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APPARATUS FOR COOLING ELECTRON DISCHARGE DEVICES

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FIG. 1

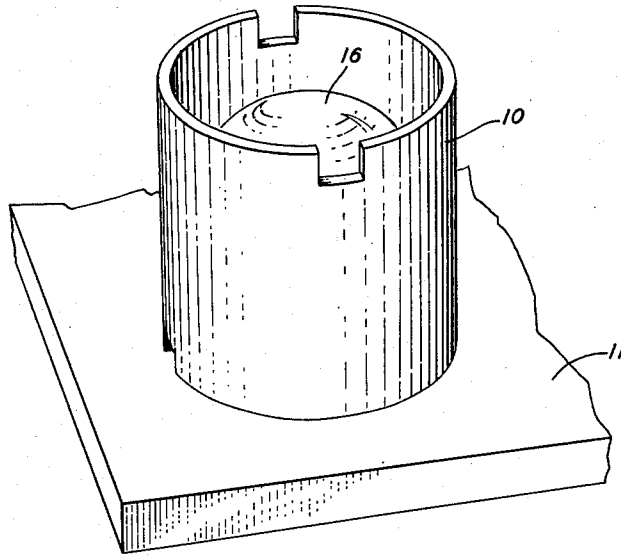
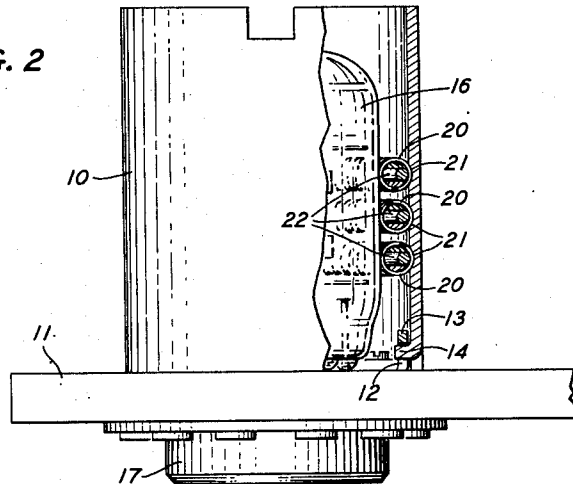


FIG. 2



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APPARATUS FOR COOLING ELECTRON
DISCHARGE DEVICES

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1 Claim. (Cl. 257—263)

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This invention relates to the cooling of electron discharge devices and particularly to heat conducting shields to increase the dissipation of heat from electron discharge devices.

The heat generated within a vacuum tube when operating may be dissipated by convection by forced draft ventilation, as by having a blower force air past the envelopes of the tube to cool it. This method of cooling by ventilation requires accessory equipment including a blower. When tubes are placed in unattended substations it is undesirable to employ any machinery that would require maintenance, as would the rotating machinery and other parts of the blower equipment. Additionally, it is often desirable to connect the unit in which the tubes are incorporated, such as an amplifier, directly and solely into the circuit. Thus in coaxial cables the amplifier may be contained in a sealed case connected directly into the coaxial cable without any outside power supply. Then all the power to the amplifier must be transmitted over the cable itself. But the power requirements of a blower would be such that the power for the blower could not be transmitted over the cable and outside electrical connections would be necessary.

Without a forced air cooling the ventilation of tubes, and particularly when in a closed case, may not be sufficient to cool the tube envelopes. Heat may also be dissipated by radiation from the tube envelope or by conduction. The heat loss through radiation is not significant nor generally is that through conduction as the tube envelope is not in contact with any other bodies. Thus without forced air cooling the heat dissipation from a thermionic tube by conduction, convection, and radiation is insufficient for many purposes.

It is important to reduce the temperature of tubes in order to prevent decrease of their operating lifetimes. Particularly when such tubes are placed in closed units for unattended operation it is desirable to have a long tube life in order to reduce the maintenance necessary to an absolute minimum. Thus a maximum amount of heat dissipation from the tube is desirable.

It is one object of this invention to increase the life of thermionic tubes, and particularly such tubes in unattended units.

It is a further object of this invention to increase the heat dissipation from vacuum tubes without forced air cooling.

It is a still further object of this invention to

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substantially lower the temperature of the envelope of a thermionic vacuum tube by increasing the conduction of heat therefrom.

These and other objects of this invention are achieved by positioning a shield of a good heat conducting material around the vacuum tube. A plurality of helically wound springs are arranged within the shield and make contact with the glass envelope of the tube in the region of or opposite the internal elements of the tube. These springs thus have turns extending between the glass envelope of the tube and the inner surface of the shield. Each turn of the helical spring makes a conduction contact with the envelope of the tube, and each such contact is provided with two parallel heat conduction paths to the shield. By winding the springs fairly tightly a considerable number of such conduction points and paths are provided to conduct heat from the envelope of the tube to the shield. The shield in turn is mounted on a good heat conduction base or mounting chassis to which the heat is dissipated.

