

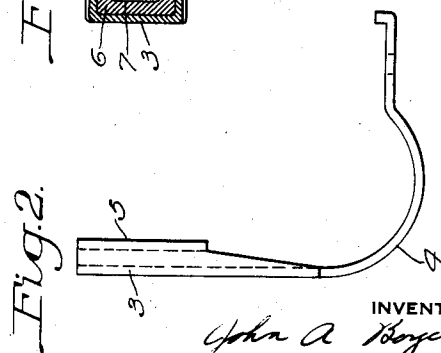
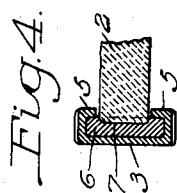
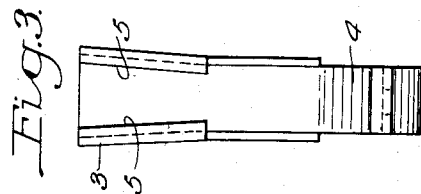
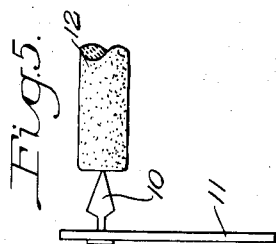
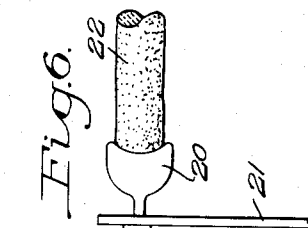
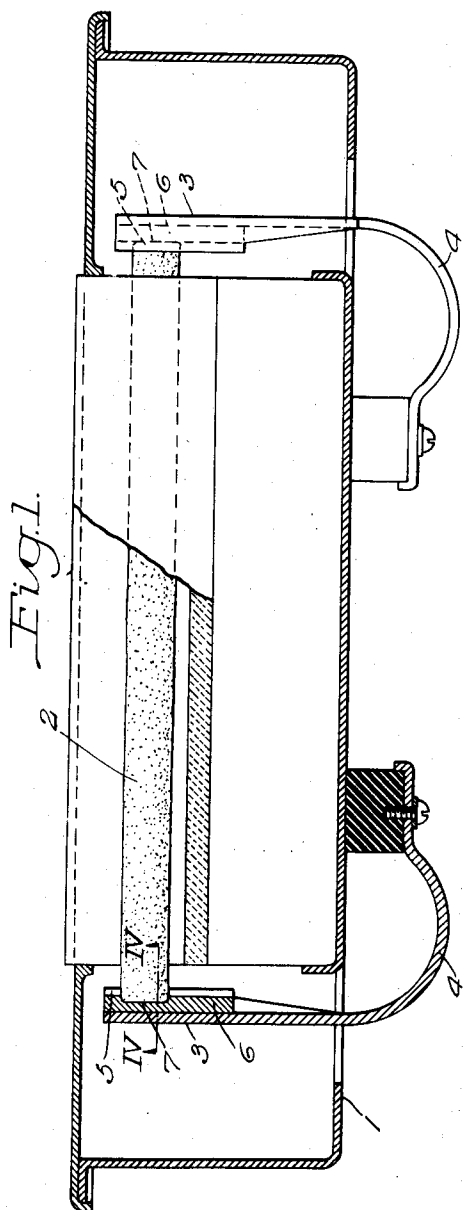
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ELECTRIC HEATING APPLIANCE

Filed Aug. 19, 1929



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UNITED STATES PATENT OFFICE

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ELECTRIC HEATING APPLIANCE

Application filed August 19, 1929. Serial No. 386,998.

This invention relates to electric heating appliances, and more especially to contact terminals for electric heating appliances employing rigid resistors as the heating elements. The invention relates especially to a contact terminal of an aluminum alloy particularly adapted for this purpose.

In the drawings,—

Figure 1 is a section taken partly in elevation of an electric heating device embodying my invention;

Figures 2 and 3 are detail elevations showing the construction of one of the contact terminals;

Figure 4 is a sectional view taken on the line IV—IV of Figure 1; and

Figures 5 and 6 are fragmentary elevations showing forms of contact terminals.

Heating appliances, such as domestic electric room heaters, hot plates, stoves, etc., are often made with rigid non-metallic resistors as the heating elements. These non-metallic resistors are usually made of crystalline refractory conducting material formed into rods or bars. As an example of such type of resistors may be mentioned the resistors sold under the trade name of "Globar" which are bars consisting principally of recrystallized silicon carbide.

These non-metallic resistor elements are highly refractory and may be operated at a high temperature and have a long life. The surfaces of such resistors are somewhat rough and present high spots or projecting crystals as contrasted with a metallic surface which may be finished to a smooth condition.

