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HEAT EXCHANGING CONNECTOR

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Fig. 1.

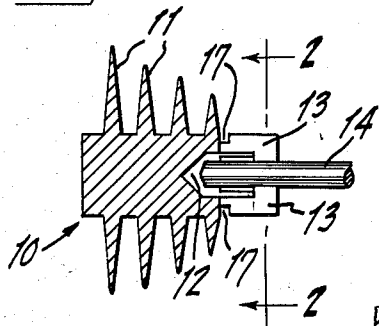


Fig. 2.

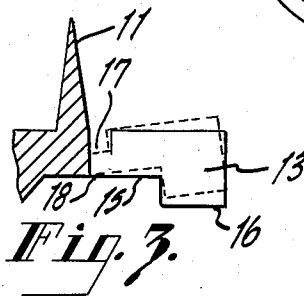
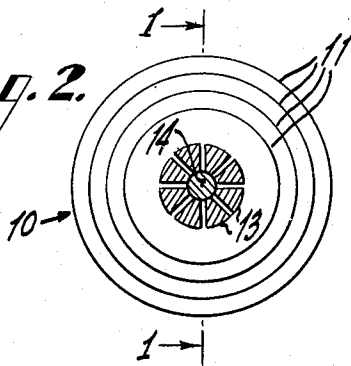
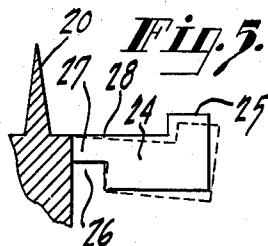
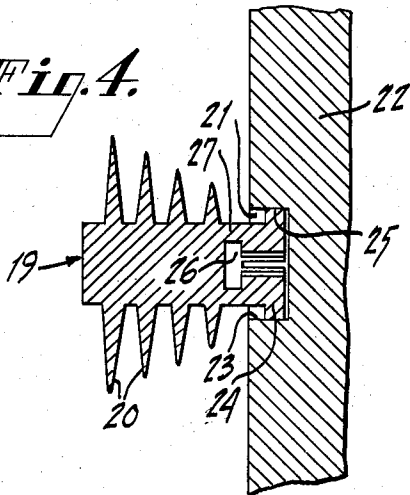


Fig. 4.



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HEAT EXCHANGING CONNECTOR

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4 Claims. (Cl. 339—112)

This invention relates to heat exchange devices, and particularly to a heat dissipating connector adapted for use with electron tubes.

It is customary, in the case of electron tubes having external anodes of high energy dissipation, and where excessive temperatures at an anode seal may result in damage to the tube, to provide a heat-dissipating means in the form of a separate anode terminal connection or cap. Generally, this anode connection or connector has been made of a material which is a good electrical and thermal conductor, such as copper. The anode connector is often slotted to provide contact fingers which are bent inwardly slightly so as to provide a physical contact between the anode and connector.

It has also been the practice to design and construct certain devices, such for example as electron tubes operable at relatively high power, wherein the heat dissipating means is an integral part of the device. Such heat dissipating means by virtue of being integrally associated with the device, provides better heat dissipation than the separate connector, but offers difficulty in the manufacture, and assembly.

Accordingly, it is an object of this invention to provide an improved heat exchanger such as a removable heat dissipating means, and more particularly a heat dissipating means in the form of a separate terminal connector for an anode, characterized by advantages of good thermal, electrical, and mechanical contact usually associated only with the above-described integrally constructed form of heat dissipating means.

In accomplishing this and other objects of the invention, I have provided an improved structure, the preferred form of which is illustrated in the accompanying drawing, wherein:

Figure 1 shows a sectional elevation of a heat exchanging anode connector according to the invention,

Figure 2 is a sectional view along the line 2—2 of Figure 1;

Figure 3 is an enlarged view of one contact member or finger of the anode connector shown in Figures 1 and 2;

Figure 4 shows a sectional elevation of a heat exchanging anode connector adapted for use with devices having a recess for engaging the heat exchanger; and

Figure 5 is an enlarged view of one contact member of the anode connector shown in Figure 4.

