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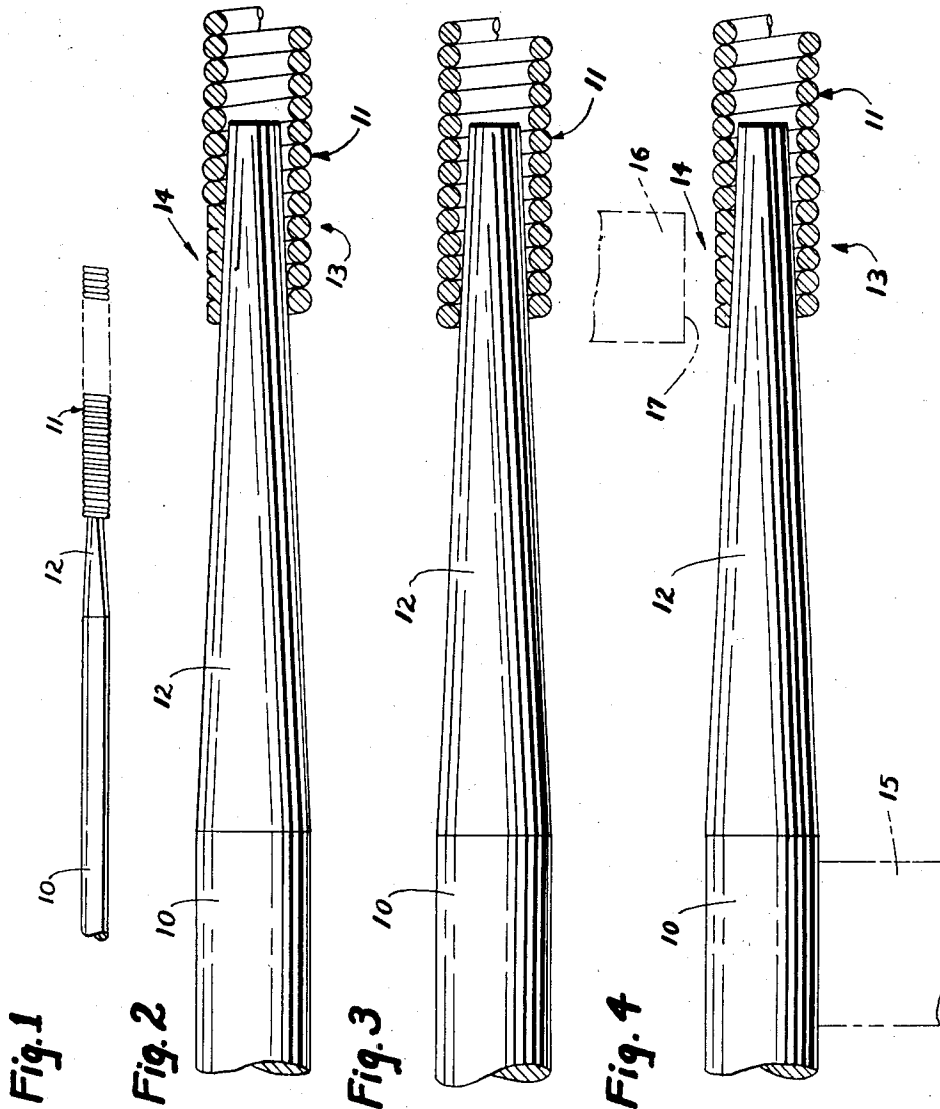
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TERMINAL PIN RESISTOR ASSEMBLY FOR ELECTRIC HEATERS

