Nov. 1, 1960 YOSUKE M. MIZUHARA ET AL 2,958,797

DETACHABLE COOLER FOR ELECTRON TUBES

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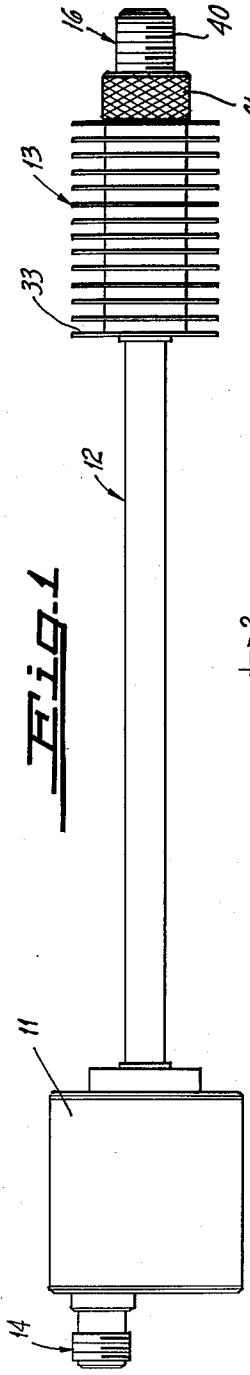



