June 20, 1950

H. J. DAILEY

2,512,143

ELECTRON DISCHARGE DEVICE HAVING A RADIATOR INTEGRATED THEREWITH

Filed Dec. 15, 1948

2 Sheets-Sheet 1

Fig. 1.

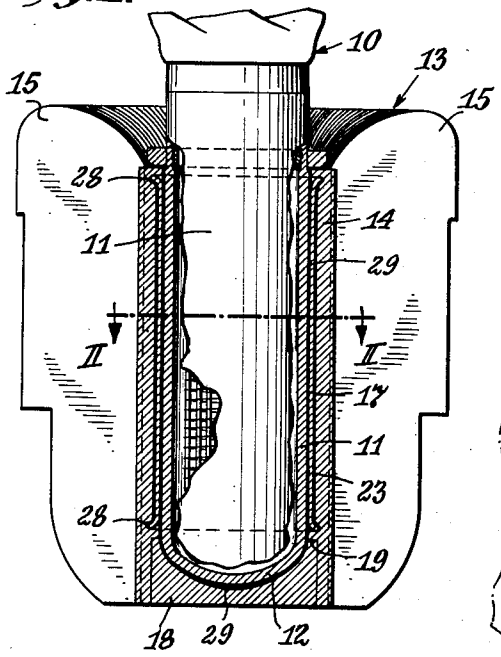


Fig. 2.

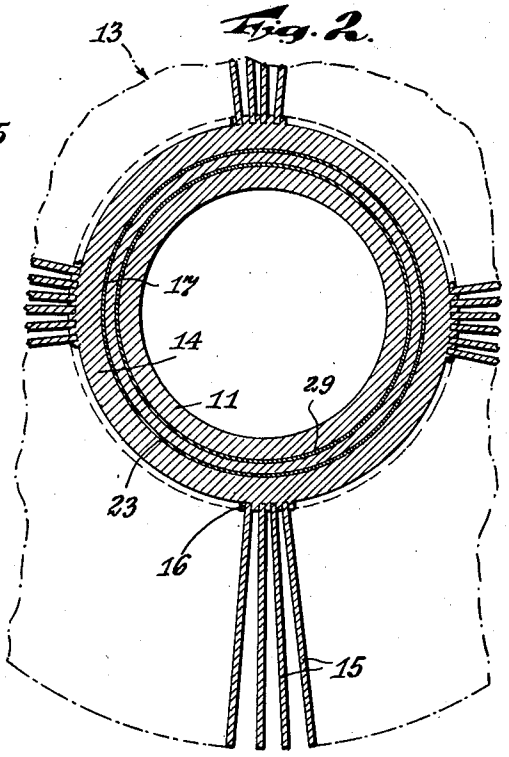


Fig. 3.

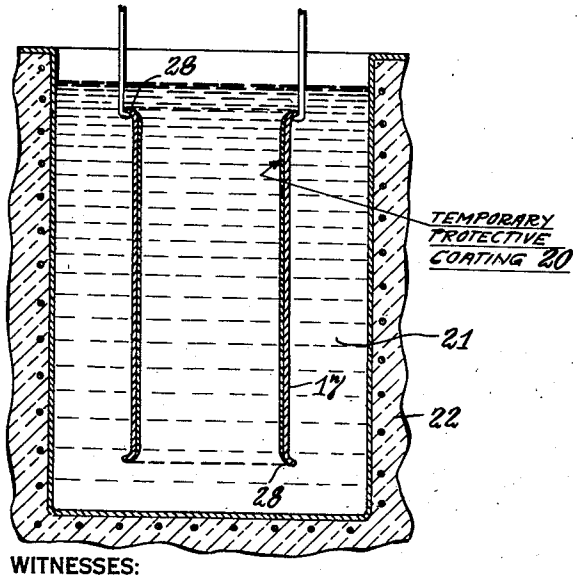
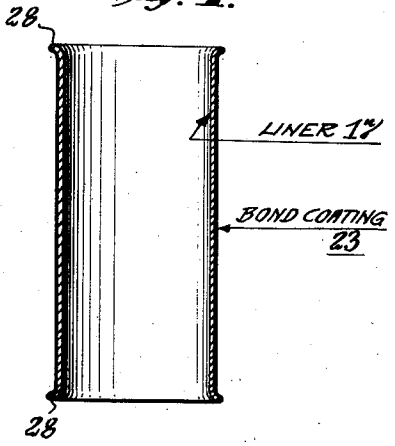


Fig. 4.



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Fig. 5.