Filed May 8, 1957

2 Sheets-Sheet 1



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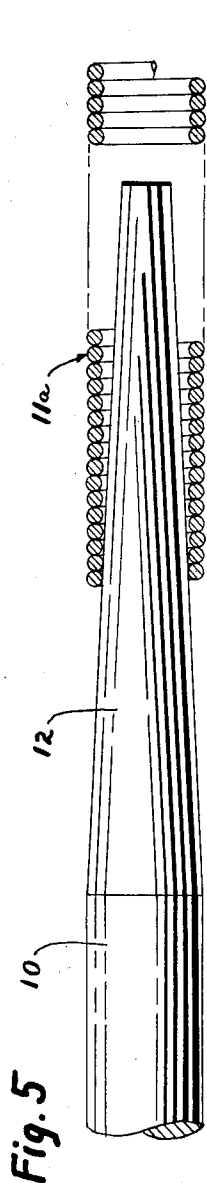
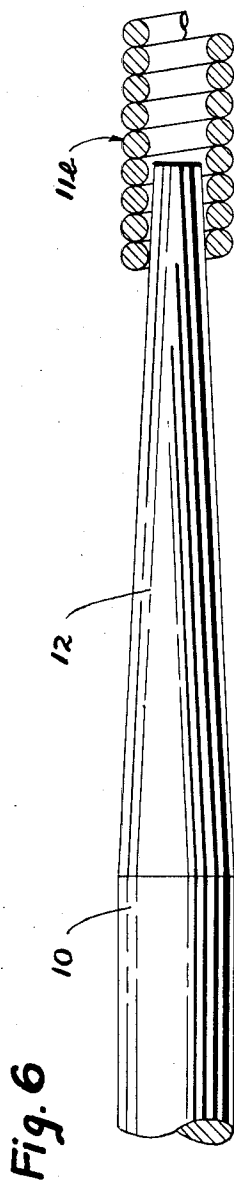
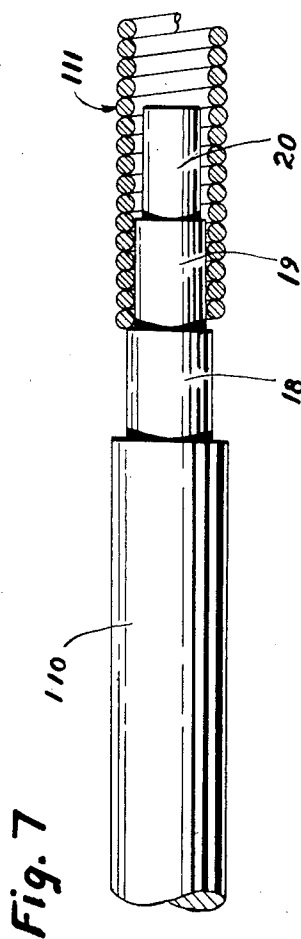
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TERMINAL PIN RESISTOR ASSEMBLY FOR ELECTRIC HEATERS

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2 Sheets-Sheet 2



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TERMINAL PIN RESISTOR ASSEMBLY FOR ELECTRIC HEATERS

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7 Claims. (Cl. 338—329)

The present invention relates to electric heaters, more particularly to improved methods of making electric resistance heaters and to the improved heaters made thereby, and the principal object of our invention is to provide new and improved methods and articles of such character.

In the manufacture of electric resistance heaters, a long standing problem has been that of making suitable electrical connections to the resistor wire which becomes heated when current is passed therethrough. This problem becomes more and more acute as finer and more delicate resistor wires are employed and the need for a satisfactory, low cost connection becomes even greater as heater production mounts since even a small percentage of rejects or a small saving in cost per unit amounts to large sums.

The present invention is particularly adapted although not necessarily limited for use in manufacturing tubular metallic sheathed electric resistance heaters of the type wherein a coiled resistor is embedded in compacted, electric insulating, heat conductive material enclosed in a tubular metallic sheath from whose one end a terminal pin protrudes. The terminal pin extends into the sheath and is electrically connected with the resistor and the protruding portion of the terminal pin is adapted to be connected to a source of electric current. Normally, a terminal pin is connected to each end of the coiled resistor member and each terminal pin protrudes from a respective end of the enclosing sheath; however, only one end of the resistor and its terminal pin will be disclosed herein since the arrangement at both ends is the same.

In the manufacture of certain types of heating elements, there exists not only the necessity of obtaining a good electrical connection between the terminal pin and the resistor but also the necessity of providing a high mechanical strength connection therebetween. This latter attends because certain processes require that the resistor be tensioned by pulling the terminal pins at respective ends of the resistor in a direction away from each other. It has heretofore been proposed that the terminal pin be welded to the resistor to provide a permanent connection which possesses both high mechanical strength and low electrical resistance; however, in the past, insurmountable difficulties stood in the path of a practical application of this obvious expedient to high production operations. Because of the small size of the resistor wires and because of the materials involved in the resistor wire and the terminal pin, it is necessary to precisely control both the pressure exerted by the welding electrode and the welding current in order to obtain a satisfactory weld. Variations in one direction of either the pressure or the welding current may cause the resistor wire to be crushed or burnt so badly that the weld will have little strength. On the other hand, variations in the opposite direction may result in the resistor merely being stuck to the pin with a resulting poor connection. While it has been possible to obtain

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satisfactory welds under low production, laboratory type conditions, low cost, high production has not heretofore been possible without prohibitive losses in rejects.

