June 30, 1936. J. O. GARGAN ET AL 2,046,020

ELECTRIC DISCHARGE DEVICE

Filed Feb. 7, 1923

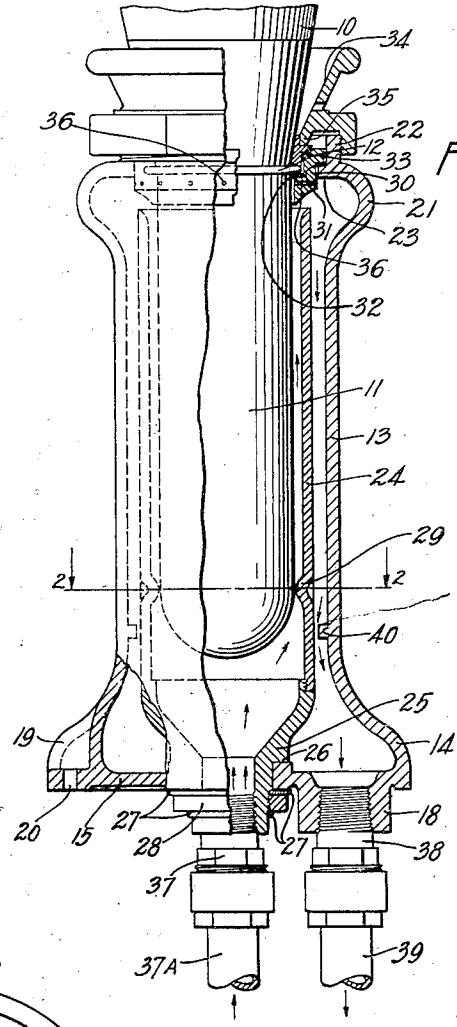



FIG. 1

FIG. 3.

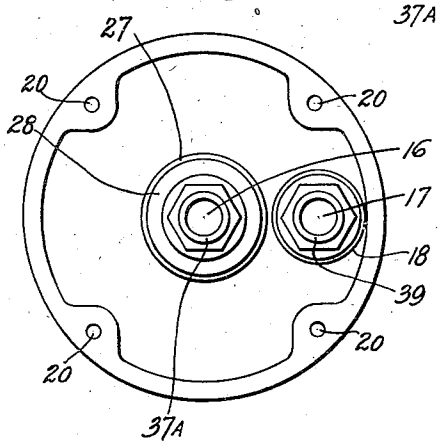
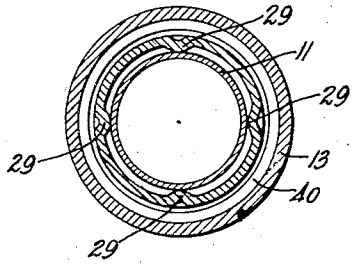



FIG. 2.




INVENTORS
JOHN O. GARGAN
FREDERICK W. YOUNG
BY Walter C. Kiesel
ATTORNEY

Patented June 30, 1936

2,046,020

# UNITED STATES PATENT OFFICE

2,046,020

## ELECTRIC DISCHARGE DEVICE

John O. Gargan, Brooklyn, and Frederick W. Young, Long Island City, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application February 7, 1928, Serial No. 252,633

14 Claims. (Cl. 250—27.5)

This invention relates to fluid circulating containers and more particularly to a combined cooling jacket and socket for high power electron discharge devices.

Heretofore in the design of sockets for water-cooled discharge devices it was thought that a centrifugal flow of water was necessary in order to attain the high velocity of the cooling fluid flowing in the container. Accordingly, the inlet and outlet ports were placed in such positions so as to attain this type of flow within the anode cooling chamber. Containers of such design have been found satisfactory in dissipating the heat from the anodes of electron discharge devices operating at a capacity as high as 5 kilowatts.

However, when greater power is used, of the order of 25 kilowatt capacity, a great deal of difficulty is experienced due to the fact that the design of the container controls the flow of the cooling fluid and sufficient cooling is not accomplished to dissipate the great amount of heat for the greater power used. It was found that the tendency of the water to flow spirally from the inlet to the outlet port caused eddies at the vortices of the container, thereby forming pockets in which air was entrapped. It was also found that the water flowed toward the wall of the cooling chamber instead of toward the heated anode surface. Another defect observed was that the water swirled about portions of the surface of the anode and caused air bubbles to form thereon. Consequently, the areas on which bubbles formed were insulated from the cooling medium and the heat was not carried away from these areas.