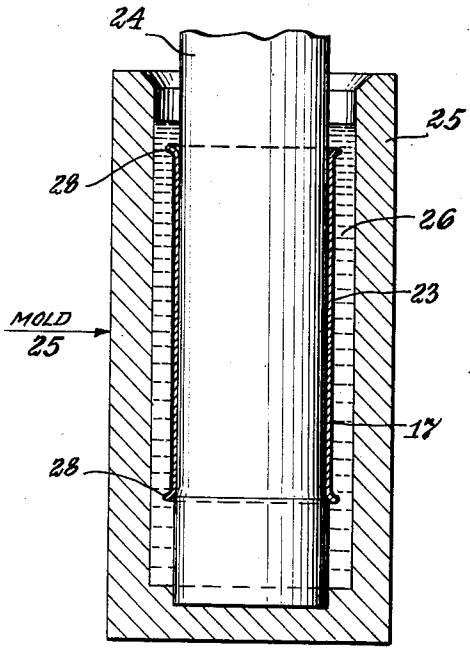


Fig. 6.

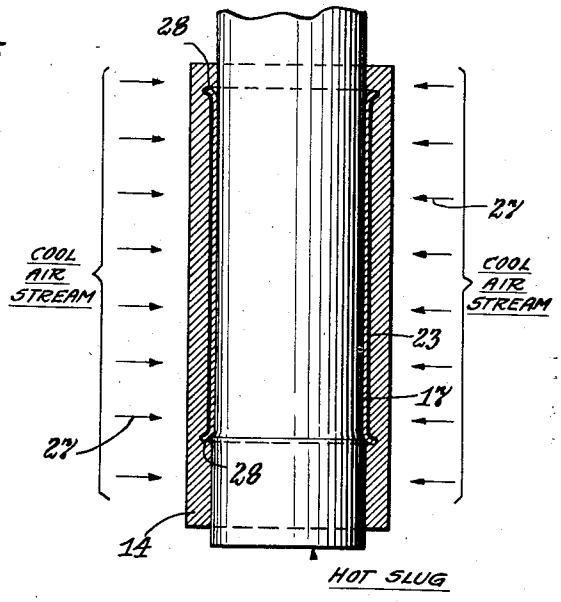


Fig. 7.

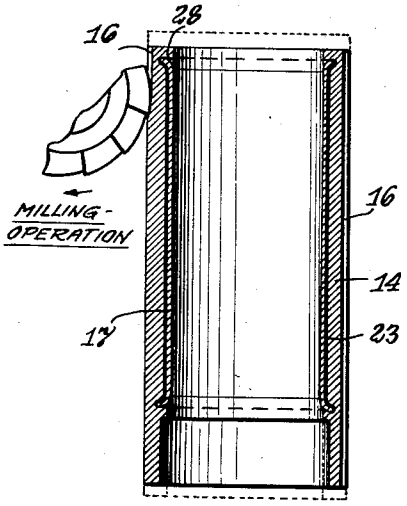
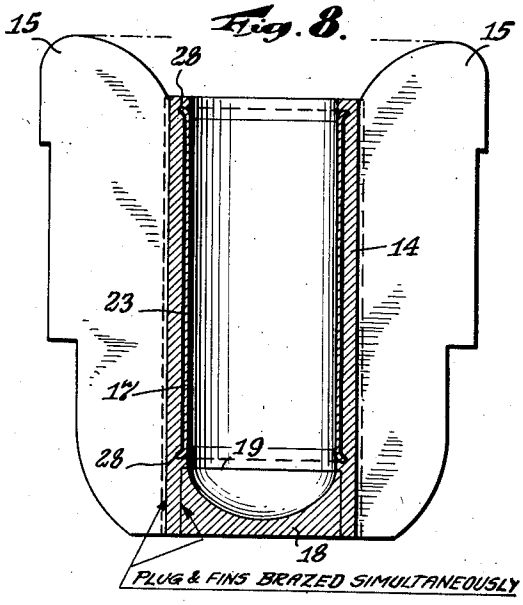


Fig. 8.



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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE HAVING A RADIATOR INTEGRATED THEREWITH

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Application December 15, 1948, Serial No. 65,434

9 Claims. (Cl. 250—27.5)

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This invention relates to radiators and more particularly to radiators for electron discharge devices.

Present day transmitting tubes included in the general classification of electron discharge devices, are the source of intense heat during operation, and require radiators of good thermal conductivity and adequate surface area to disperse the generated heat. Radiators employing copper fins have been commonly used. While the tubes alone are relatively light, not usually exceeding twenty-five pounds, the copper radiators may be several hundred pounds, and thus require a crew of several men or a crane to handle and to make tube replacements as needed from time to time. If it were possible to merely substitute aluminum or other light-weight metal or alloy for the copper in fabrication of the radiators, great saving of weight would be accomplished as density of aluminum is approximately 168 pounds per cubic foot as compared with 555 pounds for copper. However, until now, the fabrication of a radiator of aluminum, magnesium or alloy thereof and assembly with a transmitting tube has not proved practical. A prerequisite for a successful radiator is that it must have a secure bond with the copper anode of the transmitting tube, but aluminum, for example, when fabricated, quickly forms a very stable oxide surface to which it is, for all practical purposes, impossible to make a good solder joint. This lack of adequate bond with the anode has prevented adoption of aluminum radiators for transmitting tubes, and similarly has prevented adoption of radiators of other light-weight metals and alloys.