The present invention provides a terminal pin-resistor assembly which is both inexpensive and highly efficient in producing perfect welds even under high production conditions where it is virtually impossible to maintain the heretofore necessary ideal balance between welding pressure and welding current. Moreover, the present invention greatly reduces the number of different terminal pins required to accommodate coiled resistors of various sizes since one terminal pin may be used with equal facility with a relatively wide range of resistor sizes. These and other advantages will readily become apparent from a study of the following description and from the drawings appended hereto.

In the drawings accompanying this specification and forming a part of this application there is shown, for purpose of illustration, embodiments which the invention may assume, and in these drawings:

Figure 1 is a fragmentary elevational view of an assembly provided by a preferred embodiment of the present invention,

Figure 2 is a view similar to Figure 1 but considerably enlarged and partly in section to illustrate the interior construction,

Figure 3 is a view similar to Figure 2 but prior to the welding operation,

Figure 4 is a view similar to Figure 2 but showing the manner in which the weld is produced,

Figures 5 and 6 are views similar to Figure 3 but illustrating how the same terminal pin is used with coiled resistors both larger and smaller than that shown in Figures 1 through 4; and

Figure 7 is a view similar to Figure 3 but of another embodiment of the invention.

Figures 1 and 2 illustrate a terminal pin 10 to which the coiled end of a resistor 11 is secured to provide for electrical continuity therebetween. Although it forms no part of the present invention, the resistor 11 with a terminal pin 10 at each end is usually, although not necessarily, enclosed in a tubular metallic sheath with respective pins protruding from respective ends thereof, and the sheath filled with powdered refractory material which is subsequently compacted by reducing the transverse size of the sheath. The protruding portion of each terminal pin thereafter forms a rigid member to which the usual electrical connections may be made.

The present invention is concerned with the manner in which the resistor is connected to the terminal pin and in the embodiment shown in Figures 1 through 4, it will be noted that the resistor-engaging end of the terminal pin is disposed within the coiled end of the resistor and the endmost turns 13 of the latter are welded at 14 thereto (see Figure 2).

In assembling the terminal pin with the resistor, the tapered end of the former is inserted as far as it will go into the coiled end of the latter as seen in Figure 3. Note that the taper of the pin assists its entry into the resistor. The terminal pin is then engaged with the electrode 15 of a suitable welder (Figure 4) and another electrode 16 thereof is then employed to clamp the endmost turns of the resistor against the adjoining surface of the terminal pin. Current will then be caused to flow between respective welding electrodes 15, 16 to effect the weld. It is to be noted that the working face 17 of electrode 16 is preferably parallel with the axis of the terminal pin for a purpose to appear.

Referring particularly to Figures 2 and 4, it will be seen that the endmost turns 13 of the resistor end are secured to the pin by means of a graduated weld. Note

that the endmost turn of the resistor has been secured to the pin with a considerable degree of fusion, the next turn inwardly thereof with somewhat less fusion, and succeeding turns with progressively less fusion. A graduated weld of this type is highly advantageous as compared with welds not so graduated.

Prior art welds, as previously pointed out, were not satisfactory because of the difficulty of maintaining the optimum degree of fusion between the resistor and the terminal pin. By employing a graduated weld, however, the problem of optimum fusion is quite simply solved. For example, assume that the endmost turn of the resistor were fused so completely that it was practically burnt away. If this were the only turn welded or if all turns were so welded, a weld of little mechanical strength would result since the resistor wire would break under a relatively light stress at the place where it is welded to the pin. However, with the weld graduated inwardly from a point of maximum fusion at an endmost turn, successive turns will be welded with progressively less fusion. While it is true that some of the innermost turns engaged by the welding electrode will be barely fused to the terminal pin, one or more turns intermediate such barely fused turns and the overly fused endmost turn will have the optimum degree of fusion. Accordingly, even if some of the innermost turns come loose from the terminal pin under stress because of their lack of fusion, successive turns outwardly thereof having a progressively greater degree of fusion will remain securely welded to the terminal pin.

