

March 31, 1970

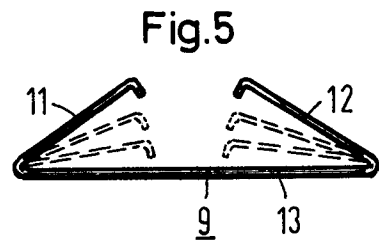
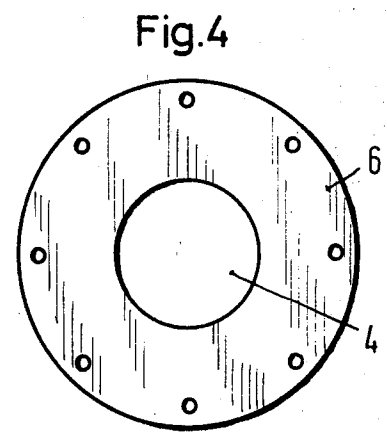
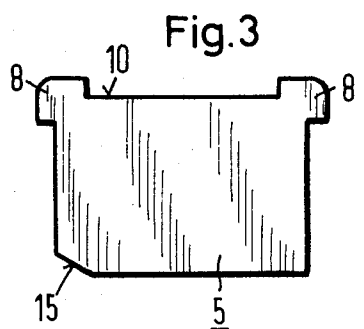
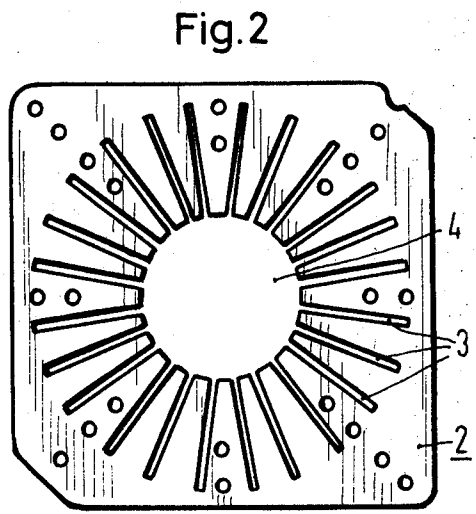
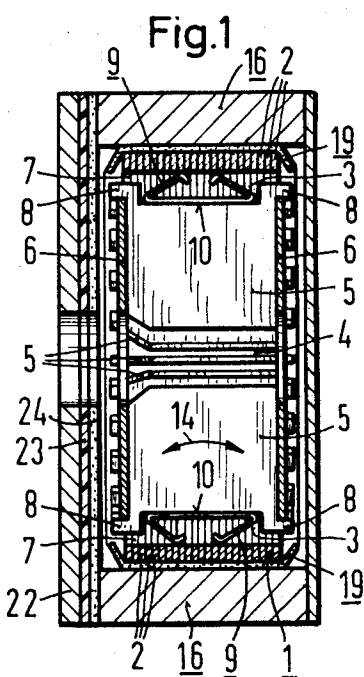
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3,503,441

