

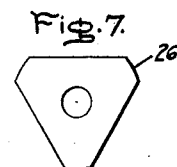
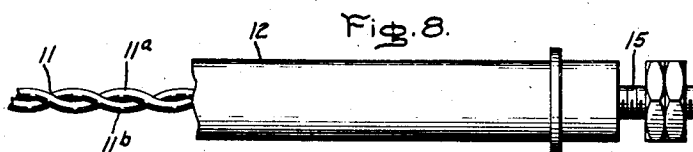
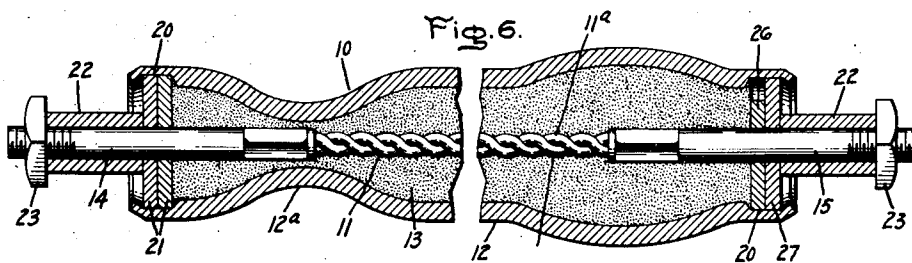
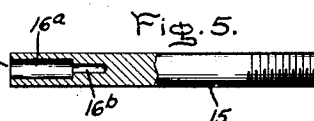
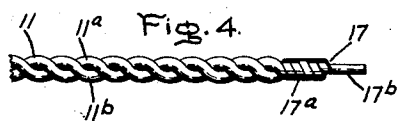
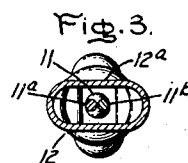
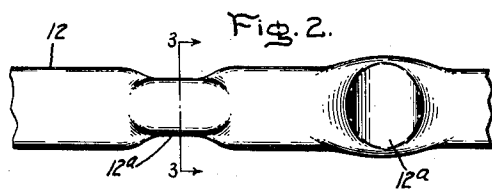
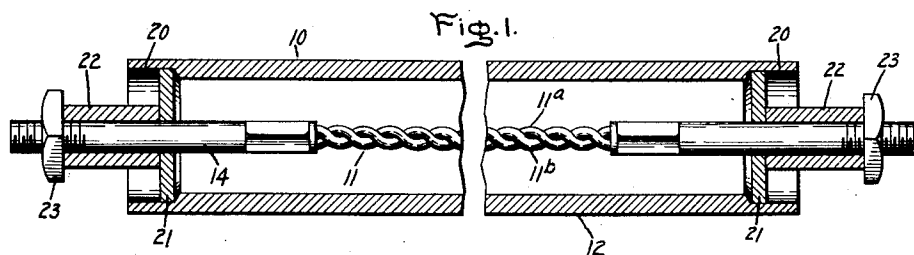
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ELECTRIC TERMINAL CONNECTION AND METHOD OF MAKING THE SAME

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ELECTRIC TERMINAL CONNECTION AND
METHOD OF MAKING THE SAME

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Original application December 3, 1929, Serial No.
411,372, now Patent No. 1,959,776, dated May
22, 1934. Divided and this application
February 20, 1932, Serial No. 594,276

2 Claims. (Cl. 29—155.5)

My invention relates to electric terminal connections, more particularly to terminal connections for electric heating units and the like, and has for its object the provision of an improved connection between the resistance conductor of the heating unit and a terminal member, and method for effecting the connection.

Although not limited thereto, my invention has particular application to electric heating units having a resistance heating element formed by twisting a plurality of resistance conductors together as described and claimed in my copending application, Serial No. 411,372, filed December 3, 1929, issued as Patent No. 1,959,776 on May 22, 1934 of which this application is a division.

In carrying my invention into effect in one form thereof, I provide the twisted resistance conductor with a stepped terminal portion and provide in the terminal a stepped bore to receive this terminal portion. I then insert the stepped terminal portion within the bore provided for it in the terminal and reduce the diameter of the terminal so as to force it into good electrical and mechanical contact with the resistance conductors. Preferably the terminal will be reduced to such an extent that the material of the terminal will be forced into the grooves between the twisted resistance conductors.