In order to produce consistently good welds even under high production, it is only necessary to make certain that there is at least optimum fusion between the terminal pin and the endmost turn of the coiled resistor welded thereto. Indeed, a certain degree of more than optimum fusion is desirable at this place since this will insure that at least one turn will be subject to optimum fusion even though the weld varies as a result of electrode wear, variations in resistor wire hardness, line voltage variations, or any of the many other factors which have an effect on resistance welding.

In order to obtain the graduated weld hereinabove described, it is presently preferred to exert a graduated clamping pressure upon successive turns of the coiled resistor during the welding operation. As herein disclosed, the endmost turn of the resistor will be subjected to maximum clamping pressure while successive turns inwardly thereof will be subjected to progressively less pressure. This is accomplished by disposing the respective surfaces between which the resistor is clamped (i.e., the terminal pin portion within the coil resistor and the working face 17 of electrode 16) at an angle to each other.

In the embodiment thus far disclosed, this angular relationship is provided by virtue of the fact that the terminal pin end is tapered while working face 17 of electrode 16 is parallel with the axis of the terminal pin. It is to be understood, however, the aforesaid angular relationship may be increased or decreased to obtain the desired graduated weld by changing the plane of working face 17 of electrode 16 by either tilting this electrode or by forming surface 17 at a different angle to the axis of the electrode.

The taper of the terminal pin, in addition to providing the above described angularity which makes possible the graduated weld, also performs another extremely desirable function. This taper permits the same terminal pin to be used with resistors having different inside diameters and therefore greatly reduces the number of different terminal pins which need be stocked for various heaters.

In the usual construction, a terminal pin is proportioned to fit within but one size resistor such as resistor 11 and in the event resistors of other sizes are to be used, a different terminal pin must be employed. However, by using the tapered terminal pin herein disclosed, the same pin may be used with a coiled resistor 11a having a much

larger inside diameter (Figure 5) or with a resistor 11b (Figure 6) having a much smaller inside diameter. All that need be done is to insert the tapered end of the pin into the resistor until they are in close engagement and then proceed with the welding operation. Note that the pin enters a greater distance into resistor 11a before engagement therebetween occurs while the pin enters a lesser distance into resistor 11b before such engagement.

In the embodiment shown in Figure 7, the end of the terminal pin 110 is provided with stepped diameter portions 18, 19 and 20 each proportioned to closely fit within a different inside diameter coiled resistor. Pin portion 19 is adapted to fit within resistor 111 which may be the same size as resistor 11. Portion 18 is adapted to fit within a resistor of the same size as resistor 11a while portion 20 is adapted to fit within a resistor of the same size as resistor 11b. While three portions 18, 19 and 20 have been shown, it is to be understood that a greater or lesser number of portions may be formed on the pin to accommodate it for use with a greater or lesser number of differently sized resistors.

In the embodiment shown in Figure 7, the heretofore graduated weld may be obtained by tilting the axis of the welding electrode which engages the coiled resistor so as to effect the desired angularity between the respective surfaces of the welding electrode and the terminal pin between which the resistor is clamped during the welding operation or by otherwise disposing the working face of the electrode at an angle with respect to that surface of the pin against which the resistor is clamped.

In view of the foregoing it will be apparent to those skilled in the art that we have accomplished at least the principal object of our invention and it will also be apparent to those skilled in the art that the embodiments herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described, hence it will be appreciated that the herein disclosed embodiments are illustrative only, and that our invention is not limited thereto.

We claim:

1. An electric heater, comprising a helically coiled electrical resistor and a terminal conductor pin having an end thereof fitting within said resistor and welded to a plurality of adjacent convolutions thereof, the degree of fusion of the weld progressively decreasing from convolution to convolution in a direction inwardly of said resistor, whereby successive resistor convolutions are secured to said pin by means of a graduated welded connection providing progressively increasing mechanical strength in a direction inwardly of said resistor and minimum electrical resistance at the outer end thereof.

