April 5, 1932. P. C. HOERNEL ET AL 1,852,777

COOLING SYSTEM

Filed June 30, 1926

Fig. 1

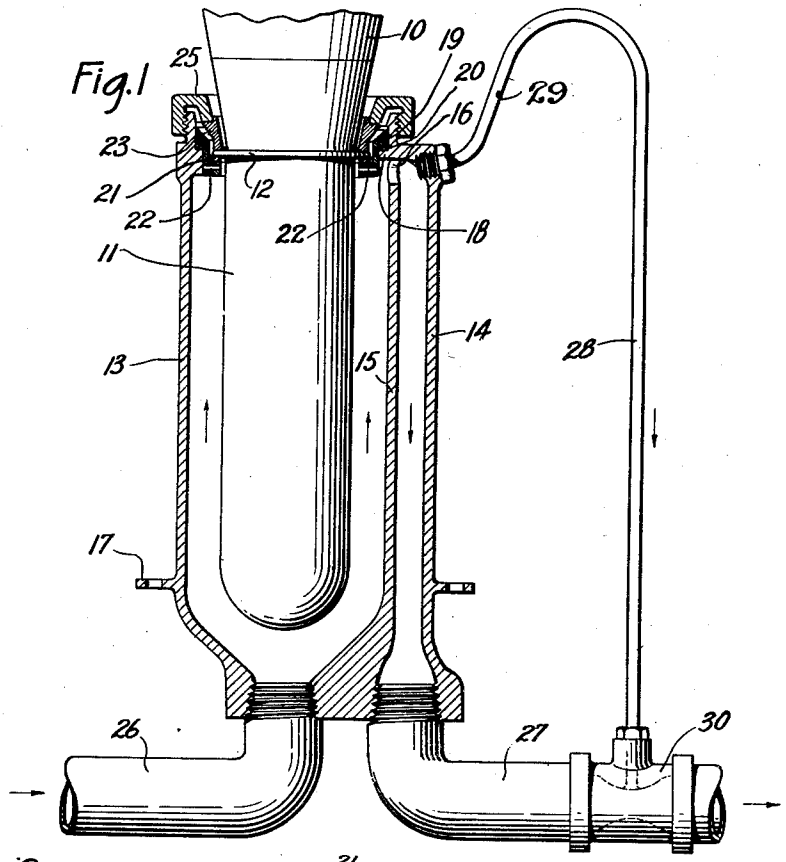


Fig. 2

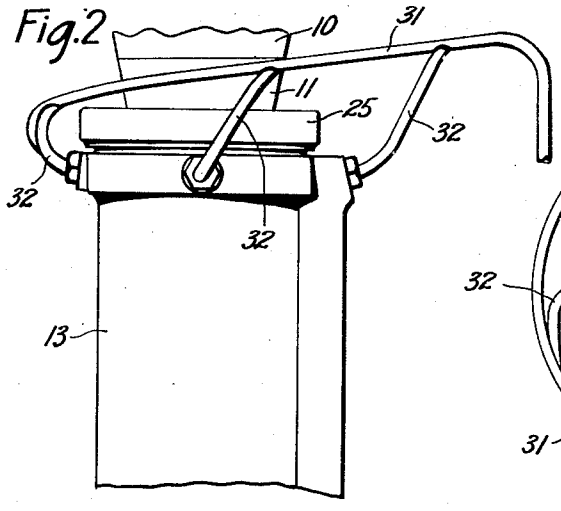
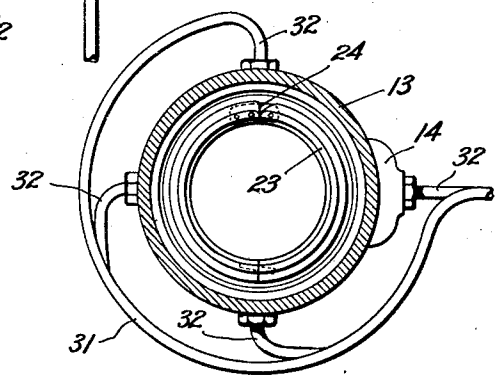


Fig. 3



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UNITED STATES PATENT OFFICE

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COOLING SYSTEM

Application filed June 30, 1926. Serial No. 119,535.

This invention relates to cooling systems for electric apparatus and more particularly to the cooling of high power electron-discharge devices.

An object of this invention is to remove entrapped air, gas or vapor from a cooling system.

Another object is to efficiently dissipate the heat from the anode of an electron discharge device.

The invention is particularly applicable to high voltage electron discharge devices of the type employing a highly evacuated enclosing vessel consisting of an insulating portion and a cup-shaped metal portion which constitutes the anode of the device. A filament and grid electrode are supported from the insulating portion and extend into the cup-shaped anode to form a three element electron discharge device. Such devices may be used in radio transmission systems as modulators, amplifiers and rectifiers. When high voltages, of the order of 10,000 to 100,000 volts, are applied to the anode, a high power output is obtained. Due to the high voltages used in these devices, the anode is excessively heated and some cooling means must be provided to dissipate the heat generated at the anode during operation. This may be accomplished by providing a suitable container or jacket which encloses the anode and forms a fluid-tight compartment through which water or other cooling media may be circulated. Such an arrangement is disclosed in W. G. Houskeeper Patent No. 1,571,948, issued February 9, 1926.

