

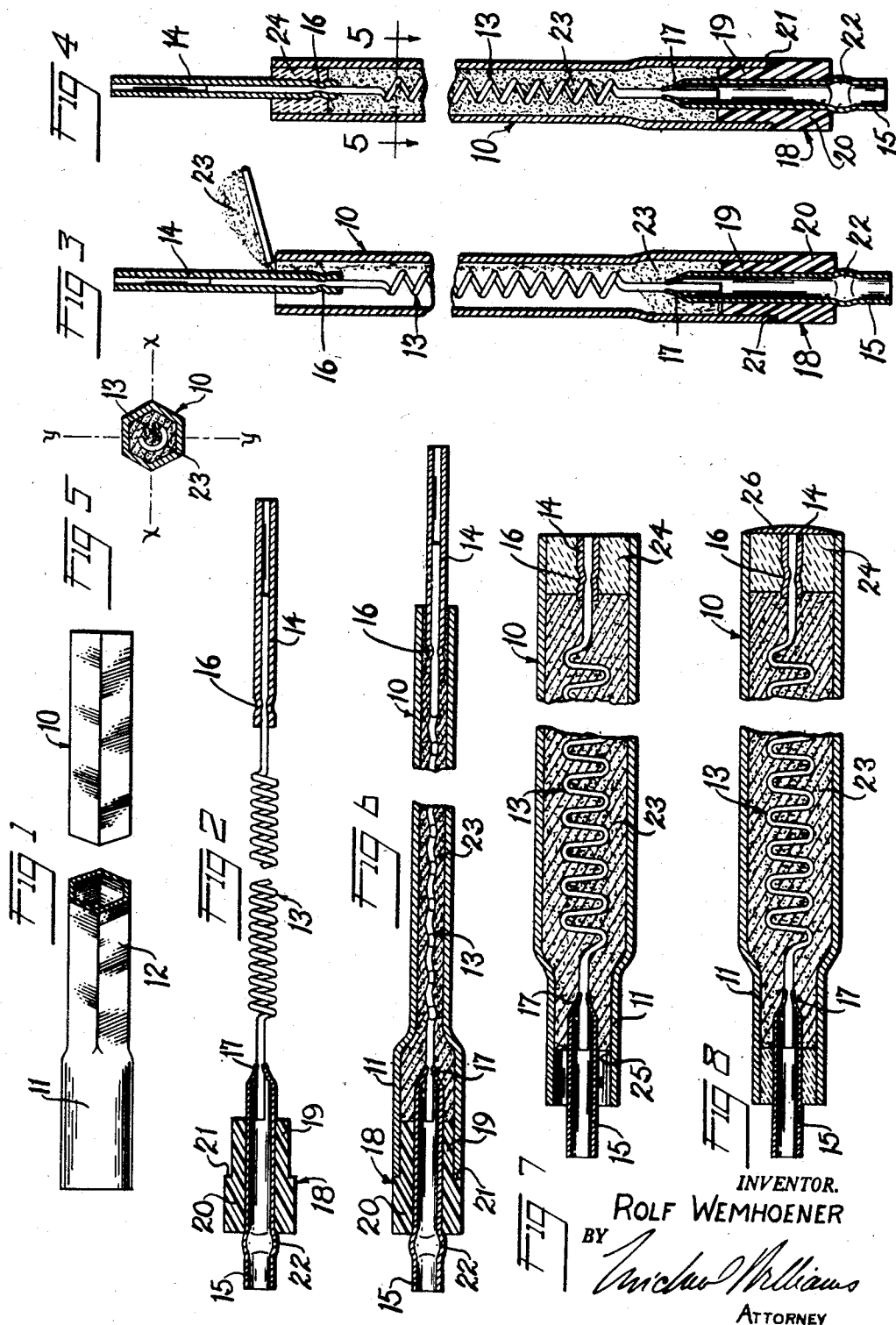
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R. WEMHOENER

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METHOD OF MAKING SHEATHED ELECTRIC RESISTANCE HEATERS

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INVENTOR.
ROLF WEMHOENER
BY *Michael Williams*
ATTORNEY

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METHOD OF MAKING SHEATHED ELECTRIC RESISTANCE HEATERS

Rolf Wemhoener, Irwin, Pa., assignor to Edwin L. Wiegand Company, Pittsburgh, Pa., a corporation of Pennsylvania

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The present invention relates to electric resistance heaters and to methods of making the same and the principal object of my invention is to provide new and improved articles and methods of the character described.