ELECTRODE COOLING DEVICE

Filed April 26, 1968

3 Sheets-Sheet 1



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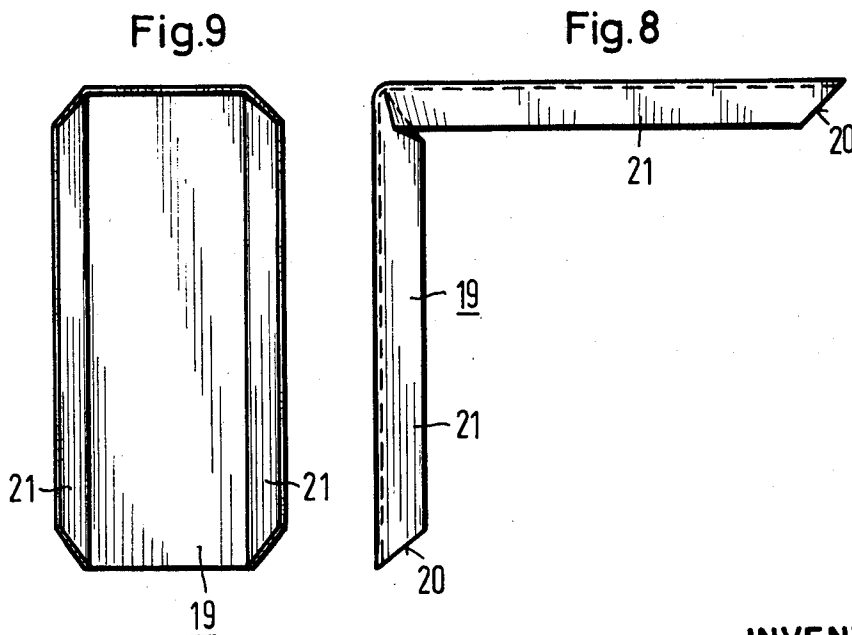
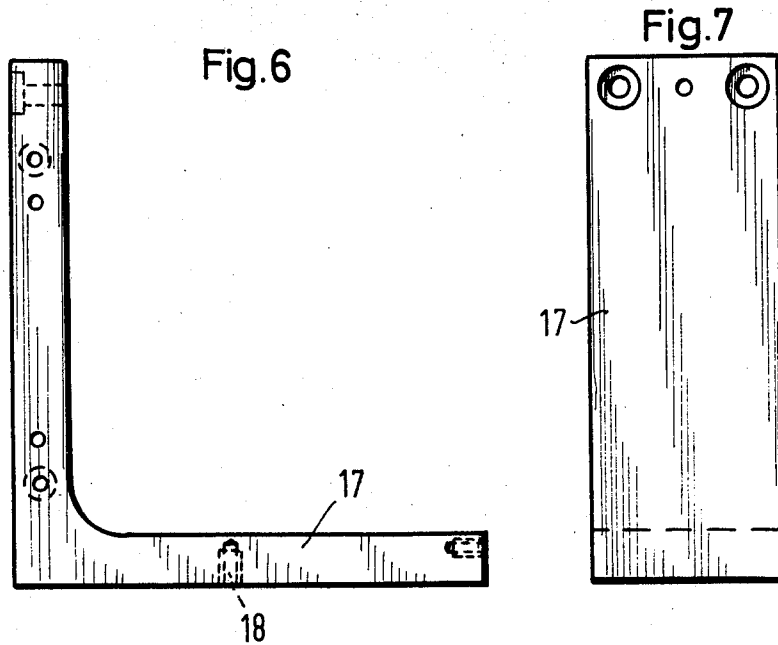
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ELECTRODE COOLING DEVICE

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig.10

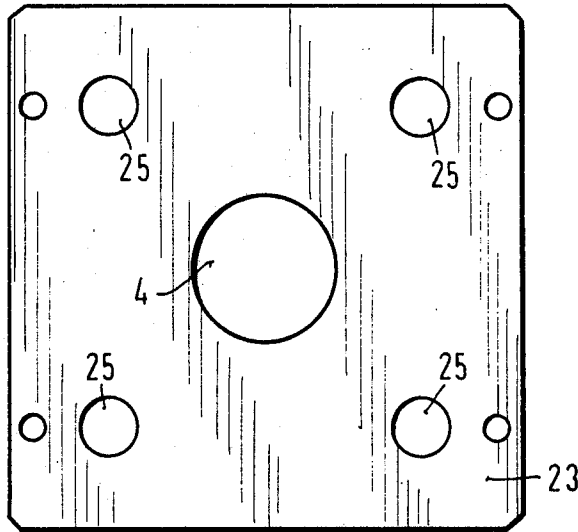
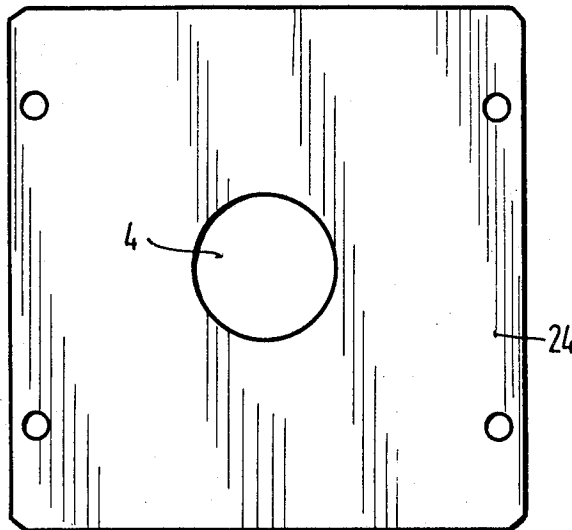


Fig.11



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3,503,441

ELECTRODE COOLING DEVICE

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10 Claims

ABSTRACT OF THE DISCLOSURE

A cooling element for high temperature tube electrodes such as electron catchers of traveling-wave tubes. The cooling element contains cooling ribs which are braced against the electrode by at least one spring. The cooling ribs are anchored to a metal block which has slots grouped in a star-like fashion around the electrode and, the cooling ribs are placed in the slots and set up in the form of a plate which is movable against the force of the spring.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to a cooling element for thermally highly strained tube electrodes interchangeable therein, in particular electron catchers of travelling-wave tubes, which cooling element contains cooling ribs which can be braced against the electrode to be cooled by at least one spring.