An object of this invention is to overcome the above difficulties in the dissipation of heat from the anodes of high power discharge devices.

Another object is to prevent the formation of insulated areas on the anode surface due to air bubbles.

A further object of the invention is to eliminate the blocking of the circulating fluid due to air pockets forming in the container.

In accordance with the broad aspect of this invention, the device to be cooled, such as an external anode of an electron discharge device, is supported in a container having two chambers. The circulating fluid is injected into the surrounding chamber through an inlet port at high velocity, to flow in a vertical direction and thereby scour the surface of the anode. The circulating fluid overflows from the surrounding chamber in an equal radial direction into the outlet chamber and is removed from the container through an outlet port.

In a more specific aspect of the invention the combined socket and cooling container for the external anode discharge device comprises a cylindrical metallic outer member which surrounds the metallic anode and supports it at one end and is provided with a pair of apertured openings at the outer end. A cylindrical metallic partition is coaxially located between the anode and the outer member and forms an inner and outer chamber in the container for the circulation of the cooling fluid. The metallic partition is provided with a tapered portion at the lower end which leads into one of the apertures where it is joined to the container and supported thereby to form the inlet port of the container. The partition is open at the other end of the container to form a spillway for the circulating fluid into the outer chamber which then flows to the outlet port. In this construction the cooling fluid enters the inner chamber through the inlet port and travels upward at a high velocity along all portions of the anode surface, thereby scouring the heated surface of the anode to prevent portions of the anode being insulated by the formation of air bubbles. The cooling fluid overflows at the periphery of the partition and enters the outer chamber leading to the outlet port.

A feature of the invention relates to means for overcoming the blocking effect of the water flowing toward the outlet port. This is accomplished by restricting the flow of the cooling fluid near the outlet port by forming an internal flange on the container so that the water is compelled to enter the lower portion of the outer chamber through a thin annular orifice between the restricting flange and the outer wall of the metallic partition. This creates a differential pressure between this point and the outlet, thus insuring an equal flow at all points and eliminating any preferential flow in the circulating system.

Other features of the invention will be apparent from the following detailed description and the accompanying drawing in which:

Fig. 1 is a view in elevation of the improved cooling container for an electron discharge device made in accordance with this invention with portions broken away to more clearly show the detailed construction;

Fig. 2 is a cross-sectional view on the line 2—2 of Fig. 1 showing the relative positions of the elements within the cooling container; and

Fig. 3 is a plan view of the supporting end of the container showing the positions of the fluid circulating ports.

Referring to Fig. 1 there is disclosed the combination of an electron discharge device of the high voltage type comprising an enclosing vessel having an insulating portion 10 preferably of glass and a cup-shaped metal portion 11 which forms the anode of the device. An outwardly projecting flange 12 is formed on the anode 11 adjacent the flared end thereof to provide supporting means for the electron discharge device in a cooling container. The container or jacket 13 consists of a cylindrical body portion

having a circumferential flared portion 14 at the supporting end which is substantially closed by a flat base portion 15. The base portion is provided with a central aperture 16 and an off-set aperture 17 formed in a projecting collar 18 which is integral with the base and body portions of the container. The flared portion 14 of the container is provided with equally distributed depressions 19 and holes 20 in these depressions are provided to mount the container upon a suitable structure. For instance, on a frame such as is disclosed in J. O. Gargan, Patent 1,570,959, dated June 26, 1926. The other end of the container 13 is provided with an outwardly curved portion 21 which terminates in an upwardly extending threaded portion 22 which is substantially in alignment with the cylindrical wall of the container 13. An inwardly projecting flange 23 is formed integral with the container and forms the boundary of a relatively large throat or opening through which the cup-shaped anode 11 may be inserted in the container.

A cylindrical metallic partition 24 having an apertured tapering end portion 25 is coaxially positioned in the container between the cup-shaped anode 11 and the wall 13 of the container and supported by a rigid connection to the base 15. This partition is preferably made in two sections to facilitate manufacture and reduced costs preferably by threading the cylindrical portion 24 to the tapered or funnel shaped portion 25. The tapered portion 25 is provided with a shoulder 26 which is seated on the base 15 and forms a joint therewith. The tapered portion 25 extends through the base 15 and is externally threaded to receive a nut 28 which securely clamps the tapered member to the base 15 and rendered water-tight by soldering at the points 27. A plurality of indentations 29 are formed on the cylindrical wall of the partition 24 and are equally spaced around the surface thereof to centrally position the lower end of the cup-shaped anode 11.

