April 19, 1960 J. H. CHISLOW 2,933,292
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HEAT ABSTRACTING AND SHIELDING MEANS FOR ELECTRON DISCHARGE DEVICES

FIG. 2

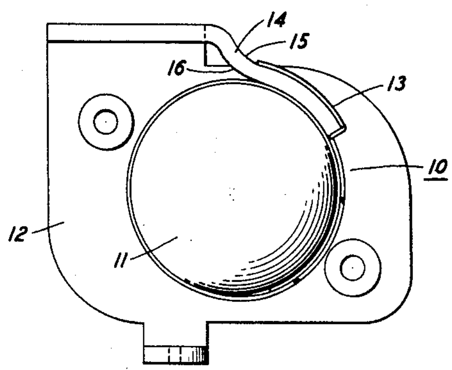

FIG. 1

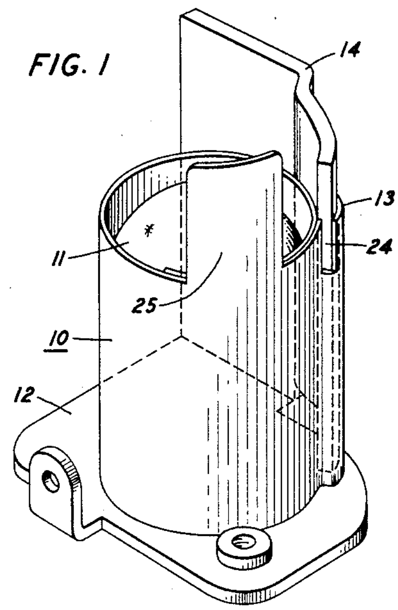

FIG. 3

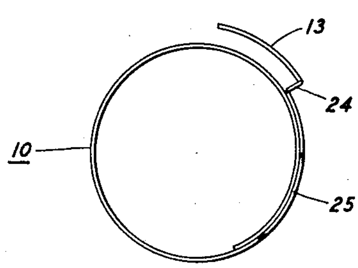

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FIG. 4

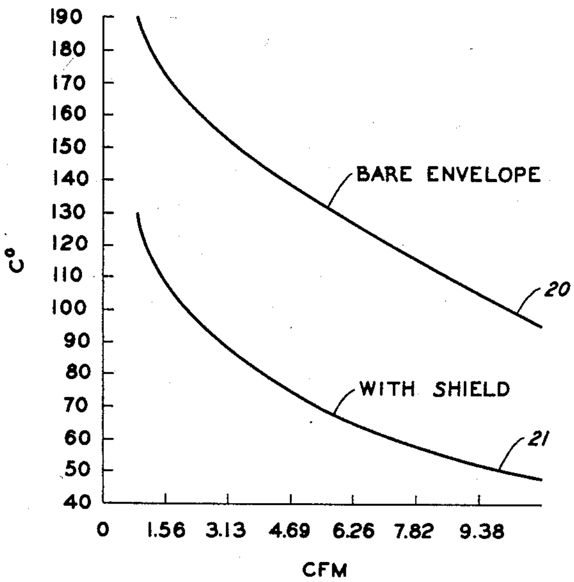
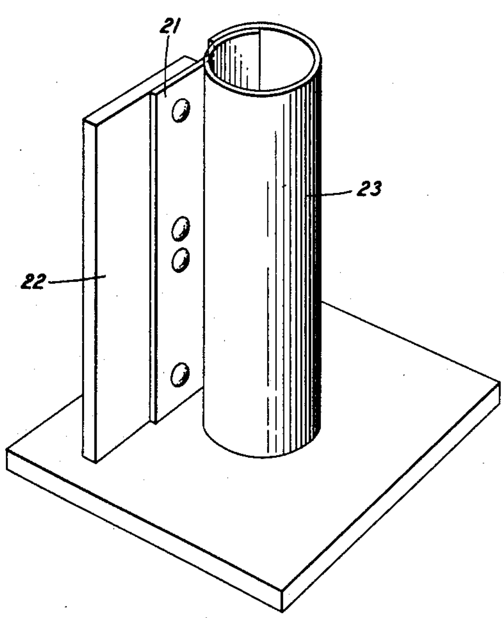


FIG. 5



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HEAT ABSTRACTING AND SHIELDING MEANS FOR ELECTRON DISCHARGE DEVICES

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4 Claims. (Cl. 257—263)

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

It is well known that the problem of heat abstraction from vacuum tubes is a formidable one as the life of vacuum tubes is considerably reduced at elevated envelope temperatures. Furthermore, vacuum tubes operate in conjunction with and adjacent to circuit components such as resistors, capacitors, inductors, et cetera, whose predictable life is a function of operating temperature, and, accordingly, heat from vacuum tubes has an adverse effect on the lifetimes of these components.