There has long been a need for an economically produced, sheathed, ribbon-like electric resistance heater since prior art methods have so far failed to produce a low cost heater having the requisite qualities.

My invention provides high quality, ribbon-like, sheathed electric resistance heaters at low cost and this advantage together with others will 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, an embodiment which my invention may assume, and in these drawings:

Figure 1 is a fragmentary elevational view of a detail employed in carrying out my invention and illustrating an early stage of the novel method in forming a ribbon-like, sheathed electric heater,

Figure 2 is a fragmentary sectional view of a sub assembly employed in practicing the present invention,

Figures 3, 4, 6, 7 and 8 are fragmentary longitudinal sectional views illustrating various stages of the invention, and

Figure 5 is a transverse sectional view generally corresponding to the line 5—5 of Figure 4.

Since an understanding of the prior art methods employed in producing sheathed electric resistance heaters will be advantageous in comprehending the present invention, a brief description of such prior art methods will first be disclosed.

The usual steps employed in forming sheathed electric resistance heaters comprise positioning a coiled resistor member within a deformable tubular metallic sheath which is round in cross section, filling the sheath with finely divided electric-insulating, heat-conductive material; and pressing the sheath transversely to form it to the desired cross sectional configuration and to compact the finely divided material about the resistor member.

In utilizing the prior art method in attempting to form thin, ribbon-like heaters, it has been found that a very high percentage of the resistor members are literally torn apart as a result of the pressing operation. This, of course, resulted in useless, open circuit heaters. With this prior art method, the percentage of scrapped heaters is so high that the costs of production of heaters of this type is prohibitive.

According to the present invention and referring to Figure 1 wherein a tubular metallic sheath 10 is illustrated, it will be seen that one end 11 of the sheath is preferably round in cross section, for a purpose to be disclosed, while the remainder 12 of the sheath has a hexagonal cross section (see also Figure 5). This hexagonal cross section is preferred at the present time for reasons to become clear; however, the present invention

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contemplates the use of a sheath formed to other cross sections such as, for example, to an oval cross section.

The sheath 10 may be conveniently formed by pressing a portion of a round tube of the requisite size to the desired hexagonal cross section by the use of suitable dies, one end of the tube being retained in its original rounded shape. It is to be understood, however, that the sheath may be formed in a manner other than that described and that under certain circumstances the rounded end portion may be eliminated. Moreover, if desired, both ends of the sheath may have a round cross section in the event one end of the resistor is not to be electrically connected to the sheath.

Figure 2 illustrates a resistor member 13 which is adapted to be encased within the sheath 10. Resistor member 13 presently comprises a helical coil formed of the usual resistor wire and having terminal pins 14, 15 secured to respective ends thereof. Each terminal pin is herein shown to be hollow for receiving a respective end of the resistor member and each pin is crimped at 16 and 17 respectively to mechanically and electrically connect the resistor and the pins.

A sleeve 18 is apertured to slideably fit over terminal pin 15, the sleeve having a shank portion 19 of a size to slideably fit within the round portion 11 of the sheath and a radially enlarged portion 20 which provides an annular shoulder 21. The sleeve may be formed of any suitable material and, in practicing the present invention, it has been found that a sleeve formed of a polystyrene plastic material is satisfactory. After the sleeve is assembled with the terminal pin 15, the pin will be crimped at 22 to prevent disassembly.