2. In an electric heater, the combination comprising a resistor member having a coiled end providing a plurality of turns in side by side relation and a terminal conductor pin secured to said resistor member end to provide electrical continuity therebetween, one end of said terminal conductor pin being tapered for close fitting engagement within said coiled resistor conductor end and the latter being welded to that terminal conductor pin portion which is in close fitting engagement therewith by clamping said coiled resistor member end between said terminal conductor pin and a welding electrode and passing welding current through said resistor member end and said terminal conductor pin, one of the endmost turns of said coiled resistor member end engaged by the welding electrode being subject to the greatest welding pressure and successive turns inwardly of such endmost turn being subject to progressively less welding pressure as a result of the taper of said terminal conductor pin whereby the degree of fusion of the weld progressively decreases inwardly of the coiled resistor member end from a maximum at said endmost

turn to provide a graduated weld having both maximum mechanical strength and minimum electrical resistance.

3. In an electric heater, the combination comprising a resistor member having a coiled end and a terminal conductor pin secured to said coiled end to provide electrical continuity therebetween, one end of said terminal conductor pin having axially spaced portions providing different diameters for close fitting engagement within coiled resistor member ends each having a different inside diameter whereby the same terminal conductor pin may be used with such various coiled resistor member ends, said coiled resistor member end being welded to that terminal conductor pin portion which is in close fitting engagement therewith to provide a permanent, low electrical resistance connection therebetween.

4. In an electric heater, the combination comprising a resistor member having a coiled end and a terminal conductor pin secured to said resistor member end to provide electrical continuity therebetween, one end of said terminal conductor pin being tapered for close fitting engagement within various coiled resistor member ends each having a different inside diameter whereby the same terminal conductor pin may be used with such various coiled resistor member ends, said coiled resistor member end being welded to that terminal conductor pin portion which is in close fitting engagement therewith to provide a permanent, low electrical resistance connection therebetween.

5. In an electric heater, the combination comprising a resistor member having a coiled end providing a plurality of turns in side by side relation and a terminal conductor pin secured to said resistor member end to provide electrical continuity therebetween, one end of said terminal conductor pin having axially spaced portions providing different diameters for closely fitting within various coiled resistor member ends each having a different inside diameter whereby the same terminal conductor pin may be used with such various coiled resistor member ends, said coiled resistor member end being welded to that terminal conductor pin portion which is in close fitting engagement therewith to provide a permanent, low electrical resistance connection therebetween and the degree of fusion of the weld progressively decreasing in a direction inwardly of said coiled resistor member end from a maximum at one of the latter's endmost turns whereby successive turns will be welded to said terminal conductor pin by means of a graduated weld having both maximum mechanical strength and minimum electrical resistance.

6. In an electric heater, the combination comprising a resistor member having a coiled end providing a plurality of turns in side by side relation and a terminal conductor pin secured to said resistor member end to provide electrical continuity therebetween, one end of said terminal conductor pin being tapered for close fitting engagement within various coiled resistor member ends each having a different inside diameter whereby the same terminal conductor pin may be used with such various coiled resistor member ends, said coiled resistor member end being welded to that terminal conductor pin portion which is in close fitting engagement therewith to provide a permanent, low electrical resistance connection therebetween and the degree of fusion of the weld progressively decreasing in a direction inwardly of said coiled resistor member end from a maximum at one of the latter's endmost turns whereby successive turns will be welded to said terminal conductor pin by means of a graduated weld having both maximum mechanical strength and minimum electrical resistance.

7. In an electric heater, the combination comprising a resistor member having a coiled end providing a plurality of turns of uniform diameter in side by side relation and a terminal conductor pin secured to said resistor member end to provide electrical continuity therebetween, one end of said terminal conductor pin being tapered for close fitting engagement within various coiled resistor member ends each having a uniform but different inside diameter whereby the same terminal conductor pin may be used with such various resistor member ends, said coiled resistor member end being welded to that terminal conductor pin portion which is in close fitting engagement therewith to provide a permanent, low electrical resistance connection therebetween and the degree of fusion of the weld progressively decreasing in a direction inwardly of said coiled resistor member end from a maximum at one of the latter's end most turns whereby successive turns will be welded to said terminal conductor pin by means of a graduated weld having both maximum mechanical strength and minimum electrical resistance.

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Disclaimer

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Hereby enters this disclaimer to claim 4 of said patent.

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