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TERMINAL CONNECTION FOR ELECTRIC HEATING ELEMENTS

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Fig. 1.

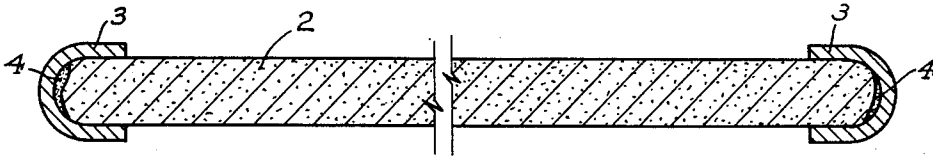


Fig. 2.

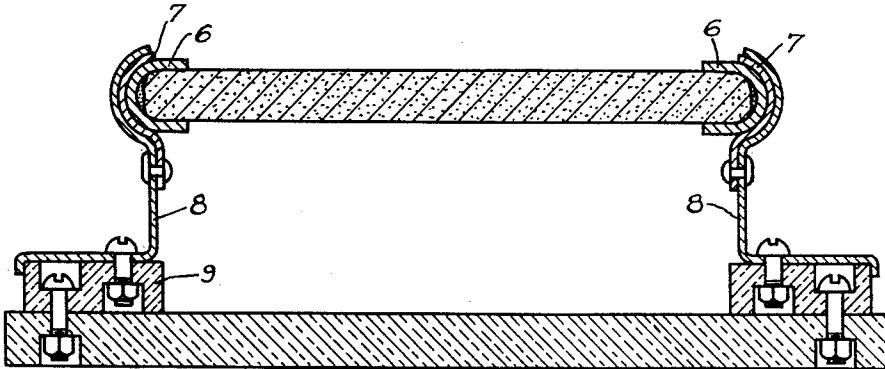
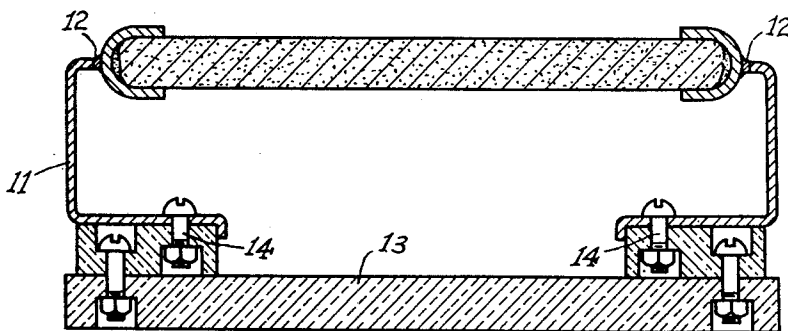


Fig. 3.



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TERMINAL CONNECTION FOR ELECTRIC
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This invention relates to terminal connections for electric heating elements, and to a method of making electrical contact with rigid non-metallic resistors used in electric heating devices. The invention is especially applicable to silicon carbide resistors such as are used for electric heating elements.

Non-metallic resistors offer many advantages for domestic appliances such as hot-plates, room heaters, and similar devices, but in their use for such purposes the maintenance of a satisfactory electrical connection has presented considerable difficulty. The electrical contact must operate at a comparatively high temperature, and the metal lead cannot be welded or joined directly to the heating element as is customary with metallic resistors. When a metal connection is rigidly attached to the resistor and the contact operated at high temperatures, the differential expansion between the metal and the resistor is usually sufficient to cause arcing and disintegration of the contact surface.

For this reason it has been customary to make electrical connection by means of resilient butt end engagement. With this latter type of contact, difficulties arise from the irregular shape of the end portion of the resistor, the irregularities in shape causing a very high current density and excessive heating at the localized points or areas of contact. With intermittent use, the resistor also expands and contracts due to temperature changes, and the arcing resulting from this slight movement often renders the contact insulating after a comparatively few hours of actual service. This condition is greatly aggravated by the high local current density at the contact caused by irregular shaped ends, and by the high operating temperature of the resistor at its terminal portion.

In my method of making electrical contact, I provide a terminal cap rigidly attached to the resistor, in such a manner that the difficulties usually encountered from differential expansion do not obtain. My improved terminal member affords a large area of contact, and causes the end of the resistor to operate at a reduced temperature. In addition, it affords a metal end portion to which a terminal lead can be welded or brazed if desired.

In applying my terminal connection, I employ a metal cap of heat resistant material, which before application is preferably of slightly smaller diameter than the end of the resistor. Such a cap can be applied to the resistor by heating the cap and obtaining a "shrink

fit", so that on cooling to room temperature the cap will be under contractive tension. I have further found that the partial filling of the cap with a metal powder so as to occupy the voids between the irregular shaped resistor end and the inner surface of the cap affords a contact of large area which will operate satisfactorily throughout the useful life of the element. The powder apparently has a cushioning effect and compensates for any expansion or contraction of the element during the repeated cycles of heating and cooling.