In accordance with the embodiment of this invention shown in Figures 1 and 2, an integral heat dissipating anode cap 10 is provided having fins 11 for radiating and dissipating heat and having at one end a socket 12 defined by fingers 13 for receiving a contact pin 14 of an external anode. If desired, a blast of air or similar cooling medium may be directed against the fins. An electrical conductor, not shown, may be connected to the cap 10 and of which the cap 10 may be a terminal. The cap 10 should preferably according to the invention, be constructed of a material, such as beryllium-copper, which has been heat-treated so that it will not anneal particu-

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larly at the fingers 13 thereof, at the operating temperatures of the tube but will retain its flexibility. As will be seen in Figure 2, fingers 13 defining socket 12 shown in Figure 1 are disposed in a substantially circular array, so as to contact a substantially continuous annular portion of the tube plate pin 14.

When forming the socket 12, a pin, not shown, of somewhat smaller diameter than the tube plate pin 14 may be placed in the socket, and the contact fingers then clamped therearound by means of a suitable jig so as to be in intimate contact with the pin. The resultant assembly is then heat treated, the effect of the heat treating being to release all strains in the metal of the spring contact fingers 13 at the reduced spacing therebetween.

The contact fingers 13 of the cap are preferably of special shape, as shown in Figure 3. Thus, the contact fingers are undercut as at 15 so that the diameter of the elongated recess, formed by a plurality of fingers 13, is less adjacent its open end than at the inward portion thereof. The extent of the undercut 15 along the length of the fingers 13 is preferably about two-thirds of the total length of the fingers 13, the remaining third including a surface 16. The depth of the undercut is relatively small in relation to the outer diameter of the circular finger array aforementioned.

In addition, the contact fingers 13 at a portion thereof spaced from their free ends, are undercut or slotted at 17 so that the periphery at such undercut portion of the circular array referred to, is smaller than the periphery defined by adjacent portions of the fingers to provide a relatively thin portion 18. The depth of this undercut 17 is preferably less than half the thickness of a contact finger, and the length of the undercut preferably extends along a relatively small portion of the total length of a finger.

While the above description has been made with reference to Figures 1, 2, and 3 showing a socket of substantially circular shape defined by the fingers aforementioned, so as to provide a substantially continuous annular engagement between the finger array and the tube plate pin 14, it should be understood that the invention is not limited to this. The invention may also be embodied in a socket 12 of any shape, such as square, hexagonal, etc. provided the tube plate pin 14 is of corresponding shape.

In describing the operation of the embodiment aforementioned, reference will be made to Figures 1 and 3. The surface 16 of each contact member of finger 13 is adapted to bear against the tube anode pin 14, as shown in Figure 1, and should be of sufficient length to provide adequate contact between the finger 13 and tube pin 14. The undercut portion 15 is provided to reduce the thickness of metal which undergoes bending strain. Additionally, the slot 17 is provided in each finger to further reduce the thickness of the finger at the region of the slot and to further facilitate a bending of the fingers by providing a space into which the metal of the fingers may be deformed, as shown in the dotted lines of Figure 3.

While the reduced thickness of the fingers at the region of slots 17 will tend to impede the heat flow through that region because of its smaller cross-sectional area, it will be apparent that the temperature gradient across the region referred to will be relatively large because of the temperature difference produced by the relatively cool fins 11 of cap 10 and the relatively hot anode pin 14 of the tube to be cooled. This temperature difference will tend to cause increased flow of heat across the thin region 18 and thereby more than compensate for diminution in heat conductivity resulting from the aforementioned reduction in cross-sectional area. Additionally, heat flow from pin 14 to the surface 16 of the fingers 13 is greatly increased by virtue of the improved forced

contact provided between that surface and pin 14. There results, therefore, a socket construction which provides improved thermal and mechanical contact between plate cap 10 and pin 14, increased facility of assembly and disassembly of plate cap 10 with respect to pin 14, and improved efficiency of heat dissipation from pin 14.