The electron discharge device is supported in the container by reducing flange 30 having a portion which is seated on the inwardly projecting flange 23 and forms a water-tight joint therewith through the rubber washer 31. The inwardly extending shelf portion of the reducing flange 30 which reduces the diameter of the opening in the container to approximately the diameter of the cup-shaped anode 11, carries a rubber washer 32 on which the flange 12 of the anode 11 is seated to completely close the upper end of the container 13. A two-part hinged clamping ring 33 engages the anode flange 12 seated on the reducing flange 30. An apertured cap member 34 which is threaded to the portion 22 of the container is provided with an inwardly projecting angular extension 35 which engages the clamping ring 33, to press the ring on the anode flange 12 and form a water-tight joint between the flange 12 and the gasket 32 on the reducing flange 30. The reducing flange 30 is slightly larger in diameter than the cup-shaped anode 11 to provide an orifice between the anode surface and the reducing flange for the circulation of the cooling fluid. The circulating fluid entering this orifice between the flange 30 and the anode 11 is drawn out through the radial drillings 36 extending through the lower end of the reducing flange 30. Furthermore, any air contained in this small space is readily released through the radial drillings 36.

The central aperture 16 formed in the base of the container and through which the funnel shaped portion of the partition extends forms the inlet port for circulating a cooling fluid along the surface of the anode 11. For this purpose the extension of the funnel shaped portion 25 may be internally threaded to receive a coupling 37 to which is attached a hose 37A for introducing the cooling fluid into the container. The collar 18 is also internally threaded to receive a coupling 38 to which is attached a hose 39 to form an outlet port for removing the fluid from the container after it has passed along the surface of the anode.

Since the electron discharge devices to which this invention is particularly applicable are capable of handling large amounts of power and operate at extremely high voltages, usually 20,000 volts or more, the cup-shaped anode generates considerable heat and if this heat is not dissipated by an efficient cooling system, serious damage may result due to the anode being destroyed. Similarly, if air bubbles are allowed to form on the surface of the anode thereby forming insulated areas from which the heat is not carried away, like damage may result from the excessive heating of the insulated areas. In accordance with this invention these difficulties are overcome by arranging the cylindrical partition 24 quite close to the surface of the anode so that the cooling fluid introduced into the chamber formed by the cylindrical partition 24 and the anode is forced in a thin vertical stream at high velocity along the anode surface, thereby scouring the surface of the anode and preventing the formation of air bubbles thereon. This arrangement insures the cooling fluid absorbing the heat transmitted by the anode and eliminates non-uniform temperature in the fluid by mixture or convection. The cooling fluid passes along the whole surface of the anode in a vertical direction and overflows at the top of the partition 24 and enters the outer chamber formed between the partition 24 and the walls of the container 13. The container is curved outwardly at the upper end to present the least resistance to the overflowing fluid or water coming from the inner chamber. This fluid then flows through the outer chamber to the outlet port 17 where it is removed from the container.

Due to the offset arrangement of the outlet port with respect to the circumferential flow of the fluid into the sump chamber formed by the tapered portion of the partition 24 and the flared portion 14 of the container, there would be a tendency of a preferential flow of the fluid at the side of the container adjacent the outlet port 17. This difficulty is overcome in accordance with this invention by the flange 40 which is formed integral with the container 13 and located between the cylindrical partition 24 and the outer wall 13. This circular flange forms an orifice of reduced diameter between the partition 24 and the flange 40 so that the cooling fluid flowing toward the outlet port is compelled to enter a reduced area so as to create a differential pressure between this point and the outlet port, thereby eliminating any blocking effect of the circulating system due to a preferential flow of the fluid in the container. This insures an equal flow of the fluid into the sump chamber where it readily flows through the outlet port without causing any swirling action in the sump chamber. The large throat provided at the upper end of the container 13 freely permits the insertion of the tubular partition 24 in the container and greatly

facilitates the assembly of the cooling device. Furthermore, if the external anode discharge device breaks down due to encrusted mineral deposit on the surface or any other failure of the device, it may be quickly replaced without removing the cooling container from the mounting.