For a more complete understanding of my invention reference should be had to the accompanying drawing in which Fig. 1 is a sectional view illustrating the electric heating unit of my above-mentioned copending application provided with an electric terminal connection arranged in accordance with my invention and showing the unit in a preliminary stage of its construction; Fig. 2 is a fragmentary view illustrating a portion of the heating element of Fig. 1 in an advanced stage of the process of making the heating unit; Fig. 3 is a sectional view taken through the line 3—3 of Fig. 2; Fig. 4 is an elevation of a portion of the twisted heating element illustrating the element prepared for connection with its terminals; Fig. 5 is an elevation of the terminal partly in section illustrating the terminal prepared for connection with the heating element; Fig. 6 is a sectional view illustrating the heating unit in a more advanced stage of its construction; Fig. 7 is an elevation of a member used in making the heating element; and Fig. 8 is a partial elevation of the finished electric heating unit provided with a terminal connection arranged in accordance with my invention.

Referring to the drawing, I have shown my invention in one form in connection with a

sheathed wire heating unit of the type described and claimed in my above-mentioned copending application, Serial No. 411,372, filed December 3, 1929. This heating unit 10 comprises a straight core wire resistance heating element 11 formed from a pair of twisted resistance conductors 11a, 11b, extending centrally of a metallic sheath 12. The resistance element is made from a suitable high resistance material having considerable resiliency, such as nickel-chromium alloy. The heating element 11 is embedded in a compacted mass of powdered heat refractory insulating material 13 such as magnesium oxide.

Metallic terminals 14 and 15 are provided for the heating element 11. Each terminal is provided with a stepped longitudinal recess 16 for receiving a correspondingly stepped portion 17 of the twisted heating element. The stepped terminal portion of the heating element is formed by a reduced twisted portion 17a of the end portion of the heating element and by the end portion 17b of one of the conductors which projects beyond the twisted portion, preferably in the axis of the element. It will be observed that when the terminal portion 17 is inserted in the stepped bore of the terminal, the reduced twisted portion 17a will be received in the larger terminal recess portion 16a and the projecting portion 17b will be received in the smaller recess portion 16b. Each terminal is compressed on its heating element terminal portion so that the metal of the terminal is forced into the spaces or grooves between the turns of the twisted core heating element. A very good electrical and mechanical connection is thus provided between the terminals and the heating element. It will be observed that before a terminal could be removed or pulled from the heating element, it would be necessary to strip the inner threads which are formed in the terminal recesses when the terminal is compressed on the unit.

In forming the heating unit, the electrical resistance elements 11a and 11b are twisted together with a relatively short pitch to form the resistance heating element 11. While I have shown but two resistance strands wound about each other to form the twisted heating element, it is to be understood that several, as for instance three or four, may be used if desired.

Electric connections are then established between the terminals 14 and 15 and their respective end portions of the heating element 11. The heating element 11 is prepared for connection with the terminals 14 and 15 by providing the stepped end terminal portions 17. The pro-

jecting portion 17b may be formed by cutting off or otherwise detaching a portion of one of the conductors (11a, 11b) so as to leave the single strand. After this, the twisted end portion 17a of the heating element is swaged or otherwise reduced to approximately the diameter of the larger terminal recess portion 16a. It will be understood that the projecting portion 17b will be bent or twisted so as to lie in the axis of the heating element and further that the portion 16b of the terminal recess will have a diameter approximately equal to that of the projecting strand 17b so that it will just receive this portion. The terminal portion 17 is then inserted in the recess 16 of the terminal, after which the terminal is swaged or otherwise compressed, preferably to a square cross-section, so that its metal is forced into the grooves or spaces between the twisted conductors of the terminal portions 17a of the heating element.

This terminal arrangement is a very important feature of my invention. It will be understood that if the twisted core wire heating element were left full size to the end rather than having the stepped formation as shown, and the terminal were provided with a straight bore to receive it, the terminal would be so weak at the end of the core wire that it would practically draw in two at this point during the subsequent swaging of the assembled heating unit.