Abstraction of the heat generated within a vacuum tube when operating is dependent on radiation, convection, and conduction. The heat loss through radiation is not significant, nor generally is that through conduction, as the vacuum tube envelope is not in good thermal conductive engagement with any other body, and heat dissipation by convection by forced draft ventilation requires some accessory equipment including a blower. Priorly it has been proposed to reduce the temperature of the envelopes of vacuum tubes by forced air cooling coupled with the use of tube heat shields. Particularly when many tubes were mounted in relatively confined spaces, it was found that heat shields alone were not sufficient to reduce envelope temperatures to the point needed for optimum component reliability. Various heat shields have been proposed to reduce the required forced-air-feed supply size. These shields have generally conducted heat from the vacuum tube envelope to a chassis or base which accordingly served as a heat sink. However, the distribution of heat over the envelope of a vacuum tube is not even, generally being a maximum directly adjacent the anode, or, in the case of multi-element tubes, midway between the two anode structures. Therefore heat was conducted from the relatively cooler upper portions of the envelope to the base past the hotter portions of the envelope. Accordingly these conductive paths had a high thermal resistance and the heat being conducted to the base or chassis resulted in further heat concentrations at the hotter portions of the tube envelope.

It is one object of this invention to increase the life of electron discharge devices.

It is a further object of this invention to increase the abstraction of heat by conduction from vacuum tubes such that the forced-air-feed supply size is either greatly reduced or the need for such cooling supply is obviated.

It is a still further object of this invention to substantially lower the temperature of the envelope of an electron tube by increasing the conduction of heat therefrom.

Another object of this invention is to provide a metallic heat transfer path from the envelope of an electron discharge device to a chassis member wherein heat is conducted away from the envelope by the shortest possible path thereby preventing the heat being conducted from itself adding to the temperature of the tube envelope.

A still further object of this invention is to provide

a tube shield in intimate thermal conductive engagement with substantially the entire envelope of the electron discharge device and with the chassis so as to increase the heat conducted from the envelope to the chassis.

A further object of this invention is to provide a tube shield the shape of which assists in developing turbulence in the air flow such that the cooling effect of convection is enhanced.

These and other objects of this invention are achieved by positioning an electron discharge device or a vacuum tube within a heat conducting shield. The shield fits snugly over the tube insuring firm, continuous contact over substantially the entire outer surface of the tube envelope. The shield is secured to a good heat conduction base or chassis tube mounting assembly acting as a heat sink by means of a flange portion extending substantially the height of the shield. Thus, it is a feature of this invention that circumferential heat conduction is provided from the tube envelope to the heat sink and concentrations of heat as found in conventional shields which conduct in an axial direction to the tube base or top are avoided. The circumferential heat flow may conveniently be represented by a multiplicity of parallel circumferential heat conducting paths.

The envelopes of tubes can generally be considered to be cylindrical, but actually in the mass production of them, the envelopes, instead of being circular in cross section, are more nearly oval or elliptical. The heat conducting shield, however, is resilient enough to allow for considerable variations without any loss of contact points with the envelope of the tube. Thus, it is a further feature of this invention that the resilient metal roll fits over the vacuum tube such 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 heat conducting shield.

The heat conducting shield, in one specific embodiment, comprises a substantially rectangular sheet of metal rolled up with a slight overlap and terminating in an outwardly projecting flange portion for frictionally embracing a good heat dissipating base or mounting assembly. The shield has a tab portion to facilitate sliding the shield on and off the electron discharge device. Thus, in accordance with aspects of this invention, a vacuum tube shield is provided that is simple in construction, inexpensive to manufacture, and easily mounted.

