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(54) **APPARATUS AND METHOD FOR STRIPPING INSULATED WIRE**

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(52) **U.S. Cl.** **81/9.4**; 81/9.51; 219/233
(58) **Field of Search** 81/9.4, 9.51; 219/233, 219/240, 227, 229, 241

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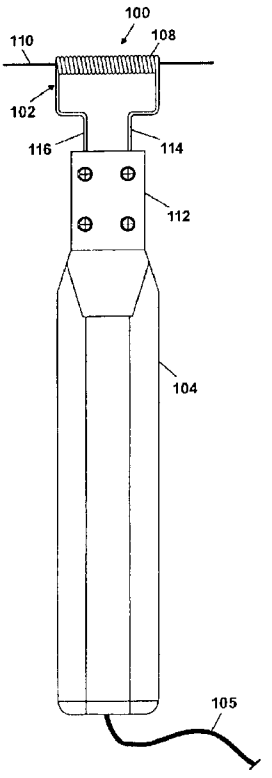
(57) **ABSTRACT**

An apparatus for stripping an insulated wire includes a resistive heater element having a first end, a second end, and a coil formed between the first end and the second end. The coil has an inner diameter that is large enough to receive a section of the insulated wire. The apparatus further includes an electronic circuit connected to the first and second ends to deliver power to the resistive heater element such that the coil uniformly distributes heat about the section of the insulated wire to thermally decompose insulation on the section of insulated wire.