The envelopes of tubes can generally be considered to be cylindrical but actually in the mass production of tubes eccentricities are often introduced so that the envelopes instead of being circular in cross section are more nearly oval or elliptical. Additionally, the temperature attained by the thermionic tube during operation may affect the glass envelope so that it does not retain its form but changes, accentuating the eccentric configuration. Also, in actual mass production the tubes are not all accurately centered on the pins in the base of the tube so that, on being placed in their sockets, the actual positions of the envelopes will vary. However, the springs which provide the conduction paths between the glass envelope and the shield, which of course is and remains always cylindrical, are flexible enough to allow for considerable variations without there being any loss of contact points with bulb or envelope of the tube.

The shield itself serves a dual function as it not only quickly removes the heat of the tube to itself by conduction along the helical springs, in accordance with this invention, but also it acts as an electrostatic and electromagnetic shield, as is well known and as is generally necessary for many tube applications.

It is therefore a feature of this invention that conduction paths be provided between the glass envelope of a vacuum tube and an outer shield by a helical spring extending around the envelope and making contact therewith at a number of

points.

It is a further feature of this invention that the envelope of the vacuum tube depress the inner turns of the helical spring so that considerable variations in the diameter and concentricity of the tube envelope can be accepted without loss of any points of thermal contact with the helical spring.

It is a further feature of this invention that the heat conducting shield surrounding the vacuum tube be mounted on a heat dissipating base and comprise a plurality of helical springs within the shield contacting the inner surface of the shield and contacting the envelope of the vacuum tube at a large number of distinct points. In accordance with this feature, the springs define two parallel heat conduction paths from each of these points to the shield and thus to the heat dissipating base.

A complete understanding of the invention and the various desirable features thereof may be gained from consideration of the following detailed description and accompanying drawing, in which:

Fig. 1 is a perspective view of one heat conducting shield illustrative of this invention mounted on a heat dissipating base and with a vacuum tube positioned therein; and

Fig. 2 is a side view of the assembly of Fig. 1, a portion of the shield being broken away to show the helical spring members contacting the envelope of the vacuum tube and the inner surface of the shield.

Referring now to the drawing, the shield 10 may advantageously be a hollow cylinder of slightly larger inner diameter than the outer diameter of the glass envelope of the tube with which it will be employed. It may advantageously be of copper or other good heat conducting material and is supported in good thermal contact with a base 11, also advantageously of good heat conducting material, as by an inner ring member 12 having fingers 13 extending upward and clamping ears 14 integral with the shield 10 and extending inward therefrom at its base.

A vacuum tube or other electronic device 16 is mounted in a socket 17 supported by the base 11. Metallic conduction of heat away from the envelope of the tube 16 to the shield 10 and thence to the base 11 is accomplished by helical springs 20 which are held in shallow grooves 21 around the inner periphery of the shield 10 by wire or snap springs 22. The axes of the helices are thus circles concentric with the cylindrical shield 10. The helical springs 20 and snap springs 22 may advantageously be of steel.

When the vacuum tube 16 is positioned within the shield 10 by being mounted in its socket 17, the envelope of the tube bears against the inner portions of the turns of the helical springs 20 biasing them and thus slightly depresses them. Each turn of each helical spring thus makes contact with the glass envelope of the tube at one contact point and from that contact point two heat conducting paths are provided back to the shield 10. A good thermal connection is made between the shield 10 and the turns of the springs 20 by the relatively long portions of the spring coils held tightly in the grooves 21 by the snap or wire springs 22.

Variations in the initial configuration of the

tube envelope, such as lack of concentricity or differences in external diameter, are taken up by the flexible springs 20 which adjust to each particular tube. The differences in tube dimensions will only result in different amounts of depressions of the inner portions of the turns of the helical springs. Similarly, any change in the external configuration of the tube during operation because of the internal generation of heat will be compensated for as the springs follow the variations in the envelope without losing any points of contact therewith.

In one specific embodiment of this invention intended for use in a coaxial cable amplifier incorporated in a sealed case and located in isolated and unattended huts, the shield 10 was of .065 inch copper tubing, 1 3/4 inches high and 1 1/2 inches in diameter, the springs 20 were of .010 inch steel wire helically wound with 20 turns per inch and the snap springs 21 were of .055 inch steel wire. The base 11 was of copper and attached to the amplifier case so that the amplifier case also dissipated the heat conducted to it from the tube envelopes through the good metallic conduction paths of the springs 20, the shield 10 and the base 11.

With this specific illustrative embodiment of this invention when employed with amplifier tubes, such as triodes or pentodes, reductions in the temperature of the tube envelope of over 70° C. are easily attained.

It is to be understood that the above-described arrangements are illustrative of the principles of the invention. Other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

Means for conducting heat from the envelope of an electron discharge device to a base member of heat conducting material which dissipates the heat conducted to it from the envelope, comprising a cylindrical shield of heat conducting material attached to and in thermal contact with said base member and surrounding the device, the inner periphery of said shield having a plurality of circular grooves therein, a plurality of helical springs within said grooves, the axes of the helices of said springs being circles concentric with said shield, and spring means positioning said helical springs in said grooves in thermal contact with said shield, the turns of said springs away from said shield being depressed by the envelope of the electron discharge device, making contact with said envelope at a plurality of points, and defining two parallel heat conductive paths from each of said points to said shield.

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