Accordingly, the fundamental purpose of the present invention, is to provide a practical radiator of light-weight material such as aluminum for an electron discharge device and particularly for a transmitting tube in that classification.

Also, in general terms, an object of the invention is to provide an improved radiator of light-weight material such as aluminum adaptable to attachment to a copper anode of an electron discharge device with a secure bond therewith.

More specifically, an object of the invention is to include within the radiator a means by which secure attachment between radiator and anode may be obtained.

Another object of the invention is to provide a liner for the radiator which can be soldered to the anode.

Yet another object of the invention is to obtain a complete bond between the liner and the radiator hub or body.

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A further object of the invention is to provide an improved method of fabrication.

Still other objects of the invention will appear to those skilled in the art to which it appertains as the description proceeds, both by direct recitation thereof and by implicaion from the context.

Referring to the accompanying drawings in which like numerals of reference indicate similar parts throughout the several views:

Fig. 1 is a longitudinal section of a radiator fabricated in accordance with the present invention and shown applied to an anode, which is depicted partly in section and partly in elevation;

Fig. 2 is a transverse section on line II—II of Fig. 1; and

Figs. 3 to 8 are longitudinal sectional views showing successive steps in fabrication of the improved radiator of the present invention.

In the specific embodiment of the invention illustrated in said drawings, the reference numeral 10 designates an electron discharge device in general, having usual triode or other electrodes of which the anode 11 shown herein is formed as part of the envelope with which it is appropriately sealed so as to be evacuated, the lower end of said anode being closed as by an integrally formed dome 12. The anode is usually made of copper and in the construction shown is an exterior part of the tube so as to be available for heat dissipation.

The radiator, designated in general by numeral 13, comprises a hollow body or hub 14 from which, in radial planes, project a plurality of fins 15. The present invention contemplates use of light-weight metal such as aluminum, magnesium, or alloys thereof, as the material of which said hub 14 and fins 15 are fabricated. As indicated in Fig. 7, the exterior cylindrical surface of the hub is milled with a plurality of longitudinal grooves 16, one for each fin, and the inner edges of the fins are applied in the grooves and brazed or otherwise securely attached throughout their engaging portions with the hub.

The interior of the radiator body or hub is provided with means for enabling the body to be securely attached to the anode throughout the juxtaposed surfaces after telescoping the said body upon the anode. According to the present invention, a metallic liner 17 is made integral with the said hub and constitutes the inner surface of the radiator body. Said liner is integrated with the hub so as to transmit heat by conduc-

tion from the anode to the hub and fins, and is a metal which can both be bonded securely with the metal of the hub and with the copper of the anode, and is preferably a metal of the ferrous group, such as iron, steel or nickel. The lower end of the hub is closed with a plug or cap 18, hollowed to substantially conform to the curvature of dome 12, said cap being preferably of aluminum or other light-weight metal and brazed or otherwise secured in place. For convenience and accuracy of assembly, the lower end diameter of the central hollow or cavity through the hub is greater than the diameter of the liner cavity so as to provide a shoulder 19 against which the plug or cap will seat at its peripheral margin.

In carrying out the method of fabrication, the liner is first given a temporary coating 20 on its interior or hollow surface as indicated in Fig. 3, of a material resistive to adhesion of aluminum or other metal of which the hub is to be cast, and protective against chemical reaction either with said metal or aluminum, or with oxygen, or the metal of the said ferrous group of which the liner is composed. Such a coating material may appropriately be graphite or similar carbonaceous compound of which "Aquadag" is one well suited to the purpose. The liner is then submerged in molten aluminum 21 or equivalent metal, shown in Fig. 3 as kept in its fluid state by inclusion in an electrically heated pot 22. By virtue of the temporary protective coating 20 on the inside of the liner, no reaction takes place between the molten metal or aluminum and the inner surface of the liner, but in view of the direct contact of the outer surface of the liner with the molten aluminum, a coating of aluminide 23 is formed thereon. With an iron or steel liner, the aluminide coating 23 will be iron aluminide, whereas with a nickel liner, the coating thus chemically formed will be nickel aluminide. The liner is then withdrawn from the molten aluminum, shown as accomplished in Fig. 4, and mounted upon a slug 24 substantially filling the cavity of the liner and protruding at the ends to constitute a male molding core. The liner, with its included molding core or slug 24 is then inserted in a female mold 25 of cylindrical shape and coaxially thereof, after which molten light-weight metal such as aluminum 26 is poured into the mold to form in this specific instance the aluminum hub or body 14 upon the liner, shown accomplished in Fig. 5. This aluminum 26 will bond with the liner on the surface thereof having the aluminide coating 23, and thus forms the hub or body 14 which becomes an integral part with the liner. The integration of hub and liner is made more positive and permanent by cooling the hub first at the outside and progressively inwardly toward the liner. As indicated in Fig. 6, slug 24 is therefore preferably hot, and as conditions may warrant, can be the original slug used as the above-described male molding core, or may be a substituted and especially heated slug applied immediately upon withdrawal of the hub or body from its female mold 25. Then cool air or other cooling medium is applied to the exterior of the light-weight metal or aluminum hub or body, as indicated by arrows 27, obtaining the desired cooling thereof progressively from the outside inwardly.