Fig. 1

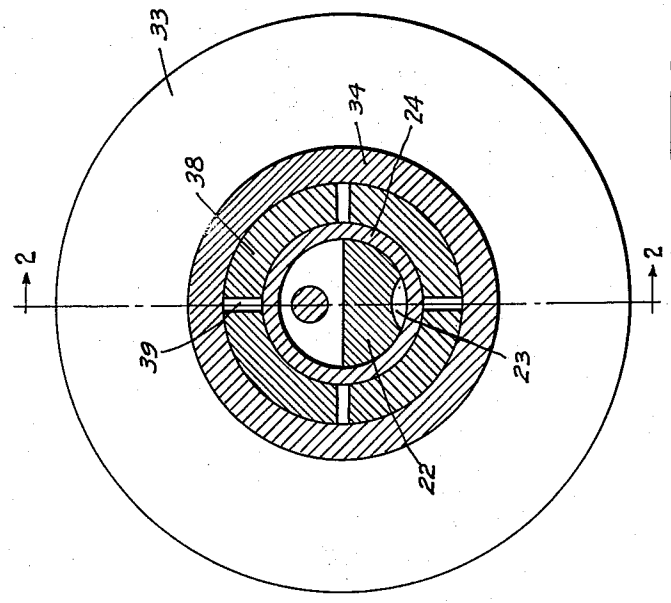



Fig. 3

INVENTORS
Yosuke M. Mizuhara
Martin E. Wolfe

BY Leon F. Herbert
Robert W. Dilts

ATTORNEYS

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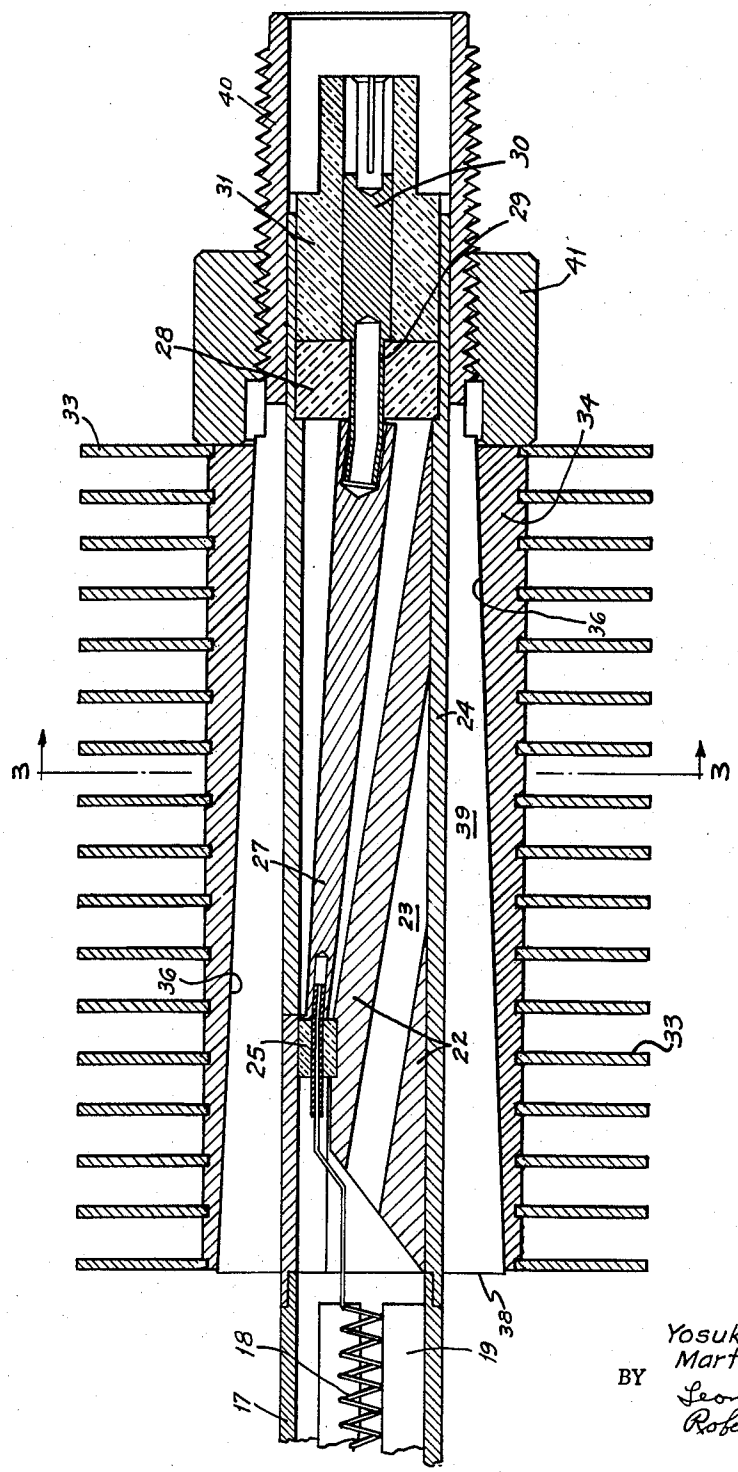



Fig. 2

INVENTORS
Yosuke M. Mizuhara
Martin E. Wolfe

BY Leon F. Herbert
Robert W. Dilts
ATTORNEYS

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# DETACHABLE COOLER FOR ELECTRON TUBES

Yosuke M. Mizuhara, San Francisco, and Martin E. Wolfe, San Mateo, Calif., assignors to Eitel-McCullough, Inc., San Bruno, Calif., a corporation of California

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7 Claims. (Cl. 313—21)

This invention relates to detachable coolers for electron tubes, and more particularly to a detachable cooler for a traveling wave tube.

As is well known, the anode of certain vacuum tubes and the collector of beam type tubes must dissipate large amounts of power. Such power is dissipated in the form of heat making it desirable, and often necessary, to provide cooling for the collector or anode whereby it will not attain excessive temperatures, and whereby the tube may be operated at relatively high powers. In the prior art, fin type cooling structures have been permanently affixed to the tube structure to provide radiation and convection cooling of the anode or collector. Detachable two-piece coolers secured to the tube by means of screws which clamp the sections of the cooler against the tube have also been employed in the prior art.

In beam type tubes which are placed in magnetic structures, the fixed cooler is objectionable since the installation of the tube is complicated by the fact that an opening must be provided in the magnet for passing the magnet over the cooling structure or over the electron gun portion of the tube. In either event, an opening of considerable diameter is required and the magnetic structure becomes complicated. By providing a magnetic structure which has a small opening, control of beam focusing is simplified, the power requirements for the magnet are reduced and the magnetic shielding which need be employed is minimized.

