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METHOD OF BRAZING RESISTOR TERMINALS

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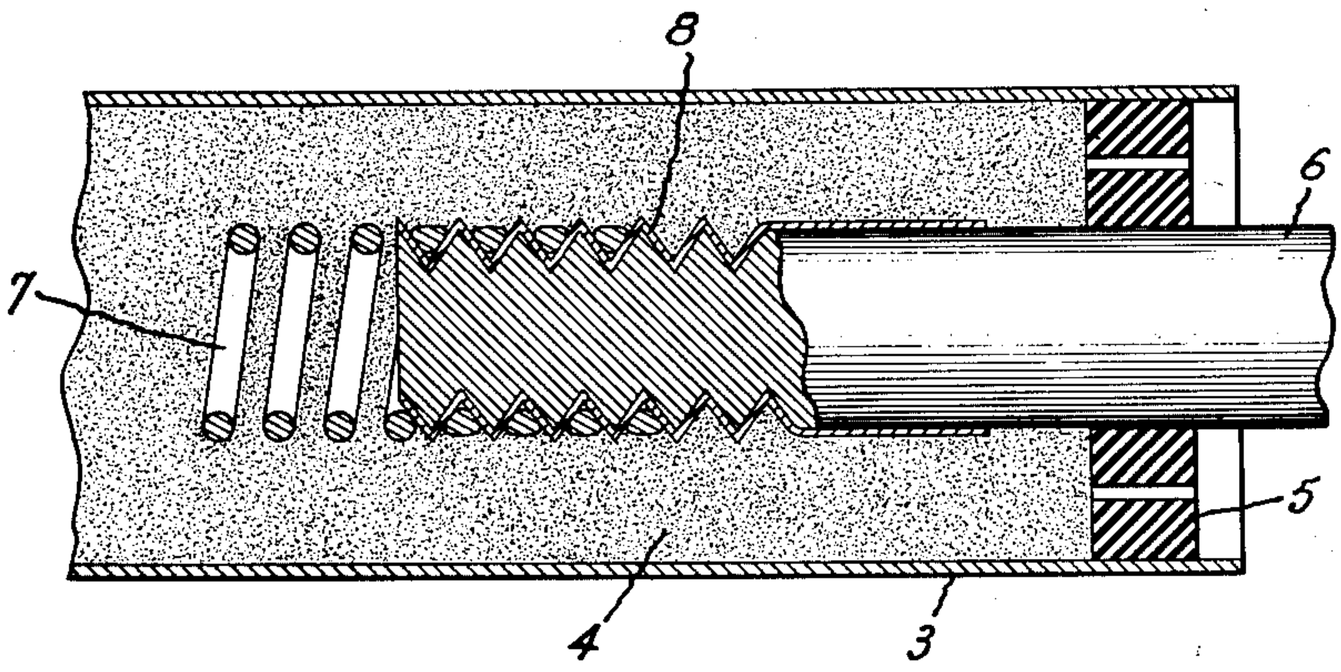

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METHOD OF BRAZING RESISTOR TERMINALS

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The present invention relates to a method of brazing, and more particularly to a method for copper brazing together metal structures at least one of which is formed of a chromium alloy. The invention is especially well adapted for the making of terminal connections in electric resistor units of the sheathed and insulated coil type.

It has heretofore been known that copper brazing of chromium alloys such as nickel chromium alloys and the like without the use of a flux cannot be carried out satisfactorily in atmospheres other than pure dry hydrogen. Such an atmosphere is not normally available in commercial heat treating furnaces. Commercial heat treating and brazing furnaces ordinarily contain an atmosphere made up of the combustion products of ordinary city gas burned in air. These combustion products ordinarily include hydrogen, various gaseous oxidizing agents such as carbon monoxide and carbon dioxide, and a substantial residuum of nitrogen.

It is a general object of my invention to provide a new and novel method for brazing metals, such as chromium alloys and the like, which are readily oxidizable at brazing temperature in atmospheres other than pure hydrogen, and to do so in an atmosphere including only a relatively small amount of hydrogen.

It is a further object of my invention to provide a new and novel method for forming a strong copper brazed joint with a chromium alloy structure and in an atmosphere including hydrogen and one or more oxides of carbon.