For further enhancing permanent integration of the body or hub upon the liner, the ends of the liner are preferably flared outwardly as at 28, and are therefore fully embedded in the aluminum or other metal of the body in the aforementioned molding operation.

After the molding operation and cooling are effected, the hub is trimmed to length and the exterior surface is milled, as indicated in Fig. 7, to provide the series of parallel grooves 16 longitudinally of the hub for reception and retention of fins 15. Plug 18 is inserted in the end of the body and then the plug and fins are simultaneously brazed in place.

At a convenient stage in the procedure subsequent to molding and cooling the body, the graphite or other temporary protective coating 20 on the interior of the liner is removed mechanically or chemically, and when the assembled radiator is ready for application to the anode of the electron discharge device, the hollow of the radiator and the exterior of the anode are cleaned. Solder is then introduced into the hollow of the radiator and heat applied until the solder is liquefied and the anode is then pressed into the hollow of the radiator until solder extrudes at the top of the radiator cavity and the parts have desired relation. The solder 29 will harden and tenaciously adhere to the liner and to the anode and provides an excellent heat-conductive path from the anode to the radiator. The solder performs the function of providing a secure bond which will not deteriorate by oxidation. By providing a structure enabling the radiator to be fabricated from aluminum or equivalent metal, a relatively light-weight radiator is obtained, and as comparative weights, it may be pointed out that where a prior art copper radiator weighed 225 pounds, an equivalent aluminum radiator in accordance with the present invention weighs only 98 pounds, thereby enabling one man to make a tube replacement in service. Since handling can be done by one man, the apparatus may be more compactly arranged, thus saving space in the transmitter station. Furthermore, providing lighter weight radiators of the present invention reduces shipping costs considerably.

I claim:

1. An electron discharge device comprising a copper anode, a radiator of light-weight metal of the character of aluminum mounted on said anode, and a liner of metal different from the anode and radiator interposed between the anode and radiator and secured to both.

2. An electron discharge device comprising a copper anode, an aluminum radiator mounted on said anode, and a liner of metal of the ferrous group interposed between the anode and radiator and secured to both.

3. An electron discharge device comprising a copper anode, an aluminum radiator mounted on said anode, and a ferrous liner interposed between the anode and radiator and secured to both.

4. An electron discharge device comprising a copper anode, an aluminum radiator mounted on said anode, and a nickel liner interposed between the anode and radiator and secured to both.

5. An electron discharge device comprising a copper anode, an aluminum radiator mounted on said anode, a liner of a metal different from the anode and radiator interposed between the anode and radiator, said liner having a coating of an aluminide of said metal thereof interposed between the liner and radiator for integrating said liner and radiator as a unit, and solder interposed between said anode and liner for securing the said liner on the anode.

6. A hollow radiator for an electron discharge

device comprising an aluminum hub, fins projecting from said hub, a liner of metal of the ferrous group within said hub and providing an inner surface for the hollow of the radiator to which solder will adhere, and a coating of an aluminide of the said metal of the liner interposed between and adherent to both the liner and the hub for inseparably integrating the liner and hub as a unit.

7. A hollow radiator for an electron discharge device, comprising an aluminum hub, fins projecting from said hub, a liner of ferrous metal within said hub and providing an inner surface for the hollow of the radiator to which solder will adhere, and a coating of ferrous aluminide interposed between and adherent to both the liner and the hub for inseparably integrating the liner and hub as a unit.

8. A hollow radiator for an electron discharge device, comprising an aluminum hub, fins projecting from said hub, a nickel liner within said hub and providing an inner surface for the hollow of the radiator to which solder will adhere, and a coating of nickel aluminide interposed between

and adherent to both the liner and the hub for inseparably integrating the liner and hub as a unit.

9. A hollow radiator for an electron discharge device, comprising a hub, fins projecting from said hub, and a liner within said hub providing an inner surface for the hollow of the radiator, said liner having a length less than the length of the hub and having flared ends embedded in the said hub.

HAMPTON JENNINGS DAILEY.

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