United States Patent

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[33] **Great Britain**
[31] **39053/67**

[54] **SPRING ADJUSTABLE COOLING FINS FOR TRAVELING WAVE TUBES**
6 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **313/45,** 313/46; 315/3.5
[51] **Int. Cl.** **H01j 25/34**
[50] **Field of Search** 313/45, 46

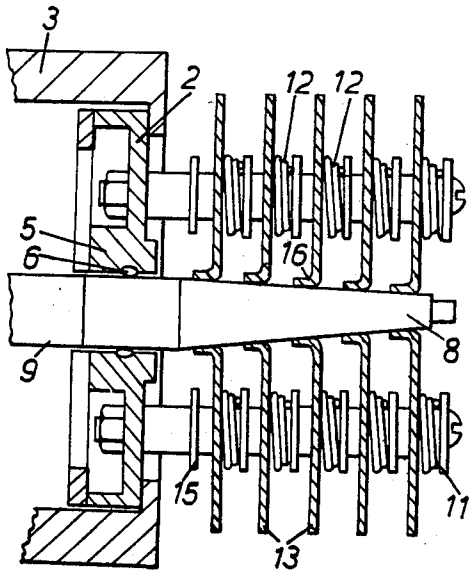
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ABSTRACT: A cooling structure for an elongated heat source, such as a conoidal electron collector electrode of a traveling wave tube, has a plurality of fins secured around and along the heat source and a set of springs urging the fins into contact therewith. A centering member permits adjustment of the heat source with respect to a mounting structure.

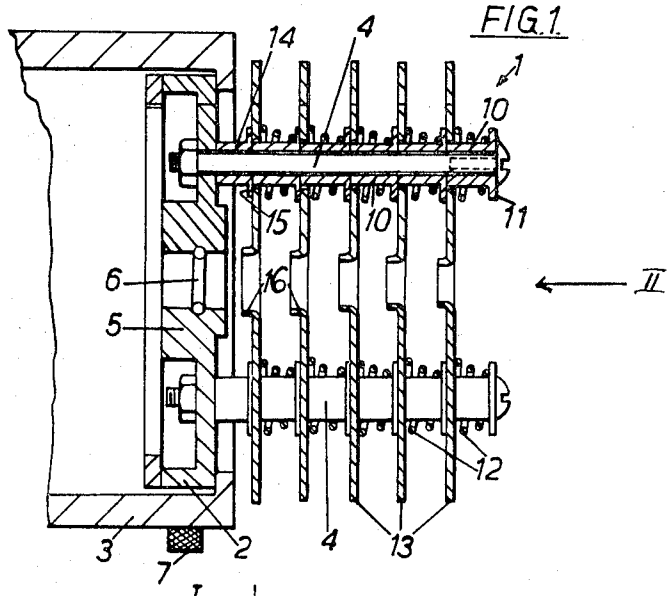


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SHEET 1 OF 2

FIG.1.



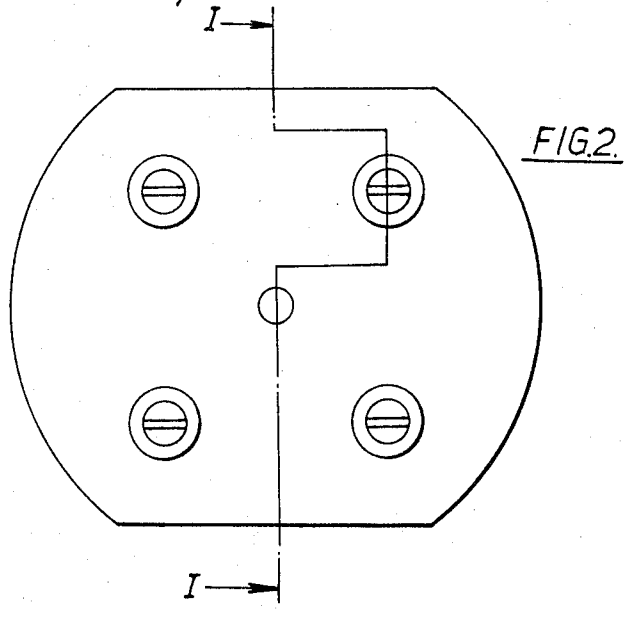


FIG.2.

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FIG.3.