While the invention has been disclosed in a particular embodiment various modifications may be made in the structure and assembly without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In combination, an electron discharge device having a cup-shaped anode, and a cooling container surrounding said anode, said container having inlet and outlet ports at one end and comprising coaxial inner and outer coextensive tubular members forming channels around said anode, said inner member being supported by said outer member adjacent to said outlet port, said channels having a continuous circular communicating passageway at one end of said container.

2. In combination, an electron discharge device having a cup-shaped external anode, and a cooling container surrounding said anode, said container comprising coaxial inner and outer tubular members forming channels around said anode, said channels having individual apertured openings at one end of said container and a common peripheral passageway at the other end thereof, said inner member having a portion extending outwardly from said outer member through one of said openings.

3. A mounting for an external anode discharge device comprising a chamber adapted to be placed around the anode of said device, said chamber having an inlet port for a cooling medium at one end and a peripheral opening at the other end, and a second chamber enclosing said first chamber having an outlet port therein adjacent to said inlet port, said second chamber being adapted to support said anode and communicating with said peripheral opening.

4. A cooling container for electron discharge devices comprising a double walled receptacle forming inlet and outlet chambers, said chambers having inlet and outlet ports respectively, and said outlet chamber having a restricted circular passageway intermediate the ends thereof leading to said outlet port.

5. A cooling container for electron discharge devices comprising a double walled receptacle forming inlet and outlet chambers, said chambers having inlet and outlet ports respectively, and said outlet chamber having an integral flange interposed between the double walled receptacle and out of contact with the inlet chamber wall to restrict the flow of fluid to said outlet port.

6. A cooling container for electron discharge devices comprising a double walled receptacle forming inlet and outlet chambers, said chambers having inlet and outlet ports respectively, and an inwardly projecting flange in said outlet chamber, said flange forming a continuous circular orifice of reduced diameter within said double walled receptacle.

7. A cooling container for an electron discharge device comprising a cylindrical metallic member having an enlarged opening at one end and a plurality of smaller openings at the other end, and a tubular partition within said member extending through one of said smaller openings and supported by said member, said tubular partition being removable through said enlarged opening in said member.

8. A cooling jacket for electron discharge devices comprising a container having a cylindrical body portion and outwardly curved end portions, an anode adapted to be supported by one of said curved end portions, said other end portion having a plurality of apertured openings, and a funnel-shaped member within said container, said member having one end attached to said container and projecting through one of said apertured openings.

9. A cooling jacket for electron discharge devices comprising a container having a cylindrical body portion and outwardly curved end portions, a cup-shaped anode adapted to be supported by one end portion and projecting into said cylindrical body portion, a funnel-shaped member coaxially positioned with respect to said anode and container and interposed therebetween, the smaller diameter end of said member being joined to said container remote from the anode supporting end, an inlet port communicating with said member, and an outlet port communicating with said container.

10. A cooling jacket for electron discharge devices comprising a container having a cylindrical body portion and outwardly curved end portions, an anode adapted to be supported by one of said curved end portions, and a funnel-shaped member encircling said anode within said container, said member having one end attached to said container and the other end out of contact with said container and anode.

11. In combination, a cooling jacket for electron discharge devices comprising a container having a cylindrical body portion and outwardly curved end portions, an anode supported by one of said curved end portions, said other end portion having a plurality of apertured openings, a funnel-shaped member interposed between said anode and the wall of said container, and means for circulating a cooling fluid in said container, said funnel-shaped member tending to force the fluid along a vertical path on the surface of said anode, the water flowing over the free edge of said funnel-shaped member and into said container.

12. In combination, an electric discharge device provided with an external electrode which requires cooling during operation, a casing surrounding said electrode, a removable sleeve mounted in said casing and spaced a relatively small distance from said electrode, and means for supplying a cooling fluid to the interiors of said sleeve and casing successively to thereby provide a relatively thin film of cooling fluid between said sleeve and electrode.

13. A cooling container for an electron discharge device comprising a cylindrical outer member having an enlarged opening adapted to receive the anode of an external anode device, a removable inner partition adapted to be interposed between said anode and said outer member, and means on said partition adapted to contact said anode for centering said anode in the container.

14. A cooling container for an electron discharge device comprising a cylindrical outer member having an enlarged opening adapted to receive the anode of an external anode device, and a removable inner partition adapted to be interposed between said anode and said outer member having indentations therein for contacting with said anode to center said anode in the container.

JOHN O. GARGAN.
FREDERICK W. YOUNG.