It is a general object of the present invention to provide an improved detachable cooler for electron tubes.

It is another object of the present invention to provide a detachable cooler having improved thermal and physical contact with the tube structure.

It is a further object of the present invention to provide a cooler which is detachably secured to an associated electron tube by releasable means operable from the end of the tube.

It is a further object of the present invention to provide a detachable cooler which is simple in construction, easy to install and remove, and which minimizes the opening required in an associated magnetic structure.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention. It is to be understod that the invention is not to be limited to the disclosed species, as various embodiments thereof are contemplated and may be adopted within the scope of the claims.

Referring to the drawing:

Figure 1 is an elevational view showing an electron tube incorporating a cooler in accordance with the invention;

Figure 2 is an enlarged sectional view of the collector end of the travelling wave tube of Figure 1; and

Figure 3 is a sectional view taken along the line 3—3 of Figure 2.

The electron tube illustrated in the figures is a travelling wave tube which includes an electron gun 11 which



projects an electron beam axially of the elongated tube body 12. The beam is collected by the collector assembly 13. The microwave energy to be amplified is applied through a coaxial connector 14 to one end of the travelling wave tube helix and is available at the other end of the electron tube at another coaxial connector 16.

Referring more particularly to Figure 2, a metallic travelling wave tube envelope 17 encloses and coaxially supports a helix 18. The helix 18 is supported coaxially by spaced insulating rods 19 which ride on the inner surface of the tube envelope 17. The electron beam is collected by the collector 22 which comprises a metallic member with an opening 23. One end of the opening is disposed on the tube axis to receive the electron beam. The opening 23 extends at an angle to the axis so that the other end terminates on an envelope extension 24 which is suitably secured to the envelope portion 17. The electrons travel into the opening 23, impinge upon the inclined surface thereof, and are reflected and collected within the opening 23.

The end of the helix is supported by a dielectric spacer 25 carried between the collector 22 and the envelope extension 24. The end of the helix is connected to a tapered conductor 27 which extends to the end of the envelope extension 24. A dielectric disc 28 carried within the end of the envelope extension 24 forms part of the envelope. The disc 28 receives and supports the tubular portion 29 of the inner conductor 30. The tubular portion 29 is sealed to the disc 28. The periphery of the disc is sealed to the envelope extension 24. Thus, the disc forms part of the evacuated envelope. The inner conductor 30 is supported coaxially within the envelope extension 24 by an insulating sleeve 31. The end of the conductor 30 is drilled and slotted to receive the pin of an associated coaxial line connector. The tapered conductor 27 is connected to the tubular portion 29 and it forms, in conjunction with the envelope extension 24 and collector 22, a coaxial transmission line which provides suitable impedance transformation between the helix and an associated coaxial transmission line to minimize reflections.

In accordance with the present invention, a detachable cooler is placed over the tube at the collector end. The cooler is secured to the tube by a wedging action which provides a component contact between the cooler and tube whereby heat is efficiently conducted away from the collector to the fin structure 33. The fin structure 33 forms part of a sleeve 34 which has a tapered bore 36. As illustrated, the fin structure comprises a plurality of discs formed as part of the sleeve 34. Cooling air is directed transverse of the electron tube to provide convective cooling of the discs. It is apparent that the fins may be in the form of longitudinal ribs which extend radially outward from the sleeve. Cooling air is directed longitudinally of the tube to provide convective cooling of the ribs. The former is the preferred embodiment.

A member 38 is adapted to surround and form physical contact with the electron tube. The member 38 is wedged between the sleeve 34 and the associated electron tube to provide good physical, thermal and electrical contact. The member 38 comprises a tapered portion which includes a plurality of longitudinal slots 39 (Figure 3) and a threaded end portion 40 which is adapted to receive the securing nut 41 and the connector of an associated coaxial transmission line (not shown).