Description of the prior art

From the German Patent 1,121,230, one already knows of a detachable cooling element for thermally high strained tube electrodes which consists of several cooling sheets individually and loosely arranged one after another, each of which cooling sheets embraces the electrode to be cooled in annular manner and which are respectively composed of two semi-disks. The two semi-disks are braced against the electrode to be cooled by at least one spring. In this manner the cooling element can be easily detached at any time with regard to its connection with the electrode to be cooled while an excellent heat transfer from the electrode onto the cooling plates is given by the feature that each plate is spanned under spring tension with the electrode by itself. Beyond this, with regard to travelling-wave tubes, such a cooling element has the essential advantage that the free end of the electron catcher can be constructed cylindrically.

In spite of its advantageous characteristics, in the case of the mentioned known cooling element, there is the difficulty that during the inserting into the cooling element, the electrode to be cooled is exposed to a relatively high mechanical stress because the cooling plates lying behind one another have to be individually pressed apart and penetrated. This mechanical stress implies a certain risk of breakage of the tube vessel which carries the electrode to be cooled. That is, all long and thin travelling-wave tubes are, to an increased extent, subject to the risk of breakage during inserting of the electron catcher into the cooling element with its cooling plates lined up diagonally to the tube axis. Apart from this, the basically good heat transfer from the electrode onto the cooling plates is in the practice impaired by the feature that because of unavoidable production tolerances, the semidisk-shaped cooling sheets do not touch the electrode to be cooled—viewed as a cross-section—in circular manner, but only more or less in spots. Besides this, it is hardly possible to design the cooling element for electrodes with different diameter so that in the case of a wider deviation of similar tube types, a plurality of cooling elements is required.

SUMMARY OF THE INVENTION

In order to eliminate the described shortcomings, it is proposed for a cooling element of the kind described in the beginning according to the invention that the cooling ribs are anchored in a metal block which shows slots arranged in radial fashion around the electrode to be cooled, in which slots the cooling ribs are respectively set up in movable manner against the force of the spring bracing them in the form of a plate radially to the electrode to be cooled.

Above all, a cooling element according to the invention shows the essential advantage that the individual cooling ribs are braced against the electrode to be cooled in longitudinal direction and therefore also guarantee a heat transfer in the case of an electrode which is not exactly circular and this feature is superior to a cooling plate enclosing the electrode in ring-shaped fashion. Because of their play in the slots of the metal block, the cooling ribs can in this case accommodate a radial deflection or an eccentricity of the electrode to be cooled without mechanically securing it into position. On the other hand, a good heat conduction between the cooling ribs and the metal block is given because of the large-surface guidance of the cooling ribs in the individual slots. Since the cooling ribs are touching the electrode to be introduced in axial direction, that is to say in insertion direction, only a very insignificant resistance opposes the inserting of the electrodes into the cooling element. In this case, the cooling ribs are in particularly advantageous manner beveled in the slip-in range of the electrode to be cooled in order to promote an extremely easy slipping-in of the electrode between the cooling ribs. The slope at the cooling ribs does not disturb the heat-transfer because the cooling ribs can rest against the electrode over the remaining length of this electrode.