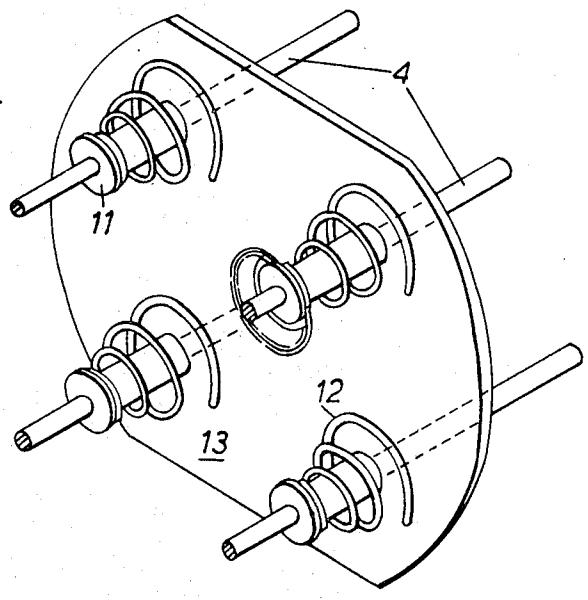
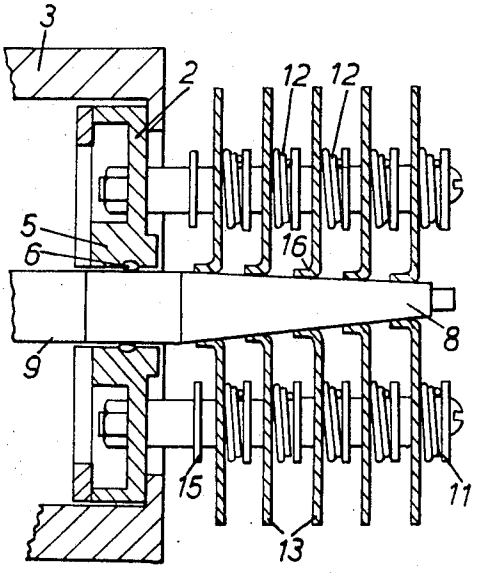


FIG.4.



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SPRING ADJUSTABLE COOLING FINS FOR TRAVELING WAVE TUBES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to arrangements for cooling the electron collector electrode of a traveling wave tube.

2. Description of the Prior Art

A commonly used type of traveling wave tube has a long pencil-shaped glass envelope portion joined at one end to a larger envelope portion containing an electron gun and to a copper electron collector electrode at the other end. The long pencil-shaped portion of the glass envelope accommodates a wire helix. In use, an electron beam is projected from the electron gun, through the helix, and impinges upon the electron collector electrode. Radio frequency energy is couple to the helix to be propagated therealong in a slow wave made which interacts with the electron beam. To keep the beam from spreading and impinging upon the helix, the traveling wave tube is inserted into a mount which includes supports for the traveling wave tube, a magnet system for focusing the electron beam through the helix and radio frequency connection means. To dissipate the heat generated by the electron beam impinging upon the collector electrode, a cooler for the collector electrode has to be provided. The traveling wave tube has to be mounted in very accurate alignment with the magnetic focusing field in order to keep interception of the beam by the helix to no more than 1 or 2 percent. This means that in most cases provision has to be made for adjusting the position of the axis of the traveling wave tube with respect to the axis of the mount. Moreover, with periodic magnetic focusing, where the direction of the axial magnetic field is reversed periodically along the length of the helix, this adjustment of position has to be made with full operational voltages applied to the tube. This means that such adjustments have to be made with a cooler fitted to the electron collector electrode and capable of slight movement with it.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a cooler for a conoidal electron collector electrode of a traveling wave tube wherein cooling fins, each surrounding the collector electrode, are supported by rods passing with clearance through holes in the fins, each cooling fin has a central flange shaped to fit around a respective axial region of the collector electrode and a set of springs urge the cooling fins axially towards the end of the cooler through which the collector electrode is inserted.

In an embodiment of the invention to be described in more detail below there is provided a collector electrode including a set of support rods surrounding and approximately parallel to the axis thereof, each support rod carrying a similar set of flanges providing stop members spaced apart along the rod, a set of cooling fins mounted on the set of rods, each fin being apertured to fit loosely on the support rods and having a central annular flange of tapering internal diameter to fit around a respective axial region of the collector electrode, and sets of compression springs, one set for each support rod, mounted on the rods with each individual spring positioned between a stop member and a cooling fin to urge the fin in the axial direction towards the end of the assembly having the larger diameter annular flanges.

The embodiment of the invention will be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, in cross section along the line I–I of FIG. 2 of the cooler secured in position on a mount for a traveling wave tube;

FIG. 2 is an end view of the cooler as seen looking in the direction of the arrow II of FIG. 1;

FIG. 3 is a diagrammatic perspective view of one of the cooling fins of the assembly of FIGS. 1 and 2 showing details of its mounting; and

FIG. 4 is a cross section through the cooler with the electron collector electrode inserted.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the embodiment of the invention illustrated in the drawings, a cooler **1** is shown in FIG. 1 secured to a centering member **2** which is part of a mount **3** for a traveling wave tube. Only the end portion of the mount **3** is shown. The mount includes a permanent magnet system for providing a magnetic focusing field along the longitudinal axis of the mount, the radio frequency connections for the traveling wave tube and means for supporting the gun end of the traveling wave tube and for adjusting the axis of the traveling wave tube with respect to the axis of the magnetic field. The cooler includes a set of support rods **4** projecting axially from the centering member **2**. The centering member **2** has an inner annular flange **5** fitted with an O-ring **6** for support of the electron collector electrode end of the traveling wave tube, the arrangement being such that the traveling wave tube may be tilted from the gun end while the collector end of the tube is pivotally supported in the flange **5**. The centering member **2** may be moved transversely with respect to the axis of the mount **3**, by means of adjusting screws **7** of which one is visible in FIG. **1**.