Temperature tests were made on an anode cap such as is shown in Figure 1, under given operating conditions of a tube having an anode pin 14. The temperature of the cap stabilized at from 65 to 70° C. Similar tests were made on a connector cap of the type previously used and which did not include the finger structure, including the offset surface 15 (Figure 3) and 28 (Figure 5) nor the slot 17 (Figure 1) and 26 (Figure 4), of the invention, nor the gradient in fin diameter shown in Figures 1 and 4. In these tests, the tube was operated under the same conditions as before. The temperature of the prior art connector cap under these conditions was in excess of 150° C.

While the foregoing tests provide a comparison between the connector cap 10 shown in Figure 1 and a prior art connector cap, in respect of heat dissipating properties, it is believed that a similar comparison including the connector cap 19 of Figure 4 to be described, would reveal substantially the same advantage of this cap over prior art caps. This is because the structure of the connector cap 19 is substantially the same as that of connector cap 10, as will be explained in the following.

The above-described device is of particular value for applications wherein there is a protruding member such as pin 14 to be inserted into the device. In addition, there are applications in which it would be advantageous to provide a heat-dissipating means which would not require a protruding member on the device to be cooled. Accordingly, a cap in the form of a plug 19 shown in Figure 4 is provided, having heat dissipating means in the form of fins 20. The plug may be placed in a recessed opening 21 in a device 22, to be cooled as shown fragmentally in Figure 4. It should be noted that this recessed opening 21 need not be of any particular shape, and that the shape and form of the side walls 23 of this opening need not conform to special design. A simple circular opening is sufficient, or the opening may be of square, hexagonal, etc. shape if so desired, provided the plug 19 has a contact portion of corresponding configuration. This contact portion is defined by fingers 24 arranged in a circular array, and having a contacting surface 25 which forms part of the periphery of the array. Inwardly of the circular array, each finger 24 is provided with a slot 26 which results in a portion 27 of reduced thickness in each finger. To facilitate bending response of the fingers 24 the portions thereof extending from surface 25 are undercut as shown at 28 in Figure 5.

It will be noted from the foregoing that the construction of the fingers 13 used in the embodiment illustrated in Figures 1 to 3 is essentially the same as that of the fingers 24 of the embodiment shown in Figures 4 and 5. However, it will be noted that in Figures 1 to 3 the slots 17 are in the outer periphery of the finger array, whereas in Figures 4 and 5 the slots 26 are provided internally of the socket defined by the fingers 24. It will be further noted that the contacting surface 25 of the fingers shown in Figures 4 and 5 define an outer periphery of the finger array, whereas the corresponding surfaces 16 shown in Figures 1 to 3 constitute a portion of the inner walls of the socket defined by the fingers.

However, while these differences characterize structure of the fingers forming part of the embodiment of Figures 1 to 3 and the fingers shown in Figures 4 and 5, the functions of the fingers in the two embodiments are essentially similar. Thus, in each case, the slots 17 and 26 provide a space for facilitating a bending of the fingers on mounting on their respective associated devices. Furthermore, the surfaces 16 and 25 constitute

contacting surfaces of the finger array. In addition, the undercut portions 15 and 28 serve to reduce the thickness of the fingers to facilitate bending thereof during the mounting operation.

Furthermore, in each case the finger portions 18 and 27 of reduced thickness provide efficient heat conductivity paths due to the high temperature gradients between the devices 14 and 22 and the cap 10 and plug 19 resulting from the efficient heat dissipation produced by fins 11 and 20.

An additional feature of the aforementioned two embodiments as shown in Figures 1 and 4, involves differences in diameter of the cooling fins 11 and 20 on each of these elements. The fins progressively decrease in diameter in the direction of the fingers 13 and 24. The resultant reduction in fin size thus secured in the vicinity of the associated device to be cooled causes a reduction of capacity between the fins and circuit elements of the device to be cooled and thus generally results in improved circuit performance, particularly at relatively high frequencies such as are employed in television broadcast service.