Accordingly, many objects and features will be more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein like reference numerals throughout the various views of the drawings are intended to designate the similar elements or components.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 shows a longitudinal section through a cooling element according to the invention;

FIGURE 2 shows an electrical sheet-steel lamination for the construction of the metal block for a cooling element of FIG. 1;

FIGURE 3 shows a cooling rib for a cooling element of FIG. 1;

FIGURE 4 shows a disk frontally closing the metal block of a cooling element of FIG. 1;

FIGURE 5 shows a spring element for a cooling element of FIG. 1;

FIGURE 6 shows an angle for the formation of the framing of the cooling element of FIG. 1 from the front;

FIGURE 7 shows the angle of FIG. 6 from the side;

FIGURE 8 shows an insulating intermediate layer between the metal block and the frame of a cooling element of FIG. 1;

FIGURE 9 shows the insulating intermediate layer of FIG. 8 from one side of the cooling element; and

FIGURES 10 and 11 show insulating intermediate plates for the attaining of a heat brake at a cooling element of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, reference numeral 1 indicates a metal block which is formed by punched and deburred sheet-steel laminations. The laminations 2 which are shown

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in FIG. 2 as a top view which are piled up one behind the other in congruent manner and fastened together. As seen in FIG. 2, the metal block 1 has a plurality of slots 3 which are grouped in star-like fashion around a central middle hole 4. Since all sheet laminations are equal to one another, slots 3 extend the entire depth of metal block 1. Consequently, slots 3 are open towards the two front surfaces of metal block 1 vertical to the axis of center hole 4.

Into the individuals slots 3, platelike cooling ribs 5 are inserted one of which is shown on an enlarged scale in FIG. 3. In order to prevent the cooling ribs 5 from dropping out of slots 3, on both front surfaces of metal block 1 is placed one perforated disk 6 which is shown in detail in FIG. 4. The outer radius of the disk 6 is smaller than the depth of slots 3 measured from the axis of center hole 4. In this manner slots 3 are covered at the front surfaces of metal block 1 except for the openings 7 at the radially outward portion of the slot. Through the openings 7 extends a tab 8 with which each cooling rib 5 is equipped on both sides in the range of its upper edge. In this arrangement, the height of the tabs 8 is proportioned in such a manner that tabs 8 have radial play in the openings in relation to the axis of center hole 4 which play is given through the distance of the tabs 8 from the bottom of slots 3 when the tabs 8 are positioned against the perforated disk 6.

Cooling ribs 5 are movable radially toward center hole 4 by a spring 9 which is set up in every slot 3 in the space between the outward end of the slot and the upper edge 10 of the cooling ribs 5. This will bias the cooling ribs in the direction of the hole 4. As shown in a more detailed manner in FIG. 5, the springs 9 consists preferably of a sheet-metal strip which is bent into an isosceles triangle which remains open at one point to form a pair of arms 11 and 12. The free ends of arms 11 and 12 are bent towards the inside of the triangle and are positioned against the slot bottom while the base 13 of the spring 9 rests against the upper edge 10 of cooling ribs 5. Because of this shape and set-up of springs 9, a special kind of leaf spring is attained which, in addition to the described radial bias, also enables the individual cooling ribs 5 to swing in the direction of double-arrow 14. Therefore, when an electrode is inserted into the center hole 4 and between cooling ribs 5, for example an electron catcher of a travelling-wave tube, the electrode will not suffer any mechanical stress or fixation while on the other hand the springs 9 guarantee an excellent heat-contact pressure against the electrode to be cooled.

In order to additionally facilitate the inserting of an electrode between cooling ribs 5, the cooling ribs 5 are slanted at the slip-in opening as indicated by reference numeral 15. Therefore, the electrode to be cooled does not have to be chamfered at its end which is the case for electrodes inserted into cooling devices of the prior art.

The metal block 1 of the cooling device of FIG. 1 is surrounded by a frame 16 which is formed from two L-straps 17 which are screwed together with one another. One of the L-straps is shown in FIGURES 6 and 7. The L-straps 17 are preferably provided with tapped holes 18 in order to be able to screw on convectors for heat dissipation. In this arrangement, a further advantage of the invention consists in the feature that such convectors can be set up in an arbitrary manner at one of the four sides of the cooling element.

In many applications, the electrode to be cooled by the cooling device of the present invention, in particular the electron catcher of travelling-wave tubes, has a specific electric voltage applied thereto. Therefore, it is recommended to electrically insulate the cooling device of FIG. 1 from its surroundings. For this purpose, between metal block 1 and frame 16, is placed a pair of insulating intermediate layers 19. The layers 19 are of

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plastic foil which is folded together into two widths, one of which is shown in FIGURES 8 and 9. The layers are inserted between metal block 1 and frame 16 and is especially suitable for this purpose. In this case, the layers 19 are supposed to overlap one another at their corners 20. In order to increase the dielectric strength, layers 19 are proportioned wider than the length of metal block 1. Thereby, one obtains edge strips 21 which jut out beyond the metal block in rooflike manner when the cooling device is assembled.