It is still another object of my invention to provide a new and improved method of making a terminal connection between a threaded terminal bolt and a coiled resistance wire in a resistor unit of the sheathed insulated type.

It is a particular object of my invention to provide a new and novel method of making a sheathed and insulated electric heating resistor including a chromium alloy resistance wire copper brazed to a terminal conductor.

The novel features which are characteristic of my invention are set forth with greater particularity in the appended claims. My invention will be further understood, however, and its various objects and advantages further appreciated by reference to the following detailed specification taken in conjunction with the accompanying drawing, the single figure of which shows a pair of metal structures assembled together in juxtaposition in preparation for a brazing operation in accordance with my invention.

Referring now to the drawing, I have shown a

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fragmentary cross-sectional view of an assembly of metal structures to be copper brazed together. By way of example of my new and improved brazing method I have shown the structure to be brazed as an improved terminal structure for an electric heating resistor of the metal sheathed type illustrated in Patent 1,367,341—Abbott. Such a resistor comprises an outer metal sheath, such as a steel tube 3, within which is tightly compacted a mass of granulated heat refractory electric insulating material, such as powdered fused magnesium oxide 4. Embedded in the body of magnesium oxide and held spaced from the walls of the tube 3 by the magnesium oxide and by insulating spacers, such as a perforated spacer 5, I provide a threaded terminal bolt 6 connected to a helically coiled electric resistance element or wire 7. The terminal bolt 6 may suitably be formed of steel, and has its threaded end portion plated, as at 8, with a suitable brazing metal such as copper or a copper-cobalt alloy containing about 3% cobalt. I prefer, however, to employ a copper-nickel-iron brazing alloy containing about 85% copper, 10% nickel and 5% iron. It will be understood by those skilled in the art that when I refer hereinafter to "copper brazing" or to "copper plating" of one of the parts to be brazed I do not intend that my invention shall be limited to the use of pure copper only, but I intend to include within these terms the use of any suitable copper brazing alloy such as those mentioned above. Threaded on to the threaded end of the terminal bolt 6 and staked in place I provide a helically coiled electric resistance wire 7 formed of a chromium alloy, such as an alloy containing approximately 80% nickel and 20% chromium.

In carrying out the brazing operation of a chromium alloy in accordance with my invention, one of the parts to be brazed together, such as the terminal bolt 6, is first copper-plated. The helically coiled chromium alloy resistance wire 7 is then threaded on to the threaded end of the bolt 6 to form a joint, as shown in the drawing. Next the threaded on portion of the resistance wire is staked into the threads of the bolt to improve the metal contact at the joint, as indicated by the deformation of the threaded on turns of the coil 7. The coil and terminal assembly are then inserted into a metal tube or sheath 3 and held in spaced relation with the walls of the sheath by means of a plurality of perforated insulating spacers such as the spacer 5. With the terminal assembly thus in place in the tube, the entire tube is filled with a mass of granulated

fused magnesium oxide, the oxide filtering through the perforated spacers. In the completed article this oxide has the function of holding the resistance coil and terminals firmly in place and insulating them from the walls of the sheath 3. The magnesium oxide is then tightly compacted into the tube by any suitable means. For the purpose of thus tightly compacting the magnesium oxide, I prefer to reduce the diameter of the outer tubular sheath 3 by swaging or rolling.

With the structures to be brazed together thus assembled with a thin coating of brazing metal in the joint between the structures and the entire structure embedded in a compacted mass of granulated fused magnesium oxide, I place the entire structure in a heat treating furnace or other suitable space containing an atmosphere including approximately 10–20% hydrogen and various oxides of carbon. I prefer to utilize an atmosphere comprising approximately 16% hydrogen, 10% carbon monoxide, 5% carbon dioxide, 1½% methane and the remainder nitrogen. The structures are then heated up to an annealing temperature which may, for example, suitably be of the order of 1125° C. At this temperature the copper plating melts and makes a very effective brazed joint with the chromium alloy coil and the steel terminal bolt.

The metal sheathed resistance heating unit which I have illustrated by way of example benefits from the foregoing heat treatment not only in that the terminal brazing opperation is carried out, but also in that the outer steel tube or sheath is annealed at the same time. This annealing operation is usually necessary after swaging or rolling of the tube, so that my new and novel method of copper brazing as applied to resistor units of the type illustrated may be carried out without any heat treating operations other than those which are otherwise necessary for the production of this type of resistor.

