March 12, 1935. H. B. McEUEN 1,994,140

INTERNAL RADIATOR FOR ANODES

Filed Nov. 20, 1931

Fig. 2.




Fig. 5.

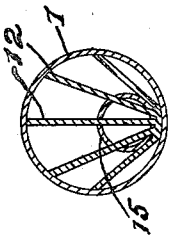



Fig. 1.

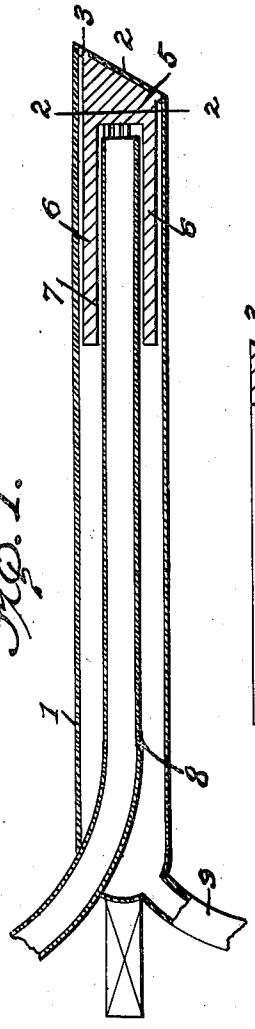



Fig. 3.

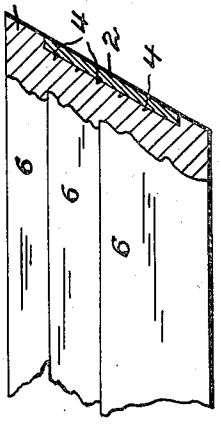
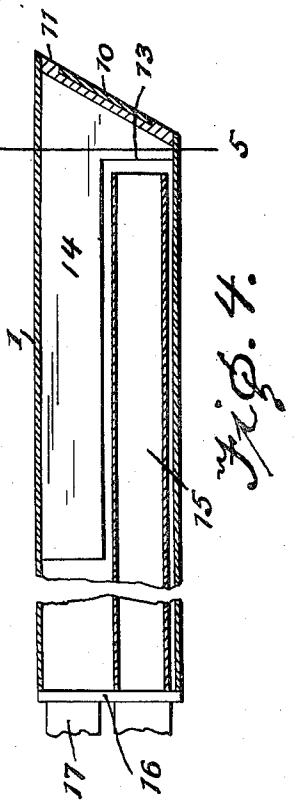



Fig. 4.




INVENTOR.
H. B. McEUEN
BY Edward J. Fletcher
ATTORNEY

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# UNITED STATES PATENT OFFICE

1,994,140

## INTERNAL RADIATOR FOR ANODES

Harry Bernard McEuen, Jacksonville, Fla.

Application November 20, 1931, Serial No. 576,378
Renewed May 24, 1934

17 Claims. (Cl. 250—35)

This invention is directed to an improvement in anodes for X-ray tubes, with particular regard to permitting material increase of the total load capacity of such tube without overheating.

In tubes as heretofore proposed the input capacity has been materially restricted and output energy limited by the necessary smallness of the focal point of the anode and the limitation in effective cooling to maintain the usual tungsten button below the melting or gassing point.

The primary object of the present invention is to provide for effective cooling of the tungsten button even under materially increased input as compared with the present type, thereby materially increasing the range of effectiveness of the apparatus, without danger to the operator or liability of damage of the parts.

The important constructive detail of the present invention is the provision of metallic means for diffusing the heat of the button proper over a comparatively large area, and subjecting this area to the heat exchange with a cooling medium in circulatory flow, to dissipate or carry away the heated condition.

The invention is illustrated in the accompanying drawing, in which:—

Fig. 1 is a view in longitudinal section of an anode of an X-ray apparatus, showing the application of the improved cooling means.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged sectional view, partly in elevation, showing the connection of the tungsten button and the metallic backing therefor.

Fig. 4 is a view similar to Fig. 1, showing a slightly-different form of cooling means.

Fig. 5 is a vertical sectional view, taken on the line 5—5 of Fig. 4.

The showing here is of an anode for use in connection with X-ray apparatus, and while more particularly designed for use in connection with the apparatus described in my copending application, Serial Number 428,798, February 15, 1930, is obviously capable of other and varied uses and purposes, and any and all such are contemplated.