Resistor 13, terminal pins 14, 15 and sleeve 18 will next be assembled with the sheath 10 by inserting pin 14 within the sheath from the rounded end 11. The resistor 13 and its associated parts will be positioned as shown in Figure 3 with sleeve 18 closing the end 11 of the sheath and with shoulder 21 in abutting relation with the sheath. The coiled resistor will preferably be tensioned by pulling terminal pin 14 in a direction away from terminal pin 15 a predetermined amount and holding the pins in this position so as to insure that the resistor coil will not sag against the interior of the sheath and to space the convolutions of the coil apart a predetermined amount for a purpose to be shown.

As shown in Figure 3, terminal pin 14 will be held centered within the sheath by any suitable means and the interior of the sheath filled with a suitable electric-insulating heat-conductive material 23, such as powdered magnesium oxide. Filling may be carried out by means of a conventional filling machine (not shown) which is adapted to vibrate the material into the sheath as the latter is held in a vertical position with the end 11, closed by the sleeve 18, lowermost.

After the sheath is filled, the upper end (in the position of parts shown in Figures 3 and 4) will be closed by means of a bushing 24 positioned in this end of the sheath. It will be understood that sufficient space will be provided at this end of the sheath for receiving the bushing 24 and that the bushing is of a size to slidably fit into the sheath and has a central aperture through which terminal pin 14 protrudes. Bushing 24 may be formed of any suitable deformable, dielectric material which will not fragment when the sheath is pressed in a manner to be disclosed. As an example, it has been found that a bushing formed of green lava possesses the requisite qualities.

With the sheath filled and bushing 24 in place, opposite flat sides of the sheath will be pressed together (between suitable dies or the like) to flatten the sheath to the desired ribbon-like form and to tightly compact the material 23; however, the rounded end portion 11

of the sheath will not be flattened since this might cause grounding of the terminal pin 15 thereagainst.

As illustrated in Figure 5, the hexagonal sheath is wider across the $x-x$ axis than it is across the $y-y$ axis and it is an important feature of the present invention that the sheath is flattened along the wider ($x-x$) axis by pressing opposed sides thereof. Since the sheath is already wider along the $x-x$ axis, further flattening along this axis does not effect the radical change in shape which occurs when pressing a sheath which is round in cross section. Accordingly, it is possible to flatten the sheath without tearing apart the resistor wire from which the coil 13 is formed.

As previously mentioned, the present invention is not limited to flattening a hexagonal sheath since a sheath having any cross section which is wider along one axis than it is along a transverse axis could be employed. By way of example, a sheath having an oval cross section could be employed in practicing the invention; however, at the present time, it is preferable to employ the hexagonal cross section instead of the oval cross section since filling a sheath having an oval cross section in the manner described complicates the assembly operation because of the difficulty of maintaining the resistor centered within and in spaced relation to the interior of the sheath.

It is to be understood that flattening of the sheath in the manner heretofore disclosed will also flatten the coiled resistor 13 and cause it to assume the undulated configuration shown in Figure 7. However, the resistor will assume this undulated configuration only if diametrically opposed portions of each convolution of the coil are axially spaced apart a distance substantially equal to the spacing between adjoining convolutions of the undulately configured resistor. If the convolutions of the coil are not sufficiently spaced apart before pressing, the convolutions will collapse one upon the other instead of being positioned in side-by-side relationship. Collapsing of the convolutions of the coil one upon the other will cause shorting out of at least portions of the resistor wire with a resultant loss in efficiency.

As a result of the flattening operation and as shown in Figure 7, bushing 24 will be crushed and tightly compacted in position at the end of the sheath. Following the flattening operation, terminal pin 14 will be cut off flush with the end of the sheath and terminal pin 15 will be cut off flush with the end of sleeve 18. The heater will then be placed in an oven or the like and subjected to a sufficiently high temperature so that the sleeve 18 will be burned away to leave a cavity 25 at the rounded end 11 of the sheath.

