Aug. 7, 1934. A. H. HEYROTH 1,969,132

TERMINAL FOR ELECTRIC HEATING APPLIANCES

Filed July 16, 1932

Fig. 1.

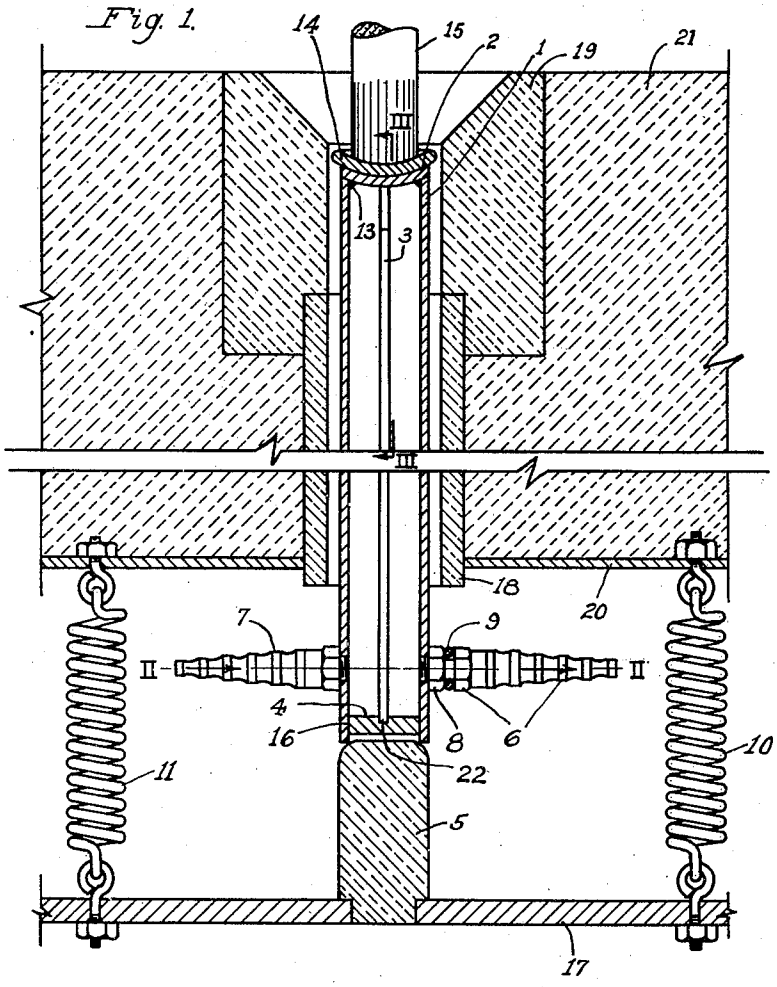


Fig. 2.

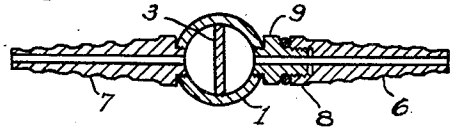
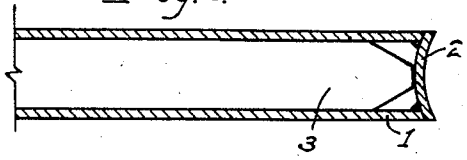


Fig. 3.



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TERMINAL FOR ELECTRIC HEATING APPLIANCES

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3 Claims. (Cl. 13—25)

This invention relates to electric heating appliances, and more particularly to renewable contact terminals for electric heating appliances.

Heretofore in the manufacture of water-cooled terminals for electric heating elements, several undesirable features have presented themselves which are ever recurrent sources of trouble and hinder the successful operation of the terminals. Previously, a small injector pipe has been extended axially within the terminal tube to conduct ingoing water to the hot end of the terminal. In the course of time, murky water passing therethrough deposits sludge which decidedly impairs its effectiveness, and also hard water produces a scale formation which will eventually seal the tube.

Moreover, it is highly desirable to provide new terminal facings for each silicon carbide heating element replacement (as well as initial elements) since in present practice, replacements are successively handicapped to an increasing extent in that they are brought into engagement with a steadily depreciating terminal socket. To meet this objection, this invention provides for the replacement of a contact which keeps the used element ends in a condition equal to the ends of new elements. In addition to the inherent weaknesses mentioned above, the conventional type of water-cooled contact has the disadvantage of relatively high cost which makes them relatively unsalable in view of the fact that the terminal accessories often cost more than the element to which they are accessory.

