Our invention relates to discharge devices and especially to an air cooler for a vacuum tube with an external anode.

An object of the invention is to provide an optimum design of air coolers for discharge devices, particularly vacuum tubes with an external anode.

Another object of the invention is to provide an air cooler that may be readily assembled.

Another object of the invention is to provide an air cooler for a vacuum tube with an external anode that can be assembled in the field.

Generally speaking, the amount of power dissipation by a cooler is proportional to three factors, namely, the average temperature difference between the fins and air, the rate of heat transfer from copper to air, and the total area of the cooling surface.

Heretofore coolers have been designed in regard to the shape of the fins without any thought as to the relation between the various parts of the cooler to obtain an optimum design. We have discovered that there is a definite relationship between the diameter of the core and the diameter of the fins attached thereto that provide an optimum design. This discovery is that the diameter of the core should be approximately one-half the diameter of the fins attached thereto.

In the light of this discovery, it is obvious that considerable wastage of material has been made by the elongated fin diameters in the air coolers of the prior art. The diameter of the core according to our invention may be anywhere from .4 to .6 of the diameter of the fins and should preferably be within .45 to .55 of the diameter of the fins.

In Fig. 1 we have represented a typical vacuum radio tube with its glass insulating envelope sealed to an exterior copper anode 11. The familiar grid lead 12 is also represented passing to an exterior connection 13. The connections 14 extending to the familiar cathode from exterior connections 15 are also disclosed. This representation of a tube is to be taken in an illustrative sense and not in a limiting one.

Closely fitting about the exterior anode 11 is a core 16 of copper soldered to the anode, preferably by cadmium, although other substances may be used. This copper core 16 is preferably of a cylindrical shape slightly longer than the anode and having in its cylindrical surface a plurality of slots 17 in which are welded or brazed the fins 18. These fins should have the minimum fin thickness and minimum spacing possible between the fins at their connection to the core surface.

We have discovered that the diameter of the core, as represented in Fig. 1, should be approximately one-half the diameter of the fins. This dimension may vary from .4 to .6 as previously mentioned, but should preferably be within .45 to .55. This particular relationship provides the optimum dimensions for effective cooling. Adding to the length of the fins does not proportionately increase the heat dissipation.

Within these optimum dimensions the fins may be bent at 19 as illustrated in Fig. 3, or curved as illustrated at 20 in Fig. 4, in order to increase...
their area. A plug 21 may be inserted around the curved bottom end of the anode as illustrated in Fig. 1.

In Figs. 5 and 6 we have illustrated a very economical and easily assembled type of air cooler. The cast core, such as would be utilized in Fig. 1, sometimes contains a number of blow holes and occasionally there is imperfect contact between the core and the fins attached thereto that causes undesirable high temperature drop.

In Fig. 5 we have illustrated an air cooler which is composed of comparatively thin punchings 23 stacked up around the anode 11. These punchings have a top cover plate 26. There is also a bottom plate 27 with a projection 28 extending upwardly to fit closely around the bottom of the exterior anode 14. These punchings have a central circular plate 25 with integral radial fins or pins 39 extending therefrom. The stacked plates 23 form a core body. The diameter of the central plates 23 is approximately one-half the diameter of the punching, including the radial fins 39. These punchings are pressed together, preferably by the bolts 31 illustrated on the drawings. They are then soldered together. The plug 29 prevents the solder from flowing out the bottom. It also helps transfer heat from the curved bottom of the exterior anode outwardly to the fins.

Certain particular types of tubes have an unusually long exterior anode. In such a case it might not be desirable to design an air cooler requiring air to travel the length of the tube inasmuch as at a given velocity the air may be too hot at the outlet, thus reducing the efficiency of cooling at the upper end of the tube. Moreover, friction resistance in long narrow ducts of the cooler may reduce the cooling efficiency. Our invention is adapted for such a special tube to provide a cooler with an air blast perpendicular to the axis of the tube.

In Figs. 7 and 8 we have disclosed an efficient design for such a special tube. This design is made out of punchings which under the cover plates 32 have a central area 33 and then an extension 34 to the left on one punching, and to the right 35 on the next punching. The width of the central area 33 of the stacked punchings forming the core body exposed to the air flow may be approximately one-half the distance through the air cooler, including the alternate projections 34 and 35. The punchings may be bound together such as by bolts 33 illustrated in connection with Fig. 5. Each of the plates acts as an individual and independent heat radiator and provides a direct heat flow therethrough from the central opening to the outside without the interposition of any joint.