As illustrated in Figure 8, the cavity 25 will then be filled with a suitable mixture which, after hardening, forms a hard dielectric plug which prevents escape of the electric-insulating, heat-conductive material from this end of the heater and protects the heater against the entrance of foreign substances. The other end of the heater is adapted to be closed by silver solder 26 or the like. This will seal the end of the heater adjacent terminal pin 14 and insure a good electrical connection between such terminal pin and the sheath.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiment 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 embodiment is illustrative only, and that my invention is not limited thereto.

I claim:

1. The method of making a ribbon-like sheath electric resistance heater, which comprises positioning a resistor member within and in spaced relation to the inner wall of a tubular sheath having a hexagonal transverse

cross section, filling the sheath with electric-insulating, heat-conductive material, and pressing opposed flat sides of the sheath toward each other to reduce the thickness of the sheath and to compact the material about the resistor member.

2. The method of making a ribbon-like sheathed electric resistance heater, which comprises forming a tubular sheath to a hexagonal transverse cross section, positioning a coiled resistor member longitudinally within the sheath and in spaced relation to the inner wall of the latter, filling the sheath with electric-insulating, heat-conductive material, and pressing opposed flat sides of the sheath toward each other to reduce the thickness of the sheath and to compact the material about the resistor member.

3. The method of making a ribbon-like sheathed electric resistance heater, which comprises forming a tubular sheath to a transverse cross section wherein it is wider along one cross sectional axis than it is along a transverse axis, positioning within the sheath and in spaced relation to the inner wall of the latter a coiled resistor member having a main body portion and a terminal portion, filling the sheath with electric-insulating, heat-conductive material, and pressing only the portion of the sheath adjacent the main body portion of the resistor conductor transversely and in a direction generally normal to the wide axis of the sheath to further reduce its thickness and to compact the material about the resistor member.

4. The method of making a ribbon-like sheathed electric resistance heater, which comprises forming all but one end of a round tubular sheath to a hexagonal transverse cross section, positioning within the sheath a coiled resistor member and locating such resistor member at the hexed portion of the sheath and a terminal portion of such resistor member at the rounded end portion of the sheath, filling the sheath with electric-insulating, heat-conductive material, and pressing only the opposed flat sides of the hexed portion of the sheath toward each other to reduce the thickness of such sheath portion and to compact the material about the resistor member.

5. The method of making a ribbon-like sheathed electric resistance heater, which comprises positioning a coiled resistor member within a tubular sheath having a transverse configuration wherein it is wider along one cross sectional axis than it is along a transverse axis and locating a main body portion of such member and a terminal portion thereof in spaced relation to the inner wall of the sheath with the terminal portion adjacent one end of the sheath, filling the sheath with electric-insulating, heat-conductive material, and pressing only the portion of the sheath adjacent the main body portion of the resistor member transversely and in a direction generally normal to the wide axis of the sheath to further reduce its thickness and to compact the material about the resistor member.

6. The method of making a ribbon-like sheathed electric resistance heater, which comprises forming all but one end of a round tubular sheath to a hexagonal transverse cross section, positioning within the sheath a coiled resistor member having terminal conductor portions at each end and locating such resistor member and its terminal portions in spaced relation to the inner wall of the sheath with the terminal portions adjacent respective ends of the sheath, filling the sheath with electric-insulating, heat-conductive material, and pressing only the opposed flat sides of the hexed portion of the sheath toward each other to reduce such sheath portion and to compact the material about the resistor member.

7. The method of making a ribbon-like sheathed electric resistance heater, which comprises positioning a helical coil resistor member within and in spaced relation to the inner wall of a tubular sheath which is wider along one cross sectional axis than it is along a transverse axis, filling the sheath with electric-insulating, heat-conductive

material, and flattening the coil and the sheath and reducing the thickness of the sheath and compacting the material about the resistor member by pressing the portion of the sheath adjacent the resistor member transversely and in a direction generally normal to the wide axis of the sheath and moving diametrically opposed portions of each convolution of the coil to a substantially flat, side-by-side, spaced undulated configuration. 5

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