The electron collector end of the traveling wave tube is illustrated in FIG. **4**. The electron collector electrode **8** is of copper and generally conoidal shape, the main portion being frustoconical. The electron collector electrode is sealed at the end of a pencil-shaped glass envelope portion **9** adjacent which the collector is cylindrical. The O-ring should be of heat-resistant material such as neoprene or it may take the form of a light helical spring formed into a ring. It fits firmly about the cylindrical portion of the electron collector electrode but allows the traveling wave tube to be pivoted from its far end about the center of the O-ring. In some cases the O-ring can be omitted, the collector electrode then resting on the flange **5** itself.

Returning to the consideration of FIG. **1**, the support rods **4** each carry a set of sleeves **10**, each sleeve terminating at one end in a flange **11** which provides a stop member for the individual ones of a corresponding set of compression springs **12**. A set of cooling fins **13** fits loosely over the sleeves **10** and each of the springs **12** presses against a corresponding one of the cooling fins **13** at the end of the spring remote from its stop member **11**. The sleeves abut end to end with an additional sleeve **14** and end stop **15** seating against the support member **2**, the end stop **15** limiting the movement of the fins **13** to the left, as seen in the drawings.

Each of the cooling fins **13** has an annular flange **16** whose internal diameter tapers so that it fits around a respective axial region of the frustoconical part of the electron collector electrode, as shown best in FIG. **4**. Before the electron collector electrode is inserted into its cooler, the compression springs space the fins **13** apart between the end stop **15** and the stop member **11** on the extreme right of the assembly. The traveling wave tube is inserted into the mount at the electron gun end of the mount—to the left of the figures in the drawings—and the electron collector electrode enters the annular flanges **16** and automatically aligns each cooling fin with the axis of the collector electrode. As the traveling wave tube is pressed home, the electron collector electrode presses against each of the flanges **16** and forces the cooling fins to the right, as viewed in FIGS. **1**, **2** and **4**, so compressing the springs **12**, as shown in FIG. **4**. It is thus ensured that each cooling fin is in good thermal contact with the electron collector electrode. At the same time, because of the clearance fit between the cooling fins and the sleeves **10**, the traveling wave tube is still free to pivot about its support at **6**, carrying the cooling fins with it the necessary slight amount. Successive adjustments of the position of the electron gun support (not shown) and of the screws **7** may now be made until the traveling wave tube is correctly aligned with the magnetic axis of the magnet system.

Although it is preferred that the annular flanges **16** are of a frustoconical shape to fit accurately throughout their length about a corresponding region on the electron collector electrode, at the cost of some reduction in area of contact, the flanges may be of circular cross section if the increased thermal resistance at the contact between collector electrode and the cooling fin can be tolerated. Particularly in such arrangements the exact taper of the conoidal electron collector electrode is not critical, the position of the fins adjusting themselves to take up irregularities.

In a practical embodiment of the invention **5** fins were provided, spaced one-fourth inch apart in the absence of the traveling wave tube, their internal diameter ranging form from 0.340 inch at one end of the cooler to 0.260 inch at the other end. The fins, as viewed in FIG. **3**, were formed of 3.75-inch diameter, the top and bottom portions being cut off horizontally to leave a distance of 3 inches between upper and lower edges.

With the cooler dimensioned as above it was found possible to dissipate 150 watts from the electron collector electrode in free air with the temperature rise of the collector electrode limited to 220° C. With forced air cooling, using an air flow of 20 c.f.m. it was found possible to dissipate 300 watts from the electron collector electrode with the temperature rise of the collector electrode lime limited to 150° C.

I claim:

1. A cooler for an elongated heat source and mounting structure comprising a plurality of cooling fins each adapted to surround the heat source, means for adjustably securing the fins to the mounting structure, each cooling fin having a shaped portion fitting around a respective axial region of the heat source, and a set of springs, each spring disposed adjacent respective cooling fins and urging the respective cooling fins into contact with the heat source.

2. The device of claim **1** wherein said means for adjustably securing the fins includes means for adjustably centering the heat source with respect to the mounting structure.

3. The device of claim **2** wherein said heat source is a conoidal electron collector electrode of a traveling wave tube, each fin having a central flange shaped to fit around said region.

4. The device of claim **3** wherein said means for adjustably securing the fins includes a plurality of support rods passing with clearance through holes in said fins, said springs being mounted on said rods to urge the cooling fins axially towards the mounting structure end of the cooler through which the collector electrode is inserted.

5. The device of claim **4** wherein said support rods are disposed around and approximately parallel to the axis of the collector electrode, each support rod carrying a similar set of flanges providing stop members spaced apart along the rod, said cooling fins being mounted on said rods, each fin being apertured to fit loosely on said rods and having a central annular flange of tapering internal diameter to fit around said respective axial region, said springs being compression springs including one set for each support rod mounted on said rods with each individual spring positioned between a stop member and a cooling fin to urge the fin in the axial direction towards said end, the large diameter annular flanges being positioned at said end.

6. The device of claim **3** wherein said means for adjustably securing the fins includes an annular centering member adjustable transversely in position with respect to the longitudinal axis therethrough, said support rods being secured to the annular centering member.