Unless precautions are taken when operating at high voltages, there is a tendency for air pockets or confined gases to form in the jacket and air bubbles to collect on the anode surface. This air or gas retards the circulation of the cooling medium and prevents complete cooling of the anode. Consequently the anode may be so over-heated as to be partially destroyed.

In one embodiment of the invention a fluid-tight jacket or container surrounds the cup-shaped anode of an electron discharge device and is provided with inlet and outlet pipe connections for the circulation of a cooling medium around the anode, to dissipate the heat generated therein. An auxiliary outlet pipe or tubular member is connected to the end of the container adjacent the entrance of the anode and communicates with the interior of the container. This member extends at an upward angle with respect to the container and forms a constricted passage-way for the escape of confined air from the container. Because the highest point of the tubular member is above the level of the circulating medium within the container, and since the diameter of the opening therein is small, very little of the circulating medium passes through the auxiliary tubular member.

While this invention is particularly applicable to electron discharge devices, it may also be used in connection with other apparatus wherein trapped gases or vapors are troublesome in fluid circulating systems.

A feature of the invention is the by-pass connection of the tubular member to the outlet pipe connection so that the cooling medium passing through the outlet connection performs an aspirator action in the auxiliary tubular member or by-pass pipe to remove the entrapped air from the container.

This arrangement removes all the non-circulating fluids, such as air, gas or vapor, from the container during the operation of the device and maintains efficient cooling of the anode of the electron discharge device.

When very high voltages are used, such as 10,000 volts or more, it is desirable to remove the air more rapidly to allow freer circulation of the cooling medium to prevent deterioration of the anode. This may be accomplished in accordance with another feature of the invention by a multiple header or manifold having branches which communicate with the container at spaced positions around the periphery thereof, to remove the confined air from the container and prevent the formation of air bubbles on the anode surface.

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

Fig. 1 illustrates in cross-section an assem-

bly of an electron discharge device cooled in accordance with this invention.

Fig. 2 is a partial view of a device illustrating a modified form of the invention, and,

Fig. 3 is a plan view of the device shown in Fig. 2.

Referring to Fig. 1, there is disclosed the combination of an electron discharge device 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 discharge device. An outwardly projected annular 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. This container or jacket consists of a substantially cylindrical metal casting 13 having an offset longitudinal portion 14, and an integral partition 15 having an aperture 16 which forms a communicating passage-way between the main chamber formed by the jacket 13 and the longitudinal channel formed by the offset portion 14. An outwardly extending annular flange 17 is formed on the jacket so that the assembled structure may be attached to a supporting framework. The upper end of the container is provided with a relatively wide opening or mouth having substantially the same diameter as the interior of the container. An inwardly projecting annular flange 18 is provided adjacent the end of the opening to form a seat for a reducing flange 19, a gasket 20 being provided between the seat 18 and the flange 19 to provide a water-tight connection. The flange 19 is provided with an inwardly projecting shelf, to reduce the large diameter of the mouth of the jacket to approximately the diameter of the anode 11. The anode 11 of the electron discharge device is inserted in the main chamber of the container 13 and the annular flange 12 on the anode is seated on a gasket 21 which is placed on the shelf portion of the flange 19. A plurality of radial drillings 22 are formed through the shelf of the flange 19 to provide means for circulating the cooling medium and the removal of air from the small space adjacent the anode and the shelf of the flange 19. A two-part clamping ring 23, provided with a leaf hinge 24 rigidly attached to one half of the ring 23 and pivotally attached to the other half of the ring, surrounds the anode 11 above the projecting anode flange 12, to form a pressure member whereby a water-tight and secure joint may be obtained between the anode 11 and the flange 19. The upper end of the jacket or container is externally threaded to receive an aperture collar 25 which is threaded thereto and is provided with a downwardly extending inner edge which engages the ring 23, to clamp the anode 11 securely in the container 13. This arrangement is substantially the same as the structure disclosed and claimed in a copending application to H. Vadersen, Serial No. 91,202, filed February 27, 1926 and entitled "Electron discharge devices". The lower end of the main chamber formed in the container 13 is tapered to a threaded opening to receive an inlet pipe connection 26. The parallel chamber formed by the offset portion 14 of the container and the partition 15, is also provided with a threaded opening on its lower end to receive an outlet pipe 27. This structure provides means for circulating a cooling medium, such as water, at high pressure, through the main chamber of the container surrounding the anode 11, the water or other cooling medium passing to the outlet pipe connection 27, through the connecting passage-way 16 and the chamber formed by the offset portion 14.