The shield serves a dual function as it not only effectively removes the heat of the tube to the heat dissipating base or mounting assembly, 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.

A complete understanding of the invention and of these and other features and advantages thereof may be gained from consideration of the following detailed description in conjunction with the accompanying drawing, in which:

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

Fig. 2 is a plan view of the assembly of Fig. 1;

Fig. 3 is a plan view of just the heat conducting shield of the embodiment of Fig. 1;

Fig. 4 is a graph of tube envelope temperature above ambient as a function of air flow; and

Fig. 5 is a perspective view of a modification of a mounted heat conducting shield made in accordance with the principles of the present invention.

Referring now to Fig. 1, the shield **10** is a hollow cylinder rolled from a thin resilient metallic material so as to fit snugly around an electron discharge device insuring firm, continuous contact over substantially the entire outer surface of the envelope of the device; the shield 10 itself is best seen in Fig. 3. A typical electron discharge device or vacuum tube 11 is shown within and in good thermal conductive contact with the shield 10. The tab portion 25 is an integral part of the shield and serves to facilitate sliding the shield 10 on and off the vacuum tube 11. The shield 10 may advantageously be of beryllium copper for this alloy exhibits heat conductive properties and is sufficiently resilient when formed into the shield 10 to grip the vacuum tube 11 making good heat conductive engagement therewith.

The vacuum tube 11 with the shield 10 around it is positioned on the metallic mounting assembly 12. The flanged portion 13 of the rolled cylinder is formed so as to engage the tongue plate 14 of the mounting assembly 12 in intimate contact and thus provide a good heat conductive path from the shield 10 to the tongue plate 14.

The slot 24 provides a region of high compliance for the purpose of easy insertion and removal of the shield, and precludes the possibility of distorting critical mating surfaces by the insertion or the removal of the shield 10. Thus, the continuity of heat abstractive contact of the shield 10 with the vacuum tube 11 is assured irrespective of the frequency of insertions and removals.

Referring now to Fig. 2, one side 15 of the tongue plate 14 of the mounting assembly 12 is seen to be in intimate contact with the flanged portion 13 of the shield while it other side 16 is in contact with a portion of the shield 10 outer surface. As well as being the body to which the vacuum tube 11 thermal energy is conducted by means of the shield 10, the tongue plate 14 effectively serves to maintain the shield 10 about the vacuum tube 11 in a mechanically secure manner.

Referring now to Fig. 4, there is graphically shown the effectiveness of the shield 10 in conducting heat from the vacuum tube 11 envelope. The scale of the vertical axis is centigrade degrees temperature rise of the vacuum tube envelope above ambient, and the scale of the horizontal axis is cubic feet per minute delivery air flow past the vacuum tube envelope. The upper curve 20 represents an unshielded vacuum tube envelope temperature rise above ambient as a function of delivery air flow, and the lower curve 21 represents a heat shielded vacuum tube envelope temperature rise above ambient as a function of delivery air flow when the tube is shielded with the embodiment of Fig. 1. It appears clearly that the shield 10 greatly reduces the forced air feed supply size required to maintain a given envelope temperature.

In one specific embodiment of this invention for use with novel vacuum tubes the shield 10 was rolled from 0.010 inch beryllium copper alloy strip. ½ hard strip was annealed to ¼ hard, then cut and rolled, and then heat-treated back to ½ hard. Before rolling, the shield 10 measured 3¾ inches long and 1$\frac{7}{32}$ inches high with the tab portion 25 extending an additional ½ inch in height, and when rolled formed a hollow cylinder ¾ inch in diameter. The mounting assembly 12 was made of 0.064 inch aluminum alloy sheet. The beryllium copper shield 10 had a 0.0002 inch thick coating of tin electrodeposited upon it. The additive finish of tin reduced the formation of oxide films on the shield. This was desirable because these films exhibit a higher resistance to the conduction of thermal energy than does the shield 10 material. Further, the tin finish resulted in a smaller galvanic couple between the shield 10 and the aluminum mounting assembly 12 than that formed between an unplated shield and the mounting assembly 12. Still further, the tip plate reduced the interface coefficient between the envelope of the vacuum tube 11 and the shield 10, thus resulting in better heat transfer between these bodies.