Still another disadvantage of present day types of terminals resides in the dimensions of the contact which is in the form of a relatively thick tip welded on the terminal tube, and is provided with a socket to act as a contact and receptacle for the end of the element. Due to the operation of these terminals at very high temperatures, (about 1400° C.), it has been heretofore necessary to use heat resistant materials, such as chrome iron, which are of exceedingly high melting point, are resistant to oxidation and corrosion, and yet are suitable for electrical contact with the heating element. Any other of the common materials will oxidize and melt out. Moreover, these tips have had to be relatively thick, say ¾" to 1", in order to prevent leaks through pitting because of arcing, and in addition, to provide sufficient material for redressing the socket whenever necessary.

It has been found that aluminum is particularly advantageous for terminal facings since it is soft and has a relatively low melting point which practically eliminates the arcing which occurs with intermittent service. This elimination of arcing makes it possible to use a very thin piece of chrome iron in the disc or tip since it is not necessary to have it of substantial thickness to withstand the strain of arcing and subsequent oxidizing. The desired efficient water-cooling is thus obtained by utilizing a thin tip which keeps the aluminum contact at a low temperature. The contact between the aluminum and resistor is particularly efficacious inasmuch as it has been found that to use a metal which is relatively soft (and preferably one which will become softened at a relatively low temperature) permits irregularities on the resistor to penetrate the soft metal.

With resilient aluminum-faced terminals, a silicon carbide heating element can be operated under conditions where the resistor is subject to repeated heating and cooling, such as in domestic heaters and other household equipment, and under conditions where terminals faced with harder but more heat resisting metals and alloys are commercially inoperative because of arcing and subsequent disintegration of the metal contact. Although aluminum has been used in this manner, it has been thought impossible to use it in high temperature application, such as industrial furnaces, as it could not be cooled sufficiently. However, through the use of these especially constructed water-cooled terminals, which are the subject in part of this application, the applicant, as hereinabove stated, provides sufficient cooling of the contact so that aluminum (one of the best materials yet found) can be used in high temperature application.

Aluminum outlasts the highly heat resistant but hard metals or alloys because it provides a contact of greater area and because it is relatively soft and permits any high points or projecting ends of the crystals of the resistor to become embedded in the aluminum. The aluminum contact thus conforms to the portion of the resistor against which it bears, giving, in effect, a greater contact area than would obtain if the end of the resistor were pressed against a hard metal which would not conform to the irregularities of the surface. Because of the greater area of contact, the current densities at the junction are lower and less heat is generated. Moreover, arcing is substantially eliminated since the slight embedding of the end portions of the resistor tends to prevent mechanical movement at the end portion of the resistor against the metal terminal during the initial period of heating.

Aluminum softens at temperatures considerably below its melting point. It begins to soften at a temperature of approximately 400° C. This property of softening at only slightly elevated temperatures contributes to the adaptability of aluminum for use as a contact material because it provides what might be termed a self-compensating contact, inasmuch as the metal will soften at a local hot spot and permit the projecting points of the resistor at such a place to

penetrate further into the aluminum surface and thereby provide a larger contact surface with a decrease in resistance.

The aluminum contact, by virtue of its high thermal conductivity, reduces the temperature of the surface of the resistor in contact with it. Moreover, when the aluminum is heated to about its melting-point, it forms a pasty mass with its oxide. Aluminum is, therefore, quite heat-resistant and can be used where metals of considerably higher melting-points melt or burn out.

The resistor elements employed are preferably rods of recrystallized or self-bonded silicon carbide, having their end terminal portions impregnated with elemental silicon, whereby the specific electrical conductivity of the end portions is greater than the main body of the resistor rod. The end portions, therefore, operate at a considerably lower temperature than the body portion. Such resistors are commonly referred to as having "cold ends". Resistors of this type are described in the application of Ferdinand Eichenberger, Serial No. 615,933, filed January 30, 1923, and are sold in this country under the trade name "Globar".

Further advantages of my invention will become apparent from the following specification and the drawing forming a part thereof, wherein:

Figure 1 is a diagrammatic plan view of the terminal within the furnace mounting;

Figure 2 is a section of the terminal on the line II—II of Figure 1; and

Figure 3 is a section of the terminal on the line III—III of Figure 1, showing the baffle in engagement with the socket 2.