The forms of the invention shown in Figs. 1. and 4, differ simply in the specific forms of radiator fins and in the fact that the cooling agent for the form in Fig. 1 is designed to be pressure operated, while the cooling agent of the form shown in Fig. 4 is responsive to thermo-siphon action.

In the form shown in Figs. 1, 2, and 3, the tube 1 is arranged at one end for the reception of the target, made up of a tungsten button 2. For the purposes of this invention the button 2 is embedded in a metallic, preferably copper, backing sheet 3. To insure the maximum heat conductive contact and also more securely fix the button to the backing sheet, the button is formed with projections or spurs 4, which are embedded in the material of the backing sheet.

The backing sheet, which is comparatively thin is integrally or otherwise formed to provide fins 5, radiating from the center of the backing and terminating immediately free of contact with the tube 1. These fins for an appropriate distance from the center of the backing sheet have a limited extension rearwardly, the remaining and relatively outer portion of each fin being extended rearwardly for a considerable distance, as indicated at 6. The fin extensions 6 thus define a central passage 7, open at the rear and having relatively narrow fin portions at the front.

A tube 8 for the cooling agent, whether water, oil, or other medium, is projected through the end of the tube 1 remote from the target, and extends centrally of the tube 1, with its open forward end terminating immediately adjacent the short fin lengths. The tube extends longitudinally of the passage 7, defined by the fin extensions 6, being preferably free of contact with the edges of such fin extensions to permit free flow of the cooling agent. The end of the tube 1 remote from the target is sealed in an appropriate manner, except for the passage of the tube 8, preferably entering at the upper portion of the tube, and for an outlet 9 for the heated water. The outlet, which is of tube form may be integral with the end sealing element, or secured thereto, such outlet tube merely communicating with the tube 1 at the sealed end.

In the form shown in Figs. 4 and 5, the target is similar to the form first described, including a tungsten button 10, and a metallic backing 11, the cooperation of the button and backing, including the spurs, being as illustrated in Fig. 3. It is of course to be understood that while the provision of the spurs 4 are to be preferred, other similar means may be arranged in either form, or any such means eliminated.

The backing 11 of this form is also provided with fins, such fins 12 in this case radiating from an area or point at the extreme lower edge of the backing, and diverging therefrom upwardly, as clearly shown in Fig. 5. The lower portions of these fins 12 terminate inwardly of the backing and a short distance therefrom, as at 13, while the upper portions of the fins are extended longitudinally of the tube 1, as fin-extensions 14.

A tube 15 for the cooling agent extends through

the sealing end 16 of the tube 1, and is directed lengthwise the tube 1, parallel to and in spaced relation with the lower portion of the wall of the tube. The free open end of the cooling tube 15 terminates immediately in advance of the terminals 13 of the short lower portions of the fins 12. An outlet tube 17 communicates with the upper portion of the tube 1, being appropriately secured in the sealed end of such tube 1.

In the form shown in Figs. 1 and 2, the cooling agent is delivered through the tube 8 under more or less pressure, and the circulation through the tube 1 and through the outlet 9 is maintained by this pressure. In the form shown in Figs. 4 and 5, the circulation is maintained by thermo-siphonic action, the cooling agent rising through the fins, becoming heated, and flowing out the higher outlet.

In both forms the heat of the focal point is readily distributed by conduction to the extremely large relative metallic area, broken into fin formation to present maximum surface area, and through the circulation of the cooling agent in contact with this large metallic surface area, the heat is carried away from the target and dissipated. The rapid and effective cooling of the target permits a material increase in the electrical energy which may be employed, with obvious advantageous results.

The rapidity of the circulation of the cooling agent may be controlled as desired in the pressure system, and will be automatically controlled in the thermo-siphon system. Of course in the thermo-siphon system the tubes 15 and 17 may be in communication with an external tank for continuous circulation, with the tank subject to an external cooling agent. This arrangement is conventional, and requires no particular illustration.

In more detail it is contemplated that the tungsten button should be at least two inches in diameter and the metallic backing relatively thin, say about two millimeters in thickness, the fins being of corresponding diameter. The metal employed is preferably copper, owing to the high heat conductivity of such metal, though specific limitation to copper is not intended.

In connection with that characteristic of the invention designed to prevent damage to the parts, attention is called to the fact that the fins serve as a grid-like reinforce to the matrix, preventing the matrix and button from bulging from the pressure of the cooling fluid or due to the pull of the vacuum in the X-ray tube proper. As previously stated a thin backing is contemplated, and hence the extreme value of the fins as a reinforce is apparent.