One of the great practical difficulties in employing non-metallic rigid resistors of this type has been the provision of suitable contacting means between the resistor and the metallic terminal members. A metallic contact held against the surface of the resistor bears only on the high points of the somewhat rough resistor surface, and the current passing from the metal to the body of the resistor is therefore concentrated at relatively small contact areas or points. The result has been a tendency to arcing and local overheating.

Many attempts have been made to solve the

difficulty of providing satisfactory contacts. In general these have comprised principally mechanical designs for the metal contact member with the incorporation of a piece of heat-resisting metal at the junction of the resistor and contact terminal, or the ends of the rods have been coated with a film of metal by spraying or plating.

Such mechanical devices have included metal caps for the rods, cumbersome split rings and side contacts, wrapping the ends of the resistor elements with heat-resistant wire, and similar mechanical devices. In such previous attempts principal reliance has been upon a metal which is particularly heat resistant, such as the nickel-chromium alloys, iron, chromium alloys, nickel, and nickel alloys. These alloys are hard as well as heat resistant, and in fact, hardness has been considered a desirable property in most of these metals.

Thin metal films applied to the ends of the rod are not durable because their intimate union with the resistor causes them to assume the same temperature as the resistor and because they are too thin to form a cushion and thus eliminate arcing and local overheating.

Contacts of soft, relatively low melting point metal, such as aluminum, have also been suggested, and are described and claimed in the copending application of Harold N. Shaw, filed of even date therewith. Metallic aluminum is soft and readily fusible, so that when used as the contact piece the high points or projecting crystal points of the resistor surface tend to embed themselves in the aluminum and give a greater area of contact than with a hard metal. The aluminum melts at approximately 660° centigrade and becomes soft at even lower temperatures. While the aluminum contact terminals have proved satisfactory where the terminals are exposed and can readily radiate or conduct away the heat, they are not entirely satisfactory for shielded or enclosed terminals.

The present invention relates especially to this class of terminals, namely, those in which the high points of the resistor surface may embed themselves in the metal, and

especially to terminals having greater heat resistance than aluminum and a long softening point temperature range.

In many of the domestic heating appliances, the contact terminals are so exposed that the metallic aluminum may be used as a contact material. However, in other appliances the terminals are enclosed or partially enclosed or shielded so that they become much hotter than open or exposed terminals. In such cases contacting members of the same general nature as aluminum but of a higher softening point are required.

I have found that certain of the aluminum alloys have a higher melting point as well as a softening range prior to complete fusion; and that these alloys provide durable contacting members for rigid non-metallic resistors, particularly for intermittent service and in devices which prevent rapid dissipation of heat from the terminal members. Most domestic appliances are subjected to intermittent service in which the current is turned on to the resistors for a short time and then the current shut off, so that the devices are subjected to continued cycles of heating and cooling. This makes the terminal conditions severe, tending to cause arcing and local overheating.

As examples of such alloys are the aluminum base alloys containing a metal of the iron group, more particularly the iron family comprising the metals iron, nickel and cobalt, preferably up to about 40% of nickel or up to about 30% of iron. Greater amounts of nickel and iron may be alloyed with the aluminum in certain cases where plasticity of the alloy under heat is not required, but in cases where the successful operation of the contact depends upon the high points of the resistor surface becoming embedded in the contacting member to prevent excessive heating, it is desirable that the above amounts of nickel and iron should not be greatly exceeded. This is because of the fact that with these figures as the upper limits for the nickel or iron, aluminum exists in the resulting alloy in a free as well as in a combined state. It is a well recognized fact that when aluminum is alloyed with a second metal, the aluminum may crystallize as substantially pure metal microscopically intermingled with the other constituents of the alloy, or it may be combined as an intermetallic compound or separate as a phase having none of the characteristics of the pure metal. The intermetallic compounds usually have both physical and chemical properties which are entirely different from those of the component metals, so that as the percentage composition of the compound is approached or exceeded, the properties of the aluminum disappear. In the alloys having a composition within the limits specified above, a portion of the alu-

minum will exist in the alloy in the free or uncombined condition. These alloys have an incipient melting point slightly lower than of pure aluminum, although their temperature of complete melting is considerably higher. As the amount of the alloying metal is increased beyond the point where free aluminum occurs as a separate constituent of the alloy, the alloys of aluminum with the metals of the iron family do not possess a low incipient melting point, and the property of softening at a comparatively low temperature is lost.

Alloys consisting of nickel and aluminum and containing up to about 42% of nickel have an incipient melting or softening temperature of approximately 620° centigrade. An alloy containing 40% nickel has a very small percentage of molten metal at this temperature and is not completely melted until it reaches approximately 1100° centigrade. By a variation of composition in either direction the amount of the low melting constituent, aluminum, may be varied, thus changing the effectual melting point, or the temperature at which the alloy becomes too soft to retain its shape under the contact pressure. Thus, aluminum-nickel alloys containing up to about 42% nickel retain to a degree the desirable characteristic, plasticity, of pure aluminum while hot, even though they may be brittle at ordinary room temperature. Moreover, these alloys have a solidification range of several hundred degrees centigrade.