Referring to Figure 1, 21 indicates the insulating fire-brick of the furnace proper with the iron shell 20 surrounding it. A standard terminal block mounting 19 surrounds the inner portion of the terminal, the outer portion of which is enclosed in a standard terminal porcelain tube 18. The terminal consists essentially of the terminal tube 1 in the outer end of which is formed the terminal socket 2. The baffle 3, consisting of a strip of corrosion resistant material, such as chrome iron or similar material, of a width to produce a relatively snug sliding fit across the diameter of tube 1, is pressed into tube 1 until it comes into engagement with the back or inner surface of the socket 2 (see Figure 3). Due to the space between the convex inner surface of the socket 2 and the straight surface of the baffle when in engagement, water within the terminal will find a ready passage from one side of the baffle 3 to the other, notwithstanding the fact that socket 2 constitutes a mechanical stop for baffle 3. Should it be desired to provide passages larger than those provided by the contour of socket 2 relative to the straight line end of baffle 3, the corners at the end of baffle 3 can be clipped so that this end takes the form of a blunt arrow head. See Figure 3. This water passage may be enlarged to any degree, the degree, of course, depending upon the size of the triangle clipped from each corner of the baffle 3. However, the mechanical stop is retained as heretofore at the blunt arrow point.

It will be appreciated here that the provision of the baffle 3 in the terminal eliminates the necessity of an injector pipe as used in present day terminals, and thus avoids the inconvenience caused by such pipes as noted hereinabove.

With baffle 3 inserted into tube 1, as shown in Figures 1 and 3, the outer end of baffle 3 lies sufficiently short of the outer end of tube 1 to permit insertion of metal disc 4, which is a punch part provided with groove 22 for the engagement of baffle 3, as shown in Figure 1. The disc 4 may be threaded at the edges to engage the threads of the inner casing of the terminal, but if desired, when the disc is inserted, it can be sweated in place by any well-known means, preferably by soldering. The disc 4 effectively water-seals the outer end of tube 1, and at the same time, keys baffle 3 into position to prevent both lateral and torsional displacement. However, by means of the threaded engagement of the disc, the baffle may be replaced easily and also placed in the correct operating position after such replacing. Hose nipples 6 and 7 are provided on tube 1 at its outer ends; one constituting a water outlet for the chamber on one side of the baffle, and the other constituting a water inlet for the chamber on the opposite side of baffle 3. Commonly, it is usual to employ port 7 as the water inlet port, and port 6 as the water outlet port, in which case the water takes the path indicated by arrows in Figure 1, and is readily carried through the terminal and discharged at 6, thereby preventing air accumulation within the terminal.

Since the curvature of tube 1 is relatively sharp and the wall thickness thereof relatively thin, it has been found desirable to attach the hose connections 6 and 7 to the tube by brazing, welding, or the like, rather than by employing, for example, threaded connections. If desired, both hose connections, or merely one, may be designed to form the binding posts for the electric leads, as shown at 6 in Figure 1. Here the hose connection is merely threaded on the outside to take the end 8 which forms one face of the electric cable clamp, and lock nut 9, which constitutes the clamping nut for the electric cable connection.

It will be seen that parts 1 to 8 of the above described terminal are exceedingly simple in mechanism and exceptionally low in cost as there is an absence of castings which require machining and tapping, as is now required with terminal fittings used with present day terminals.

The element contacting end of the terminal 2 may be a punch part in the shape of a dished disc stamped from heat resisting iron alloy such as chrome iron or any other suitable sheet stock. This disc or tip is only ⅛" in thickness as compared to the former terminal tips which are from ¾" to 1" thick, as previously stated, and thus overcomes the difficulties ordinarily encountered in water-cooling. This disc may be readily welded to terminal tube 1 at 13, and it is apparent that it thoroughly water-seals that end of tube 1 and provides the terminal socket 2.

The aluminum contact shim 14, which is about ⅛" thick, is stamped from sheet stock of corresponding thickness, and is dished to such a degree that it fits nicely into the terminal socket 2, and the heating element 15 is seated against the concave surface of aluminum disc 14.

For positioning the terminal and for affording pressure against the end of the resistor rod, it has been found necessary in present day practice to supply a very complicated and thus costly pressure transmitting apparatus, inasmuch as the pressure exerted upon the resistor rod has had to be accurately regulated according to the size of the bar used, as for example, a 1¼" bar required from 50 to 60 lbs. of pressure. With the water-cooled terminal of this invention there is no necessity of exerting a large amount of pressure, but only a slight degree of pressure, inasmuch as when the aluminum is heated, it softens suffi-

ciently to insure a perfect contact between it and the resistor. It will be appreciated here that the elimination of strong pressure is a great advantage since it obviously provides against the working of the rod through the tip to seriously injure the element end, as well as eliminating the costly transmitting apparatus above referred to. This being true, I have found it expedient, from the standpoint of cost and efficiency, to use an outer terminal assembly such as is shown in Figure 1. This terminal assembly consists of a stop member 5 of electrical insulating material to which a cross-arm 17 is rigidly secured.