The nature of my invention will be evident from the accompanying drawing, in which

Figure 1 is a cross-section of a resistor, in which the terminal caps are applied to the ends of the element;

Figure 2 shows a method of mounting the capped resistor and securing electrical connection by means of resilient butt end engagement; and

Figure 3 shows a method of mounting in which the terminal leads are welded directly to the cap.

Referring to Figure 1, the heating element 2 is of cylindrical or bar shape, and is composed of non-metallic conducting material such as for example silicon carbide. Upon each end of the element is fitted a metal cap 3, made from a metal or alloy having good heat resisting properties. The metal powder 4 occupies the voids between the end of the resistor and the inner surface of the cap.

In applying the cap, it is heated to a dull red heat so that the expansion of the cap will permit the insertion of the end of the element therein. The cap on cooling contracts and becomes securely attached to the end of the heating element. Before insertion of the end of the resistor into the metal cap, it is desirable that the latter be partially filled with a metallic powder. The powder is preferably one which will soften or partially melt at the temperature of operation of the terminal, and the composition of the powder may be varied to correspond with the intended operating temperature of the terminal. Aluminum powder can be used for lower temperatures, and for higher operating temperatures alloys of aluminum and nickel containing approximately 40 per cent nickel and alloys of aluminum and iron containing approximately 30 per cent iron can be used. These alloys are desirable for high operating temperatures because of their tendency to soften over a large temperature interval before

the temperature of complete melting is reached. With the aluminum nickel alloys a nickel content of from approximately 30 to 42 per cent nickel has been found satisfactory. Alloys in this range have a large temperature interval between incipient and final melting, and in addition can be readily powdered. Silicon powder, and silicon aluminum alloy powders can also be used as a contact material within the cap.

When the cap is applied as described, the metallic powder 4 fills the gaps which would otherwise be formed by irregularities in the end of the heating element, so that a contact of maximum area is provided.

Figure 2 shows a method of mounting the heating elements by resilient butt-end engagement. The same mounting may be employed at each end, or a rigid terminal may be employed at one end and resilient pressure transmitted through the rod. As shown, the metal cap 6 is engaged by a butt end terminal contact 7 which in turn is carried by a resilient arm 8 from an insulating block 9. The contact members 7 are preferably aluminum or an alloy of aluminum and either nickel or iron, within the range of composition specified for the powdered alloy used within the cap. The spring 8 can be constructed of chrome iron or of any material which will retain its resilience at somewhat elevated temperatures.

In the method of mounting shown in Figure 3, the terminal lead 11 is welded directly to the cap at 12, thus eliminating all possibility of arcing during use. The terminal member 11 may be either a heavy wire or strip, and while it is rigid enough to support the element, it possesses sufficient resilience to allow the free expansion of the element during heating and cooling. The terminal member 11 may be secured to the base 13 of the heating device by means of an insulating block 14.

The end caps may conveniently be made from a heat-resistant steel of the nickel-chrome type. Alternatively, the caps may be made of nickel,

nickel-chromium or nickel-aluminum alloys, or other suitable heat resisting material. For elements operating at lower temperatures, the caps can be made from pressed aluminum.

The resistor to which the caps are applied may be of silicon carbide, siliconized silicon carbide or other form of rigid resistor. I have found the process of particular advantage in the case of silicon carbide resistors since it affords a means of making an electrical connection between the metal and the silicon carbide which does not become insulating during the life of the element, even with repeated heating and cooling. The process is particularly applicable to recrystallized silicon carbide resistors in which the extreme end portion is impregnated with silicon. These impregnated ends are usually irregular in shape so as to make butt-end engagement more difficult than with a regular shaped end, and a connection cannot be readily welded to the rod. The capping of the rod by the method described herein makes possible either a welded connection or a butt end contact with a regular shaped end operating at a lower temperature than is the case with the usual siliconized end of the resistor.

Having thus described my invention, I claim:

1. A silicon carbide heating element having a metal terminal cap surrounding the end portion of the said element, the side walls of the cap being in intimate contact with the surface of the element, and a packing of metal powder within the cap, the said metal powder containing a substantial proportion of aluminum.

2. A silicon carbide heating element having a metal terminal cap surrounding the end portion of the said element, the side walls of the cap being in intimate contact with the surface of the element, and a packing of metal powder within the cap, the said metal powder consisting of an aluminum-nickel alloy containing less than 45 per cent nickel.

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