region between said cylinder and said jacket, thereby to increase coolant circulation past said radiator.

7. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope of the device and including a radiator,

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said radiator comprising a plurality of circumferentially spaced longitudinally extending fins, and incurved surface portions disposed between the upper portions of said fins, and a cylinder in said jacket surrounding said radiator and spaced from said jacket and radiator, said incurved surface portions of said radiator being effected for deflecting vaporizing coolant from said radiator substantially horizontally over the upper edge of said cylinder toward the region between said cylinder and radiator, thereby to increase coolant circulation past said radiator.

8. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope thereof, a coolant jacket surrounding said anode and having a coolant inlet in the lower portion and a vapor outlet in the upper portion thereof, and a heat radiator for said anode comprising a plurality of superposed annular fins, said fins including outwardly inclined underside surface portions, whereby turbulence of coolant vaporizing as a result of contact therewith is increased, and a hollow straight cylinder in said jacket surrounding said anode, said cylinder being spaced radially from both said radiator and said jacket and being completely open at both the upper and lower ends thereof.

9. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming a part of the envelope thereof, a coolant jacket surrounding said anode and having a coolant inlet in the lower portion and a vapor outlet in the upper portion thereof, and a heat radiator for said anode comprising a plurality of superposed solid annular fins, said fins progressively decreasing in diameter toward the lower end thereof and including outwardly inclined underside surface portions, whereby turbulence of coolant vaporizing as a result of contact therewith is increased, only a single straight hollow cylinder in said jacket surrounding said anode, said cylinder being spaced radially from both said radiator and said jacket and being completely open at both the upper and lower ends thereof, and means maintaining a liquid coolant in said jacket at a predetermined level just below the upper end of said cylinder.

10. A vapor cooling system comprising an electric discharge device having a tubular anode forming a part of the envelope of the device and including a radiator having a plurality of discrete radial protrusions, a coolant jacket enclosing said radiator, said jacket including an upper vapor collecting portion having a vapor outlet therein and a coolant inlet in the lower portion of said jacket admitting coolant directly into said jacket, only a single straight hollow cylinder in said jacket surrounding said anode and spaced radially from both said jacket and said protrusions, said cylinder enhancing upward flow of coolant immediately adjacent said radiator, said cylinder being completely free of any obstructions at the lower end thereof and being in open communication at said lower end thereof with said jacket, and means deflecting vaporizing coolant outwardly over the upper edge of said cylinder, extracting entrained liquid therefrom and directing said liquid downwardly toward the region between said cylinder and jacket, thereby to increase coolant circulation toroidally about said element and thus past said radiator.

11. A vapor cooling system comprising an electric discharge device having a tubular anode forming a part of the envelope of the device and including a radiator having a plurality of discrete radial protrusions, a coolant jacket enclosing said radiator, said jacket including an upper vapor collecting portion having a vapor outlet and a coolant inlet below said vapor collecting portion admitting coolant directly into said jacket, means for maintaining said coolant at a predetermined level spaced from the upper end of said jacket, a straight hollow cylinder in said jacket surrounding said anode and spaced from both said protrusions and said jacket, said

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cylinder having the upper edge thereof spaced just above said predetermined level of said coolant and opening at both the upper and lower ends thereof into said jacket, and means imparting a rotary motion about the longitudinal axis of said cylinder and anode to vaporizing coolant in only the upper part of the region between said cylinder and the anode, thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder for extraction and passage thereof into the region between said cylinder and jacket for increasing coolant circulation past said radiation and to direct vaporized coolant into said vapor collecting portion.

12. A vapor cooling system comprising an electric discharge device having a cylindrical anode forming part of the anode device and including a radiator having a plurality of discrete radial protrusions, a coolant jacket including said radiator, said jacket including an upper vapor collecting portion, a vapor outlet in said collecting portion and a coolant inlet below said vapor collecting portion admitting coolant directly into said jacket, a straight hollow cylinder in said jacket surrounding said anode and spaced from both said jacket and said radiator protrusions, the upper and lower ends of said cylinder being in open communication with said coolant jacket, means imparting a rotary motion about the longitudinal axis of said cylinder and anode to vaporizing coolant in only the upper part of the region between said cylinder and anode, thereby to centrifuge entrained liquid coolant over the upper edge of said cylinder for extracting said liquid coolant from vaporizing coolant entering said vapor collecting portion and directing the extracted liquid coolant into the region between said cylinder and jacket, and deflecting means disposed in

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said last-mentioned region directing said extracted liquid downwardly therein for enhancing thermally-caused movement of said coolant downwardly between said cylinder and jacket and upwardly between said cylinder and radiator for increasing coolant circulation by convection past said radiator.

13. A vapor cooling system as in claim 10, wherein said radiator protrusions comprise massive superposed annular fins, said fins including upwardly inclined annular underside surface portions, whereby turbulence of coolant vaporizing as a result of contact therewith is increased.

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