The cross-arm at either end supports springs 10 and 11 which adjust the pressure being exerted upon the terminal. With this form of resilient mounting, the much desired straight line motion of the terminal toward the resistor is secured and the mounting overcomes the ineffective results obtained with the resilient mounting heretofore used which worked at an angle. It is to be understood, of course, that various terminal assemblies embodying the principles of the assembly shown in Figure 1 may be used, if desired.

In operation, as element 15 approaches its normal operating temperature, the aluminum surface of disc 14, which contacts the element, is softened by the temperature sufficiently to permit it to conform to the shape of the element end (through the tension in the springs 10 and 11), and to permit the element end to sink slightly into this surface so that the material in disc 14 not only conforms to the general shape of the element end, but actually squeezes into the small pores and irregularities of the element end. This action, as hereinbefore stated, tends to perfect the electrical contact between disc 14 and element 15 which, in turn, tends to minimize the heat generated at the contact due to contact resistance.

Since the water-cooling of socket 2 is exceptionally effective due to the relatively large area of the socket which is in contact with the water, and due also to the relatively small mass of the socket, the convex surface of aluminum disc 14 which contacts the concave area of 2, does not attain a temperature sufficiently high to soften it or to render it plastic. This circumstance necessarily limits the depths to which the element 15 will penetrate into the concave surface of aluminum disc 14.

I have found that the element will not penetrate aluminum disc 14 to a greater depth than about $\frac{1}{32}$'' in normal operation, and not more than $\frac{1}{16}$'' when the element is operated at a considerable overload, although operated in furnaces so that members 2 and 14 can be used in connection with a furnace operating at temperatures from 1250° C. to 1350° C. From actual experience, therefore, it is clearly demonstrated that there is no danger of piercing the aluminum shim during normal operation, even at excessive temperatures, and therefore, the practicability of using aluminum as the contact material in high temperature furnaces is proved and is made possible by the new type of water-cooled terminal disclosed herein.

The inter-action of aluminum disc 14 and element 15 above described, renders aluminum disc 14 virtually a part of element 15. This intimacy is further enhanced by an alloying action which takes place in time at furnace temperatures. This action is in the nature of a "calorizing" action during which the aluminum takes on silicon from the element end and is thereby gradually converted (at least in the immediate vicinity of the element end) to a hard aluminum silicon alloy. Such action is particularly advantageous inasmuch as the aluminum at the contacting surfaces of the heating element is gradually converted to a relatively hard alloy with a higher softening point than that of aluminum after the aluminum has been permitted to thoroughly shape itself to the contour of the element end. The advantage in this lies in the fact that on initially closing the circuit no arcing or sizzling will take place because of the nature of the aluminum contact, and subsequently no arcing is possible for the reason that the aluminum alloying action virtually welds the disc 14 to element 15. Still another advantage of this joining action resides in the fact that upon removing element 15 for replacement the disc 14 adheres to the element 15, but does not adhere to the metal 2. The disc 14 is discarded with the old element and a new disc is inserted with each replacement. By this simple means a new terminal seat for each silicon carbide heating element replacement is insured and one of the greatest defects incident to the use of a new resistor with an old contact tip in the present water-cooled terminal is eliminated.

Although aluminum is preferred as the metal to be used for the contact shims of this invention, it is to be understood that metals having the same characteristics may be as advantageously employed. The patent to Boyer, No. 1,818,191, describes certain alloys consisting of nickel and aluminum and containing up to about 42% nickel, and aluminum and iron containing 30% iron, which have similar characteristics. It will, therefore, be appreciated that certain aluminum alloys may be substituted for aluminum. My invention is not limited to a particular metal but includes other metals or alloys within the scope of the appended claims.

I claim:

1. In an electric furnace, a silicon carbide resistor having siliconized end portions, a water cooled contacting member for conducting an electric current to the resistor, and an insert of aluminum interposed between the said contacting member and the end of the resistor.

2. In an electric furnace, a silicon carbide resistor having siliconized end portions and an electrical contact for the said resistor, the said contact consisting of an aluminum insert in contact with the end of the resistor and a thin water cooled metal backing supporting the aluminum insert.

3. In an electric furnace, a silicon carbide resistor having siliconized ends, a terminal for connecting the resistor with a source of current, the said terminal having an end portion which is relatively thin in comparison with the diameter of the terminal, a water passage within the terminal which extends to the inner surface of the said end portion of the terminal, and an aluminum insert interposed between the end portion of the terminal and the end of the resistor.

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