Besides reducing capacity effects as aforementioned, the gradient in fin diameter referred to also improves heat dissipation by the cap 10 shown in Figure 1 and plug 19 shown in Figure 4. Thus, each of the fins 11 and 20 will have an increased heat dissipating property with increase in spacing from the tube prong 14 and the tube anode 22 to be cooled. This is of particular advantage in association with the relatively thick shank of the cap 10 and plug 19 from which the fins extend. Thus, a major portion of the heat received by the shank adjacent the smaller fin will be transmitted along the shank to the other and larger fins. The heat so transmitted will be heat received by the shank portion aforementioned and beyond the capacity of the smaller fin to dissipate. The same situation characterizes the remainder of the progressively larger fins. Should heat transmitted along the cap or plug shank referred to and reaching the largest diameter fin, exceed the dissipating capability of this fin, the heat will be returned towards the smaller diameter fins, until each fin receives and dissipates a heat quantity related to the total heat quantity received by the cap or plug in the same manner as each fin is related in heat dissipating surface area to the other fins. This results in increased efficiency of heat dissipation. This efficiency is further aided by the tapered construction of each fin and by the fact that the progressive reduction in fin diameter provides increased fin areas from which heat radiation is unobstructed by an adjacent fin.

It will be apparent from the foregoing that the invention provides an improved heat dissipating structure that may be utilized advantageously in a connector for connection to an anode of an electron tube. The structure referred to is characterized by substantially the same heat dissipation as a structure integral with the anode, and yet possesses the advantage of being separable from the anode, not only for convenient service as a removable connector, but also for facility in manufacture.

What is claimed is:

1. A terminal connector for an external anode of an electron tube, comprising an integral structure including an elongated shank, a plurality of oppositely disposed fingers extending from one end of said shank, and a plurality of disc-like fins extending from the sides of said shank and coaxial therewith, said fingers having side surfaces adjacent their free ends adapted to engage said anode and having transverse grooves adjacent said shank, said grooves having one group of walls defining shoulders on said fingers movable into said grooves on flexure of said fingers in opposite directions, whereby bending of said fingers in a movement of relatively large magnitude at said grooves is facilitated for engaging said anode and for urging said side surfaces against said anode to

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provide a forced electrical and mechanical contact between said fingers and said anode.

2. A terminal connector adapted to engage an external anode of an electron tube, comprising an integral structure including an elongated shank having a plurality of elongated contact members extending from one end of said shank and defining a closed array and adapted to engage a portion of said anode having surfaces defining an array similar to said closed array, said contact members each having a slot extending transversely thereof and adjacent said shank for providing reduced cross-section of said contact members, said slot having a wall defining a shoulder movable into said slot on flexure of said contact members, to increase bending resiliency of said members for initiating engagement with said anode surface, said integral structure including a plurality of tapered disc-like fins coaxially disposed with respect to and extending from the sides of said shank for efficient heat dissipation from said shank, said bending resiliency of said contact members providing a force for good heat transfer contact between said contact member and said anode surfaces, whereby portions of said contact members on opposite sides of said slots are characterized by a relatively high temperature difference for increased heat conduction across said reduced cross-section.

3. A terminal connector comprising an integral structure including an elongated shank having a plurality of opposed contact members extending from one end of the said shank, said members having sides adjacent their free ends and a region of reduced cross-section adjacent said shank, said members having shoulders adjacent to said region and movable across said region for increasing the bending resiliency of said members, whereby said sides are adapted to engage in good thermal and electrical contact in electron tube anode to be cooled and to be connected to a circuit element, said integral structure including a plurality of tapered fins extending from said shank and disposed in a tapered array converging

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towards said region of reduced cross-section, whereby portions of said fingers oppositely spaced from said region of reduced cross-section have appreciably different temperatures for increasing heat conductivity across said region.

4. A heat dissipating cap adapted to be connected to an electron tube anode to be cooled, and comprising means extending from one region of said cap adapted to engage said anode in a forced thermal contact, whereby heat is effectively conducted from said anode to said cap, and means extending from another region of said cap for dissipating the heat conducted to said cap, said last named means comprising a plurality of spaced round fins coaxially disposed, said fins having tapers converging towards their peripheries, said fins being progressively spaced from said one region, the fin closest to said one region having a predetermined diameter, the others of said fins having diameters progressively larger than said predetermined diameter, whereby efficiency of heat dissipation from said one region is increased.

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