The cooling device of FIGURE 1 is provided with a base plate 22 which normally serves for the fastening of the entire cooling element to a high-frequency device. For example, in the case of the preferred application of the cooling device for use with an electron catcher of travelling-wave tubes the bottom plate 22 is screwed to a magnet system accommodating the travelling-wave tube. In order to be able to avoid an undesired heat transfer from the cooling element onto the magnet system in these cases, it is advantageous to provide a heat brake between the actual cooling device and base plate 22. For this purpose the bottom plate 22 is not connected directly to the cooling element, cut over two insulating intermediate plates 23 and 24 which are poor heat conductors. In this case, the intermediate plate 23 as shown in FIG. 10, which consists for example of molded plastic material, renders the anchoring of fastening of screws possible through holes 25, while intermediate plate 24 preferably consisting of plastic material (FIG. 11) covers the respective screws in electrically insulating manner.

For the construction of the shown and described cooling device one requires essentially only four individual parts, that is to say the sheet-metal cuts 2, the cooling ribs 5, springs 9 and L-straps 17. These individual parts are low in cost. Therefore, such cooling devices can be produced much less expensively than the hitherto known detachable cooling elements for thermally highly stressed tube electrons. A further simplification results from the feature that the cooling ribs can be equipped with a percentage modulation (Hub) which permits a variation of the diameter of the electrode to be cooled in a range of one to two millimeters without difficulties.

This invention is not limited to the shown example and, in particular, the metal block does not absolutely have to be constructed out of a sheet-metal package, but could also be produced out of a massive element. Furthermore, it is not necessary that the springs which brace the cooling ribs against the electrode to be cooled show the described shape. One could even provide circular springs which attack at a projection of the cooling ribs and which brace all of the cooling ribs together in radial direction against the electrode to be cooled instead of any pressure springs. In this arrangement, it would also be possible to respectively combine two cooling ribs in pairs instead of individual cooling ribs.

Accordingly, it will be apparent that many modifications and variations may be effected without departing from the novel concepts of this invention.

I claim as my invention:

1. A cooling device for cooling an electrode which is insertible therein, said cooling device comprising: a metal block which has an aperture formed therethrough and slots extending radially outwardly from said aperture and terminating in said block, cooling ribs positioned within each of said slots, and spring means on said block and engaging said cooling ribs to bias said cooling ribs radially inwardly toward the center of said aperture.

2. A cooling device according to claim 1 wherein said spring means is a plurality of individual springs each positioned within a corresponding slot for biasing the cooling rib therein radially inwardly toward the center of said aperture.

3. A cooling device according to claim 2 wherein each of said plurality of individual springs in a leaf spring.

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4. A cooling device according to claim 3 wherein each of the leaf springs is formed out of a sheet metal strip which is bent to form an isosceles triangle which is open at one point, said spring positioned within said slot so that the free ends of the spring engage the end surface of the slot and the base position of the spring engages one edge of the corresponding cooling rib.

5. A cooling device according to claim 1 wherein the slots formed in the metal block extend through the entire thickness of the block and are open at the surfaces of the block defining such thickness, and further including a perforated disc (6) which engages the front and back surfaces of the block, the major diameter of said disc being smaller than the depth of the slots from the center axis of said aperture thereby forming openings (7) at the front and rear surfaces of the block, and wherein said cooling ribs include tabs which extend through said openings, the radial extent of said tabs being less than the radial extent of said openings thereby providing play for movement of the ribs in said slots.

6. A cooling device according to claim 1 wherein said metal block consists of punched sheets metal laminations stacked one on top of the other.

7. A cooling device according to claim 1 wherein the individual cooling ribs are slanted at the slip-in opening of the cooling device for receiving the electrode.

8. A cooling device according to claim 1 further in-

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cluding a frame surrounding said metal block and joined together to enclose said block.

9. A cooling device according to claim 7 further including an insulator positioned between said block and said frame, said insulator being of a plastic foil.

10. A cooling device according to claim 9 further includes a base plate (22) positioned on one of the front surfaces of said metal block, and an intermediate layer (23, 24) positioned between said base plate and said block to maintain said base plate thermally insulated from said block.

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ROBERT A. O'LEARY, Primary Examiner

A. W. DAVIS, Assistant Examiner

U.S. Cl. X.R.

165—80, 181; 174—35.5; 313—39, 44, 45