One disadvantage of the air cooler is that it is very heavy and bulky for transportation and handling. In order to eliminate the inconvenience of shipping the air cooler already assembled to the tube to the field, we propose to ship them separately and then assemble them by any one of the methods disclosed in Figs. 9, 10, and 11.

In Fig. 9, for example, the exterior anode 11 is disclosed inserted in the opening in the core 16 with its extending fins 18. The core has a bottom plug 37 closely fitting about the bottom portion of the anode and has extending projections 38 making a tight thermal contact with the core. This plug has a depression 39 extending therein and in this impression is inserted a removable heating element 40. The slight space between the exterior anode and the core has been filled with solder, such as that of tin or cadmium, and the heating element 40 is utilized to solder the anode and core together.

In the place of installation, an air duct 41 generally surrounds the device. We also contemplate building cores with a built-in heater 42, as illustrated in Fig. 10, so that the solder may be heated up by making electrical connections to the outlets 43 of the heater. The advantage of the built-in heater 42 is that the tube may be unsoldered at any time it is desired to remove the tube from the cooler.

In Fig. 11 we have illustrated the possibility of utilizing the filament 44 of the tube to heat the solder surrounding the anode. The grid 45 is also disclosed in the broken-away portion of the anode 11.

We have accordingly disclosed an air cooler for the external anode of a vacuum discharge device that is most efficient in dissipating the heat from the anode to the current of air passing through the fins of the cooler. We have also disclosed a type of cooler which may be easily assembled at any place desired.

The design of the elements in one modification may be applied to the others. It is apparent, however, that many other modifications may be made in the particular embodiments illustrated, and accordingly we intend only such limitations to be imposed on our invention as are necessitated by the spirit and scope of the following claims:

1. A cooling device for a discharge device having an exterior anode, comprising a plurality of stacked plates having an opening for said anode, said plates having a portion forming a core body about said anode, said plates having integral fins extending alternately in a lateral direction from said core body.

2. A cooling device for a discharge device having an exterior anode, comprising a plurality of stacked plates having offset openings for said anode, each of said plates having an integral portion extending in a direction beyond and contrary to its adjacent plates.

3. A cooling device for a curved end cylindrical exterior anode, comprising a plurality of plates having an opening therein for said anode, said plates having projections forming fins, and a bottom plate having a boss with its inner end engaging and fitting the curved end of the exterior anode, said boss projecting into the opening of plates at the end of the anode and cooperating with said plates to conduct heat from the anode.

4. A cooling device for a curved end cylindrical exterior anode, comprising a core body fitting said anode, said core body having fins extending therefrom and a bottom plug having a boss with its inner end engaging and fitting the curved end of the exterior anode, said boss projecting into the opening of plates at the end of the anode and cooperating with said plates to conduct heat from the anode.

5. A cooling device for a curved end cylindrical exterior anode, comprising a core body having an opening fitting said anode, said core body having fins extending therefrom and a bottom plug having a boss with its inner end engaging and fitting the curved end of the exterior anode, said boss projecting into the opening at the end of
the core body at the end of the anode and cooperating to obtain heat transfer between said anode, core, fins and plug, said plug having a recess in its under side for application of heat to the plug and core body in close proximity to the anode.

6. A radiating arrangement for a discharge device having an anode structure which comprises a stack of flat plates, said plates alternately projecting laterally from said stack, a central core formed by the non-projecting ends of said plates, said central core having an opening therein for said anode structure.

7. A radiating arrangement for a discharge device having an anode structure which comprises a stack of flat plates, said plates alternately projecting laterally from said stack, a central core formed by the non-projecting ends of said plates, said central core having an opening therein for said anode structure, said plates providing direct heat flow from said opening to the outside without the interposition of any joint.

8. A radiating arrangement comprising a core body having a central opening for the reception of an exterior metal electrode therein, fins projecting from said core body and a heater embedded in said core body whereby said electrode may be soldered to or unsoldered from said core whenever desired.

9. A cooling device for a curved end cylindrical exterior anode, comprising a core body having an opening fitting said anode, said core body having fins extending therefrom and a bottom plug having a boss with its inner end engaging and fitting the curved end of the exterior anode, said boss projecting into the opening at the end of the core body at the end of the anode and cooperating to obtain heat transfer between said anode, core, fins and plug.

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