While I have illustrated a preferred embodiment of my invention by way of illustration, many modifications will occur to those skilled in the art, and I therefore wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of copper brazing together a threaded terminal bolt and a helically coiled resistance wire of chromium alloy in a resistor unit of the sheathed insulated type which comprises plating at least the end of said bolt with brazing metal, threading the end of said coiled wire onto the plated end of said bolt to form a joint, positioning said wire and bolt in a metal sheath spaced from the walls thereof, compacting into said sheath a mass of electrically insulating granulated heat refractory material to embed said wire and joint, and heating the assembled unit in a space containing an atmosphere including hydrogen and an oxide of carbon.

2. The method of copper brazing together a threaded terminal bolt and a helically coiled resistance wire of chromium alloy in a resistor unit of the sheathed insulated type which comprises plating at least the end of said bolt with brazing metal, threading the end of said coiled wire onto the plated end of said bolt to form a joint, staking said joint, positioning said wire and bolt substantially centrally in an elongated metal sheath spaced from the walls thereof, compacting into said sheath a mass of granulated fused MgO to

embed said wire and joint, and heating the assembled unit in a space containing an atmosphere including hydrogen, carbon monoxide and carbon dioxide.

3. The method of making a metal sheathed electric resistor unit which comprises plating with brazing metal at least the end of a terminal bolt, threading onto said plated end the end turns of a helically coiled resistance wire formed of a chromium alloy thereby to form a joint, positioning said wire and bolt within a metal sheath and spaced from the walls thereof, compacting into said sheath a mass of electrically insulating granulated heat refractory material comprising a metallic oxide to embed said joint, reducing the size of said sheath to further compact said material, and heat treating said unit at brazing temperature in a furnace containing an atmosphere including hydrogen and an oxide of carbon thereby simultaneously to anneal said sheath and braze said joint.

4. The method of making a metal sheathed electric resistor unit which comprises plating with brazing metal at least the end of a threaded terminal bolt, threading onto said plated end the end turns of a helically coiled resistance wire formed of a chromium alloy thereby to form a joint, staking said wire and bolt together at said joint, positioning said wire and bolt substantially centrally in an elongated tubular metal sheath and spaced from the walls thereof, compacting into said sheath a mass of granulated fused MgO to embed said wire and joint, reducing the cross section of said sheath to further compact said MgO, and heat treating the assembled unit at brazing temperature in a furnace containing an atmosphere including hydrogen, carbon monoxide and carbon dioxide, thereby simultaneously to anneal said sheath and braze said joint.

5. The method of copper brazing together a terminal member and a resistance wire of chromium alloy in a resistor unit of the sheathed insulated type which comprises assembling the terminal member and the resistance wire in juxtaposition to form a joint with a thin coating of brazing metal therebetween, positioning the said terminal member and wire within a metal sheath and spaced from the walls thereof, compacting into the said sheath a mass of electrically insulating granulated heat refractory material to embed said wire and joint, and heating the assembled unit in a space containing an atmosphere including hydrogen and an oxide of carbon.

6. The method of copper brazing together, in a resistor unit of the sheathed insulated type, a terminal member and a resistance wire, at least one of which is formed of a chromium alloy, which method comprises assembling the terminal member and resistance wire in juxtaposition to form a joint with a body of brazing metal adjacent the said joint, positioning the said terminal member and wire within a metal sheath and spaced from the walls thereof, compacting into the said sheath a mass of electrically insulating granulated heat refractory material to embed said wire and joint, and heating the assembled unit in a space containing an atmosphere including hydrogen and gaseous oxidizing agents.

7. The method of copper brazing together, in a resistor unit of the sheathed insulated type, a terminal member and a resistance wire, at least one of which is readily oxidizable at brazing temperature in an atmosphere other than pure hydrogen, which method comprises assembling the terminal member and resistance wire in juxtaposition to form a joint with a body of brazing

metal adjacent the said joint, positioning the said terminal member and wire within a metal sheath and spaced from the walls thereof, compacting into the said sheath a mass of electrically insulating granulated heating refractory material to embed said wire and joint, and heating the assembled unit in a space containing an atmosphere including hydrogen and a gaseous oxidizing agent.

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