I provide the metallic sheath 12 with a plurality of flattened portions 12a positioned so as to maintain the heating element central during the insulating material loading operation and during the initial swaging operations. The sheath at these flattened portions will be sufficiently wide to receive the heating element but ordinarily will not be large enough for the terminals to pass through. Consequently it is generally necessary to assemble the heating element with the sheath before the indenting operation.

The metallic sheath 12 is prepared for the assembly of the heating element 11, first by providing its ends with counterbores 20 (Fig. 1) and then by thoroughly cleaning the interior of the sheath. The resistance element 11 with its terminals attached is then inserted lengthwise within the sheath as shown in Fig. 1 and preferably is placed under a slight tension to hold it straight within the sheath. It will be understood that the heating element will have a length sufficient to permit the terminals to project from the ends of the sheath. The heating element may be supported and tensioned in the sheath by placing washers 21 in the counterbores 20 and which fit on the terminal members so as to hold them centrally of the sheath. Suitable sleeves or collars 22 are then provided on the terminal members and are secured by means of nuts 23 which are turned on the threaded projecting end portions of the terminals. It will be understood that by turning the nuts 23 inwardly on the terminal portions, the heating element will be placed under a tension sufficient to hold it central within the tube and to prevent its kinking during the indenting operation.

After the heating element has been assembled with the sheath as shown in Fig. 1, the sheath is ready for the indenting operation. As shown (Figs. 2 and 3), the indents are placed in the metallic sheath so as to provide the flattened portions 12a in pairs with the axes of the adjacent portions positioned substantially at right angles to each other. It will be observed that by reason

of this arrangement, the reduced portions of each pair taken together form a square-shaped retaining section around the resistance element, (Fig. 3). It will be understood that a number of these pairs will be spaced at intervals along the length of the sheath.

It will be observed by reference to Fig. 3 that the passageway through the sheath at these flattened portions is sufficiently large to receive the heating element 11 and by reason of the fact that the adjacent flattened portions are arranged substantially at right angles to each other, the heating element will be secured centrally of the sheath at a plurality of points spaced at intervals throughout its length. However, it is very important that the reduced sections of the sheath be sufficiently large to prevent gripping of the resistance element at any point. Thus, generally there will be some clearance between the walls of the sheath and the element. It is preferable, therefore, to form each pair of flattened portions in the sheath at substantially 45° to the adjacent pairs. In other words one pair of indents will be formed with their axes substantially at 90° to each other. Then the sheath will be rotated about its longitudinal axis through 45° and another set of indents will be formed with their axes substantially at 90° to each other. In effect, therefore, the four indents of adjacent pairs taken together will form an octagonal shaped retaining section. This arrangement precludes any possibility of the element moving from its central position beyond the limits defined by the clearance between the resistance element and the side portions of the two square retaining sections formed by the adjacent pairs. It will be understood, of course, that if the axes of the flattened portions of each pair were not thus rotated relatively to the axes of the corresponding flattened portions of the adjacent pairs, the limits of the clearance would be defined by the distance between the surface of the resistance element and the corner portions of the square retaining sections.

It will be understood that the flattened portions will be spaced so that the heating element will be properly centered within the sheath but will not be positioned so close to each other that the passageway through the sheath will be restricted. Moreover, it will be understood that the indents will be placed in the sheath not only to maintain the heating element 11 central but also to maintain the terminal members 14 and 15 centrally of the sheath (Fig. 6).

After the sheath has thus been indented, the nuts 23, the sleeves 22 and the washers 21 are removed and the interior of the sheath is thoroughly cleaned so that any scale which might have become loosened by the indenting process is removed. The interior may thus be cleaned by blowing dry air through the sheath.

The sheath is now ready for the loading operation. The sheath is closed at one end, for example at the left hand end, as viewed in Fig. 6, by a pair of solid washers 21 which fit on the terminal 14 so as to hold the terminal centrally of the tube. These washers, as shown, are received in the left hand counterbore 20. The sleeve 22 is then positioned on the projecting end portion of the terminal 14 and is secured by means of the nut 23. The terminal 15 is secured in a similar manner centrally of the sheath by means of a triangular shaped washer 26 which is positioned in the counterbore 20 at the right hand end of the sheath. The resistance conductor 11 is placed

under a slight tension by turning the nuts 23 inwardly on the terminals.