A similar relationship obtains with alloys of aluminum and iron. Free aluminum vanishes as an alloy constituent at approximately 40% iron, but as this composition is approached the alloys become so brittle that the contacts are apt to crack in service. I have found that an aluminum-iron alloy containing 30% iron has an incipient melting point of approximately 648° centigrade, and is not completely molten until approximately 1100° centigrade, thus giving a plastic range of approximately 450° centigrade. While these aluminum-nickel and aluminum-iron alloys are somewhat harder than pure aluminum, they are nevertheless softer at the operating temperature than the iron-chromium and iron-nickel alloys commonly employed as contact terminals and allow the projecting crystals points of the resistors to press into the metal. Moreover, the lower end of their plastic range is reached at a relatively low temperature and one considerably below their temperature of complete melting, so that if the current becomes concentrated at the point of a projecting crystal so that overheating results, the metal at this point becomes plastic and allows the point to become embedded in the metal, thus giving greater surface of contact and automatically reducing the local overheating. This capacity of

the metal to soften at a local hot spot and permit the projecting points of the resistor surface at such plate to penetrate further into the metal surface and thereby provide a larger contact surface with a consequent decrease in resistance, provides what may be termed a self-compensating contact.

The contacts of such aluminum alloys are much superior to those of the commonly used materials, such as the chrome-iron, chrome-nickel steels which have heat resistant but hard surfaces, and are found to last from ten to fifty times as long on a continuous intermittent test which comprises subjecting the resistor and its contacts to alternate fifteen minute periods of current turned on and off. The contact terminals of the aluminum alloys as herein described are an improvement upon and are superior to a plain aluminum contact, particularly when subjected to severe usage or when employed on enclosed terminals or other terminals which become more highly heated than the ordinary exposed terminals.

Referring to the illustrated embodiment of the invention, reference numeral 1 indicates a domestic hot plate having non-metallic rigid silicon carbide resistors 2. The resistors are held at each end by contact terminals 3. As shown in the drawings, these contact terminals are partially enclosed or shielded by the surrounding parts of the hot plate so that they do not have a good opportunity to radiate heat.

Each contact terminal comprises an alloy steel spring 4 having upper ends bent over to form inwardly directed flanges 5 to hold a contact piece 6 of an aluminum-nickel or aluminum-iron alloy. This piece 6 is preferably hollowed out somewhat as indicated at 7 to provide a seat for the end of the resistor rod 2. The end of this resistor rod is, of course, somewhat rough because of its crystalline nature. The aluminum alloy, however, permits the rough end of the rod to become embedded in it and furnish a good contact even under the severe conditions of intermittent use to which such devices are subjected.

In Figure 5 there is illustrated another form of contact; namely, a cone-shaped piece 10 of aluminum alloy yieldingly pressed by spring 11 against the end of a resistor rod 12.

In Figure 6 is illustrated still another modification of the invention in which a cup-shaped piece 20 of aluminum alloy is pressed by spring 21 against the end of a resistor rod 22.

While I have specifically illustrated and described the preferred embodiments of my invention, it is to be understood that the present invention is not so limited but may be otherwise embodied within the scope of the following claims.

I claim:

1. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an alloy of aluminum and a metal of the iron family and in which some of the aluminum is present in a free and uncombined state.

2. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an aluminum-nickel alloy, the alloy containing some aluminum in a free and uncombined state.

3. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an aluminum-nickel alloy containing up to about 42% nickel.

4. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an aluminum-nickel alloy containing approximately 40% nickel.

5. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an aluminum base alloy containing aluminum in a free state having a temperature interval between its temperature of incipient melting and its temperature of complete melting of more than 400° C.

6. In an electric heating device, the combination of a rigid resistor, and terminal members having contact surfaces of an aluminum base alloy containing some aluminum in the free state and having an incipient melting point substantially the same as the melting point of pure aluminum and a temperature of complete melting at least 300° C. above the melting point of pure aluminum.

7. In an electric heating device, the combination of a rigid resistor and terminal members having contact surfaces of an alloy of aluminum and an iron family metal containing some of the aluminum in a free state which softens at a temperature several hundred degrees below its fusion point so that projections on the resistor where local overheating occurs may become embedded in the metal.

8. In an electric heating device, the combination of a rigid resistor, terminal members having contact surfaces of an alloy of aluminum and a metal of the iron family and in which some of the aluminum is present in a free and uncombined state, and means for yieldingly holding the terminal members against the resistor.

9. In an electric heating device, the combination of a rigid non-metallic resistor and terminal members having contact surfaces of an aluminum iron alloy having not more than 40% of iron.

In testimony whereof I have hereunto set my hand.

JOHN A. BOYER.