By tightening the nut 41, the member 38 and nut 41 are moved longitudinally with respect to one another whereby the member 38 is wedged between the sleeve 34 and the wall 24 of the electron tube. A relatively tight fit is made between the various parts. Preferably, the fin structure is made of aluminum, the tapered mem-

ber 38 is made of brass and the walls of the electron tube are made of molybdenum whereby the various parts do not have a tendency to freeze.

To remove the cooling fin structure, the nut 41 is removed and the fin assembly moved back towards the end of the tube. The fin assembly is then removed and its bore is such that it passes over the threaded portion 40 of the member 38. After the fin structure is removed, the tapered member may be removed.

With the cooling assembly removed, a magnetic structure which fits close to the wall 17 of the electron tube may be mounted on the tube. The tapered and slotted member 38 is then placed on the tube and may be adapted to abut against the magnetic structure. The internally tapered sleeve including the fin assembly is then slipped onto the member 38 and the nut 41 is threaded onto the threaded portion 40. The parts are moved longitudinally with respect to one another under the forces caused by threading the nut onto the portion 40 whereby the member 38 is wedged between the sleeve 34 and the electron tube wall 17.

It is seen that a cooler which is easily mounted and dismounted from an electron tube is provided. The cooler is simple to install, easy to manipulate, and provides good thermal and electrical contact to the tube envelope.

We claim:

1. A cooler for an electron tube comprising a tapered longitudinally slotted member adapted to engage said tube, a cooling fin assembly including a sleeve having an internally tapered bore adapted to receive said tapered member, and means for moving said sleeve longitudinally with respect to said tapered slotted member whereby said tapered slotted member is wedged between the tube and the sleeve.

2. A cooler for an electron tube comprising a tapered longitudinally slotted member adapted to engage said tube, said tapered slotted member being threaded at its small end, a cooler assembly including a sleeve having a tapered internal bore adapted to receive said tapered slotted member, and a nut on the threaded end of said tapered slotted member adjustable to move the sleeve and tapered slotted member longitudinally with respect to one another to wedge said tapered slotted member against the tube.

3. A cooler for electron tubes of the type having a smooth metallic envelope portion, comprising a longitudinally slotted tapered metal member detachably engageable to said smooth metallic envelope portion, said slotted tapered member being threaded at its small end, a metal cooler including cooling fins and a sleeve having a tapered internal bore adapted to receive said slotted tapered member in wedging engagement, and a nut operatively interposed between said tapered member and said sleeve to move the sleeve and slotted tapered member longitudinally with respect to one another whereby the slotted member is urged into intimate contact with the metallic envelope portion.



4. A beam type tube including an electron gun serving to project a beam of electrons and a collector disposed to receive said beam, a metallic envelope portion surrounding the collector, a ceramic disc carried in said metallic envelope portion, a conductor adapted to connect to tube elements within the envelope extending through said disc into the evacuated envelope, said conductor having a portion extending outside of said envelope adapted to be connected to the inner conductor of an associated coaxial transmission line, a longitudinally slotted tapered member adapted to engage said envelope portion, said slotted tapered member being threaded at its small end, a cooler having external cooling fins and including a sleeve having a tapered internal bore adapted to receive the slotted tapered member, and a nut on the thread end of slotted tapered member and adjustable to engage the sleeve to move the sleeve and slotted tapered member in a direction with respect to one another to effect wedging engagement therebetween, said threaded portion adapted to receive the threaded connector of an associated coaxial transmission line.

5. In a cooler for an electron tube having a smooth exterior envelope portion, a wedge member including a plurality of circumferentially spaced tapered wedge portions, and a heat conducting and dissipating assembly mounted on said wedge member and movable therealong to decrease the spacing between said plurality of wedge portions to clamp said wedge portions to the smooth exterior of an associated envelope portion.

6. The combination according to claim 5, in which said heat conducting and dissipating assembly includes a sleeve wedgingly engageable with said tapered wedge portions, and means fixed on the sleeve for dissipating heat therefrom.

7. The combination according to claim 6, in which said means fixed on the sleeve for dissipating heat therefrom comprises a plurality of spaced radially extending fins.

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