The tube 1 may be supported in any desired manner.

Having thus described the invention, what is claimed as new, is:—

1. An anode for X-ray apparatus and the like including a tube, a target at one end thereof, means for delivering a cooling agent adjacent the target, and means carried by the target and extending rearwardly beyond the delivery end of the cooling agent delivering means to provide a relatively large heat exchange surface between the target and the cooling agent.

2. An anode for X-ray apparatus and the like including a tube, a target at one end thereof including a metallic backing, means for delivering a cooling agent adjacent the metallic backing, and a series of metallic fins extending from the metallic backing and materially beyond the delivery end of the means for delivering the cooling agent, said fins including portions of reduced length immediately in advance of the delivery end of the cooling agent delivering means.

3. An anode including a target having a metallic backing, a series of fins extending rearwardly from the backing and radiating from a lower point of the backing, the length of the upper portion of the fins exceeding the length of the lower portion thereof, and means for delivering a cooling agent in line with the reduced length of the fins.

4. An anode including a target having a metallic backing, a series of metallic fins projecting rearwardly therefrom and radiating from the lowest point of the backing, the lowest portion of the fins forming a space, and a cooling agent delivery means having its discharge end within said space.

5. An anode including a target having a metallic backing, a series of rearwardly extending metallic fins connected to the backing, said fins radiating from substantially the central point of the backing, the length of the fins within the central area of the backing being of reduced length to provide a space, and a cooling agent delivery means having its discharge end within said space.

6. An anode including a target having a metallic backing and fins projecting from the backing, said fins at a point remote from the backing being of reduced radial dimensions to define an elongated space, and a cooling fluid delivery tube having its discharge end in such space.

7. An anode including a target having a metallic backing, a series of fins extending from the backing and radiating from the central point thereof, said fins at a point remote from the backing being reduced in radial dimension to form a central pocket, and a cooling-fluid delivery tube having its discharge end in such pocket.

8. An anode including a metallic backing, fins radiating from a point substantially at the margin of the backing, said fins at a point remote from the backing being reduced in radial dimension to define a pocket extending substantially coincident with the margin of the backing, the radial length of the fins defining the pocket varying one from the other, and a cooling tube having its discharge end in such pocket.

9. An anode including a backing, a series of fin-like blades radiating from a point on the backing and extending away from the backing, each of said blades at a point remote from the backing being cut away, the remaining portions of the blades throughout such cut-away portions together defining a pocket, the margin of the pocket being defined by spaced fins, the uninterrupted radial lengths of the blades next the backing defining the end of the pocket, and a cooling tube having its discharge end in such pocket.

10. An anode including a metallic backing, a series of elongated fin-like blades carried by the backing and radiating from a point thereon, the fins adjacent the backing extending from such point substantially to the margin of the backing, the remaining lengths of the fins being reduced in radial dimension to together define a pocket, and a cooling tube having its discharge end in such pocket.

11. An anode including a target, a metallic backing therefor, a series of fins radiating from a point on the backing, each of the fins projecting from the backing in a direction opposite to the target, and being cut away for a definite

length from their free ends to a point spaced from the backing, the cut-away portions of the fins defining a pocket-like space, and a cooling tube having its discharge end in such space.

12. An anode for X-ray apparatus and the like, including a tube and a target, the target including a metallic backing having a series of heat radiating fins arranged to define a pocket, and means having its discharge end within the pocket for delivering a cooling agent within said pocket.

13. An anode for X-ray apparatus and the like, including a tube, a target at one end thereof, a series of metallic fins extending from the target within the tube, and cooling fluid delivery means having a discharge end between the ends of the fins and the target.

14. An anode having a target including a backing therefor, said backing having a series of fins radially disposed on the rear face of the backing and extending rearwardly therefrom for a distance in excess of the thickness of the backing, the fins defining an extended heat radiating surface and providing a truss-like reinforce for the backing.

15. An anode having the backing of the target formed with a series of rearward-extending reinforcing fins radiating from a common point.

16. An anode having the backing of the target formed with a series of rearwardly exteding relatively radial spaced fins to reinforce the backing and provide relatively extended heat radiating surfaces.

17. An anode having the backing of the target formed with rearwardly-extending reinforcing fins, the fins being cut away to provide a pocket for the reception of a cooling agent.

HARRY BERNARD McEUEN.