The sheath is now filled through the openings provided by the triangular washer 26 with the heat refractory powdered insulating material 13. To accomplish this, the sheath is held in an upright position in a special vibrating machine (not shown) with the end provided with the triangular washer uppermost. As the sheath is filled with the insulating material through the openings provided by the triangular washer, it is vibrated to shake the insulating material together and distribute it uniformly around the terminals and the resistance element. It will be understood that the powdered insulating material will readily pass through the flattened portions 12a to the lower portions of the upright sheath. When the sheath has been filled, a solid washer 27 which is similar to the washers 21 is inserted in place around the terminal 15 to close the sheath. The sleeve 22 and the nut 23 are then replaced and the core wire resistance element 11 is placed under a slight strain by turning the nut 23 inwardly on the terminal 15. The ends of the sheath are then turned over so as to secure the washers in the ends of the sheath.

After the sheath has thus been loaded with the powdered insulating material, I compact the magnesium oxide in these portions of the sheath between the flattened portions 12a around the core wire heating element. This further insures the central location of the heating element.

This compacting of the insulating material may be accomplished by striking the metallic sheath between each pair of flattened portions with a rather heavy impacting blow, as by hitting the sheath with a short split die in a press. It has been found that this operation so compacts the magnesium oxide around the core wire that it will be held perfectly central within the sheath during the swaging operations. After the insulating material has thus been compacted, the nuts 23 and the sleeves 22 are again removed.

The entire unit is now passed through a swaging or rolling machine for the purpose of compacting the insulating material within the sheath to a hard dense mass, the swaging operation reducing the diameter and increasing the length of the unit. Several passes through the swaging machine generally will remove the flattened portions of the sheath bulging the flattened sides outward somewhat, and it has been found that the sheath will assume a complete cylindrical shape throughout its length. The sheath will lengthen somewhat faster than the core wire during the first two or three passes through the machine. In other words, the projecting terminals will be drawn within the sheath for a short distance. However, the insulating material will generally be sufficiently compacted by the first several passes to secure the terminals against further inward movement. The twisted core wire resistance during the swaging operation will be lengthened so that the original relatively short pitch of the wire will be greatly increased. Thus in one specific heating unit, the pitch which was approximately $\frac{1}{4}$ " before swaging was increased by the swaging operation to approximately $\frac{1}{4}$ ". Moreover the terminals 14 and 15

are gradually reduced in diameter by the swaging, the recessed ends contracting around the resistance element.

It will be understood that if desired the heating unit may be annealed between successive swaging operations in order to prevent the resistance element and sheath from becoming hard and brittle.

After the unit has been swaged to the desired extent, the washers at each end are cut off or otherwise removed and the ends of the unit are squared off (Fig. 8). It will be understood that the terminals 14 and 15 will be held firmly in place by the compacted insulating material in which they are embedded.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any 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 securing a terminal to an elongated electrical conductor formed of separate elongated conductors twisted together throughout their lengths, which comprises forming a stepped terminal portion on said conductors by projecting one end portion of one of said conductors axially beyond the twisted end portion of said conductors, providing in a solid metallic terminal member a stepped bore corresponding to the stepped terminal portion on said conductors, fitting said terminal portion of said conductors into said stepped bore in said terminal member and then swaging said terminal member onto said terminal portion so that said terminal member tightly grips said terminal portion with good electrical and mechanical engagement, the projecting portion of said stepped terminal portion gripped by the corresponding part of said terminal member relieving the strain in the walls of said terminal member at the bottom of the larger part of said stepped bore set up when a force is applied to said conductors tending to remove them from said terminal member, thereby preventing rupture of said terminal member at the bottom of said larger bore portion.

2. In a terminal, a plurality of electrical conductors twisted together throughout their lengths, a stepped terminal portion on said conductors defined by one of said conductors extending axially from the twisted portion of said conductors, and a solid metallic terminal member provided with a stepped bore corresponding to the stepped terminal portion on said conductors fitted onto said terminal portion and compressed thereon in good electrical and mechanical relation with it, the reduced part of said terminal portion gripped by the corresponding part of said terminal member relieving the strain in the walls of said terminal member at the bottom of the larger part of said bore set up when a force is applied to said conductors tending to remove them from said terminal member, thereby preventing rupture of said terminal member at the bottom of said larger bore portion.

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