Due to the high temperature of the anode 11 operating at the voltages applied to this electrode and the high pressure of the circulating system, there is a tendency for air pockets to form at the upper end of the jacket, particularly adjacent the communicating passage-way 16 between the two chambers formed in the jacket, thereby preventing the free circulation of the cooling medium. Similarly air bubbles collect on the anode surface and form an air film which prevents intimate contact of the cooling medium with the surface of the anode. Consequently the circulating cooling system is retarded by this confined air in the container and portions of the anode are subjected to excessive heating.

These difficulties are overcome in accordance with this invention by providing an auxiliary tubular member or by-pass pipe which is connected to the upper end of the jacket in alignment with the connecting passage-way 16 and communicates with the interior of the container. This member or pipe is of constricted formation and extends at an upward angle from the jacket so that the passage-way extends above the level of the circulating fluid in the container 13. This arrangement forms an outlet for the air confined in the jacket which may be exhausted from the container by any suitable means such as a pump connected to the auxiliary member. Since the auxiliary tubular member is of small internal diameter and extends at an upward angle from the container, the air confined in the container is speedily exhausted and only a small percentage of the cooling fluid passes through the by-pass tubular member. Preferably the by-pass tubular member comprises a length of metal tubing of small interior diameter having an outwardly and upwardly extending portion 29 which communicates with the interior of the jacket, and a downwardly extending portion 28 which is joined to a coupling 30 which forms a constricted passage-way in the outlet pipe 27. This arrangement forms an efficient means for removing the confined air from

the jacket by the action of the cooling fluid passing through the outlet pipe connection 27 performing an aspirator action in the auxiliary tubular member, which forms a by-pass connection between the upper end of the jacket and the outlet pipe connection. Furthermore, the proximity of the by-pass outlet member to the fluid tight joint between the anode 11 and the flange 19, and the radial openings 22 in the flange constitutes an efficient arrangement for exhausting the air confined in the small space adjacent the fluid tight joint.

A modified form of the invention is shown in Figs. 2 and 3, in which a multiple header or manifold provides means for removing the confined air from the interior of the water jacket at an increased rate. This arrangement comprises a tubular member 31 of small internal diameter which has one end connected to a joint on the periphery of the water jacket and forms a single turn spiral extending upwardly and substantially surrounding the container 13. The spiral tubular manifold 31 has a plurality of branches 32 of gradually increasing length communicating with distributed points on the jacket, to form a multiple connection for the removal of confined air from the water jacket. The free end of the tubular manifold 31 may be connected to any suitable suction producing means, or to the outlet pipe connection described in connection with Fig. 1.

What is claimed is:

1. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, inlet and outlet connections for said container, an auxiliary connection from said container to said outlet connection, and a cooling medium adapted to circulate through said container and in contact with said anode, said medium flowing in said outlet connection producing a suction through said auxiliary connection.

2. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, inlet and outlet connections for circulating a cooling medium in contact with said anode and said container, and a by-pass connection communicating with said outlet connection and extending at an angle from said container above the level of the cooling medium.

3. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, means for circulating a cooling medium through said container, and a manifold air outlet connection communicating with said means and container.

4. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, inlet and outlet connections for circulating a cooling medium through said container, and an air manifold communicating with said container and outlet connection.

5. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, inlet and outlet connections for circulating a cooling medium through said container, and a tubular manifold communicating with said outlet connection, substantially surrounding said container and having the branches thereof angularly arranged with respect to said container and connected thereto.

6. In combination, an electron discharge device having an external anode, a fluid-tight container surrounding said anode, inlet and outlet connections for circulating a cooling medium through said container, and a helical tubular manifold joined to said outlet connection, substantially surrounding said container and having curved branches of graduated lengths communicating with the interior of said container.

7. In combination, an electron discharge device comprising a metallic container serving as the anode of the device, a cooling system therefor comprising a fluid-tight container enclosing a portion of said anode, inlet and outlet connections for circulating a cooling liquid through said container in contact with said anode, and a by-pass connection between said container and said outlet connection for removing entrapped air from said container.

8. In combination, an electron discharge device comprising a metallic container serving as the anode of the device, a cooling system therefor comprising a fluid-tight container forming a chamber enclosing a portion of said anode, means for circulating a cooling liquid through said chamber in contact with said anode, and means in communication with said chamber and said first mentioned means for removing entrapped gases from said container.

9. In combination, an electron discharge device having a metallic anode serving partially as a wall of said device, a cooling system therefor comprising a fluid tight container enclosing a portion of said anode, inlet and outlet connections for circulating a cooling liquid through said container, and a by-pass connection between said container and said outlet connection for removing entrapped gases, the highest point of said by-pass connection being above the level of said liquid in said container.

10. In combination, an electron discharge device having an external anode, a cooling system therefor comprising a fluid tight container forming a chamber surrounding a portion of said anode, inlet and outlet connections for circulating a cooling liquid through said chamber and in contact with the surface of said portion, a restricted section in said outlet connection, and a by-pass connection be-

tween said container and said restricted section, whereby the liquid flowing through said restricted section produces a suction in said by-pass connection to remove entrapped gases and vapors from said container.

In witness whereof, I hereunto subscribe my name this 25th day of June, A. D. 1926.

PAUL C. HOERNEL.
JOHN W. SMITH.