Referring now to Fig. 5, there is shown a modification of a heat shield according to the invention. The modification differs from the illustrative embodiment of the

invention shown in Fig. 1 in that the flange portion 21 is straight rather than stepped and is secured to a chassis or heat sink member 22 by fastening means. In the embodiment shown in Fig. 5 rivets were used. The shield 23 was made from beryllium copper alloy strip and had a 0.0002 inch layer of tin electrodeposited upon it.

Embodiments of this invention display excellent heat dissipation properties. Although the underlapped, resilient, metal cylinder may be easily slid on or off an electron discharge device, the cylinder securely grips substantially the entire exterior surface of the device such that heat transfer is not retarded by air entrapped between the exterior surface and the shield, and such that a multiplicity of direct, circumferential, high thermal conductivity paths is provided from the exterior surface to a heat dissipating chassis member.

It is to be understood that the above-described arrangements are illustrative and not restrictive 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:

1. Apparatus for conducting heat from the envelope of an electron discharge device to a chassis including a tongue plate mountng member, said apparatus comprising a resilient metal tubular member of a length substantially as great as that of the electron discharge device, the discharge device being slidably positionable within said tubular member so that said tubular member grips the envelope of the device in secure heat conductive engagement, said tubular member having a tab portion extending from the wall thereof substantially beyond the end of said vacuum tube, said tubular member having an inner underlapping portion, and also a flange portion of approximately the same length as said tubular member extending away from and then parallel to the outer surface thereof so as to substantially parallel said outer surface at a distance therefrom, said tongue plate being positioned between and in physical contact with said flange portion and said outer surface so that heat flow in said tubular member occurs along a circumferential path approximately perpendicular to its axis and heat transfer from said tubular member to said tongue plate occurs by conduction.

2. Apparatus for abstracting heat from the envelope of an electron discharge device comprising in combination a heat dissipating mounting member and a resilient heat conducting tubular member, the electron discharge device being slidably positionable within said tubular member and said tubular member being so dimensioned as to completely enclose and grip substantially the entire envelope of the electron discharge device in secure heat conductive engagement, said tubular member having a longitudinal overlapping portion and an underlapping portion in heat conductive engagement with each other, said overlapping portion extending away from and then parallel to the outer surface of said tubular member to define a flange portion, said mounting member having a tongue portion extending along the length of and adjacent to said tubular member, said tongue portion being positioned between the inner surface of said flange portion and the outer surface of said tubular member in secure heat conductive engagement therewith so that heat flow in said tubular member occurs along a circumferential path approximately perpendicular to its axis and heat transfer from said tubular member to said mounting member occurs by conduction between the surfaces thereof.

3. Means for abstracting heat from the surface of an electron discharge device comprising a heat dissipating base and a resilient heat conducting hollow cylinder having overlapping longitudinal portions in intimate heat conductive engagement with each other, said cylinder being adapted to be positioned over the electron discharge

device in intimate heat conductive engagment with substantially the entire surface thereof so that heat transfer from the electron discharge device to said cylinder occurs by conduction, said cylinder further having a longitudinal flange portion extending away from its outside surface, said heat dissipating base having a tongue portion extending along the length of and adjacent to said cylinder, said tongue portion being secured in intimate heat conductive engagement with a surface of said flange portion so that heat flow in said cylinder occurs along a circumferential path approximately perpendicular to its axis and heat transfer from said flange portion to said base occurs by conduction.

4. Means for abstracting heat from the surface of a heat generating electrical device comprising a heat dissipating base member and a thermally conductive sleeve member having overlapping longitudinal edges such that the diameter of said sleeve member is variable, said sleeve member being adapted to be positioned over the electrical device and in intimate heat conductive engagement with the surface thereof so that heat transfer from the electrical device to said sleeve member occurs by

conduction, said sleeve member having further a longitudinal flange portion extending away from its outside surface, said base member having a tongue portion extending along the length of and adjacent to said sleeve member, said tongue portion being secured in intimate heat conductive engagement with a surface of said flange portion so that heat flow in said sleeve member occurs along a circumferential path approximately perpendicular to its axis and heat transfer from said flange portion to said base member occurs by conduction.

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