8 Claims, 3 Drawing Sheets



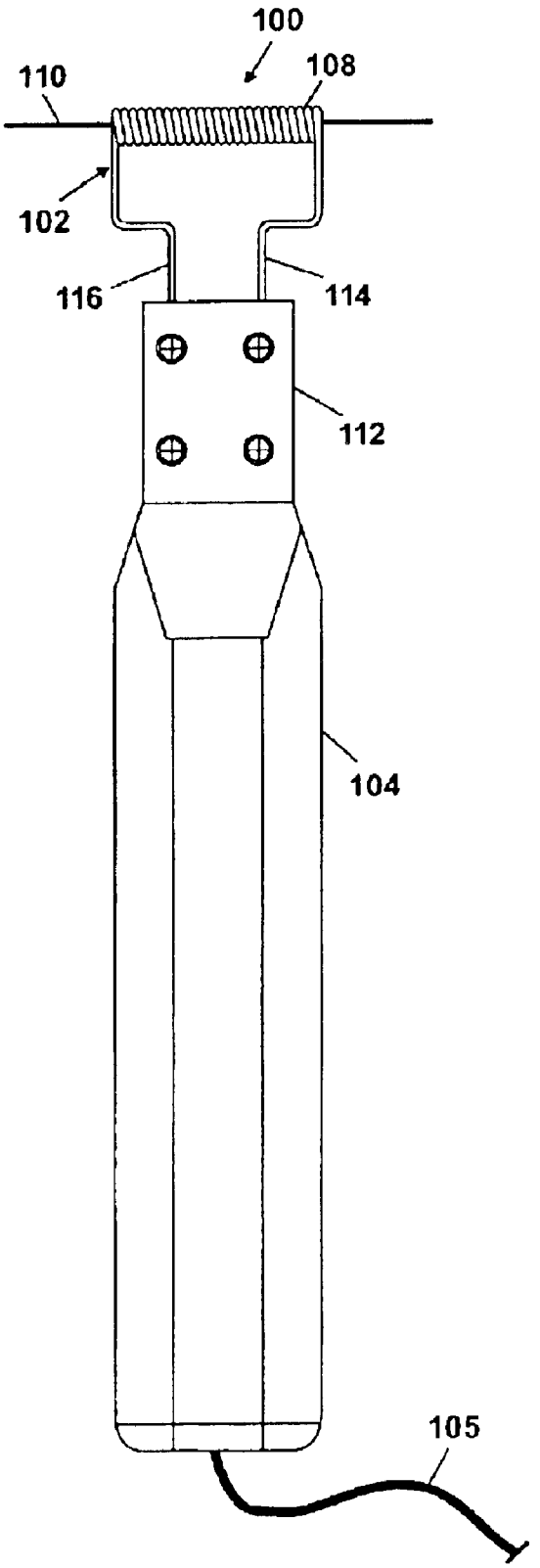


FIGURE 1A

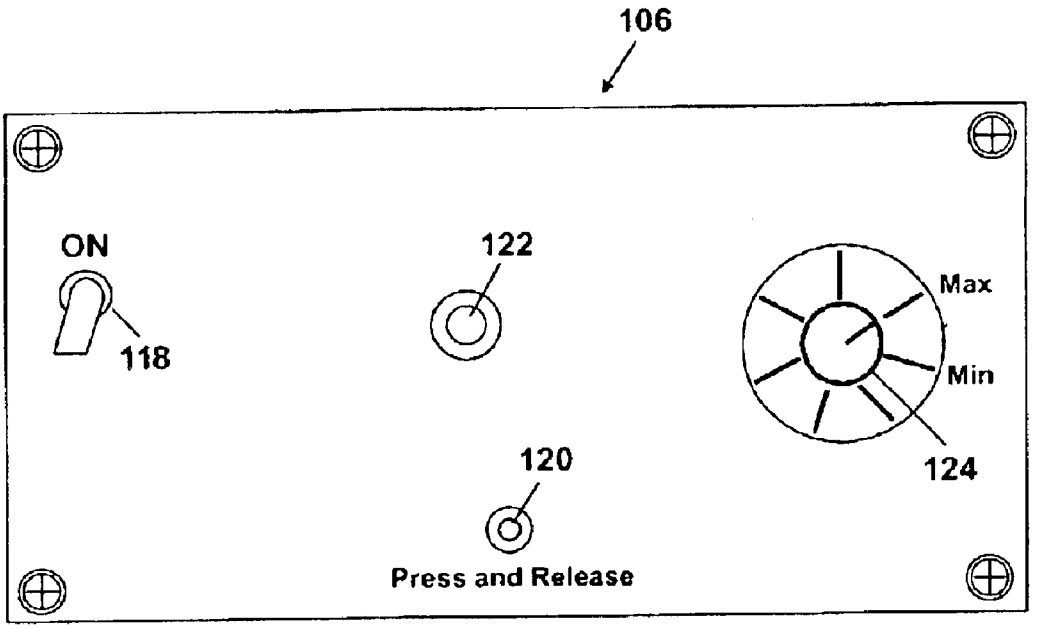


FIGURE 1B

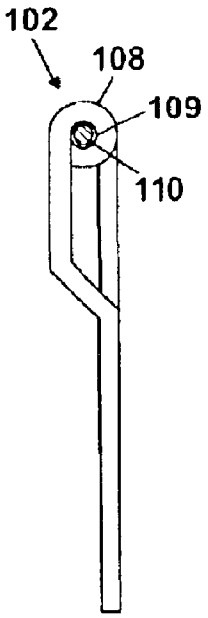


FIGURE 1C

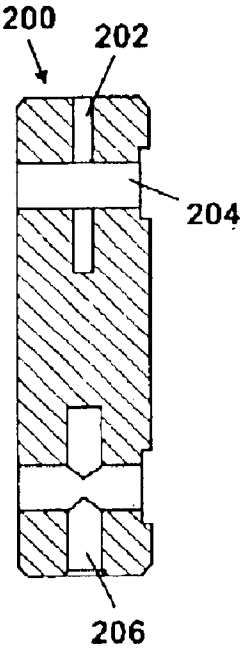


FIGURE 2

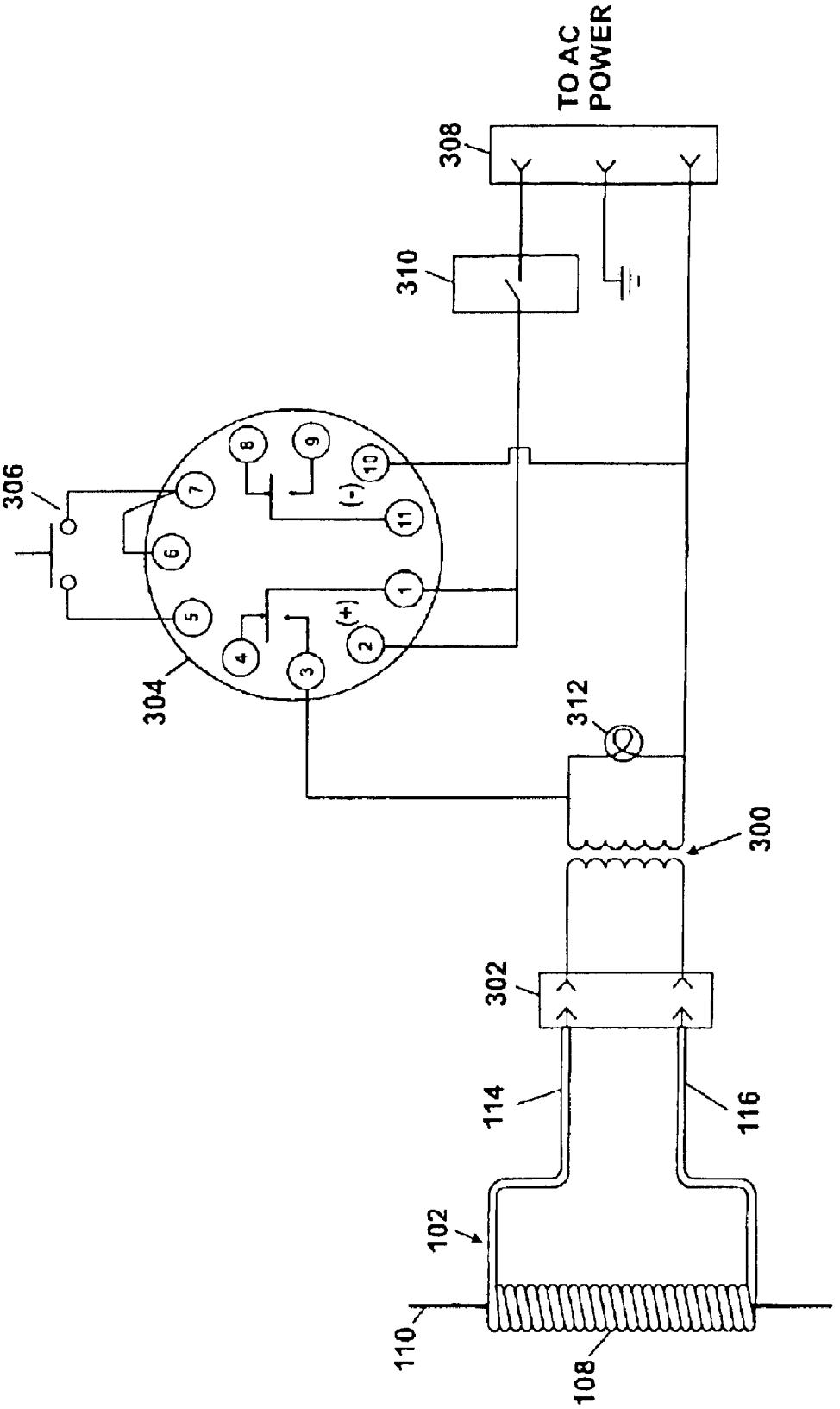


FIGURE 3

APPARATUS AND METHOD FOR STRIPPING INSULATED WIRE

BACKGROUND OF INVENTION

The invention relates generally to apparatus and methods for stripping insulated wires. More specifically, the invention relates to an apparatus and a method for stripping a magnet wire.

The term "magnet wire" as used herein is intended to mean an electrical wire fabricated by forming a polymer-based film, e.g., polyester-amide, polyester-amide-imide, polyimide, and polyurethane, on a solid conductor wire, where the polymer-based film serves as insulation. The polymer-based film provides a uniform dielectric coating without significantly increasing the overall diameter of the magnet wire. The thickness of the insulation formed on the conductor wire is known as build. The industry standards are as follows: single, heavy (or double), triple, and quad. Single and heavy builds are the most common. Table 1 below shows nominal dimensions for a copper magnet wire.

TABLE 1

Size (AWG)	Bare Diameter (mm)	Single Build Diameter (mm)	Heavy Build Diameter (mm)
26	0.4039	0.4318	0.4521
30	0.2540	0.2769	0.2946
35	0.1422	0.1575	0.1702
40	0.0787	0.0889	0.0965
44	0.0508	0.0559	0.0635

It is necessary to remove insulation from a section of a magnet wire to allow for soldering. The main difficulty in stripping a magnet wire is that the insulation layer is so thin that it is fairly easy to damage the conductor wire during insulation removal. For example, according to Table 1 above, a heavy-build 40 AWG magnet wire has an insulation thickness of about 0.0178 mm.

Prior-art mechanical stripping methods generally involve gripping the insulation wire at two places, severing the insulation between the two places with a pair of opposed blades selected for the gauge of wire, and pulling the severed insulation off the wire. Prior-art thermal stripping methods involve heating the opposed blades used in severing the insulation. These mechanical and thermal stripping methods are generally limited to large-diameter insulated wires, e.g., 30 AWG or larger. Chemical methods can be used to strip insulation wire provided that the wire is easily accessible.

From the foregoing, there is desired an apparatus and a method for stripping insulated wire regardless of wire diameter or accessibility.

SUMMARY INVENTION

In one aspect, the invention relates to an apparatus for stripping an insulated wire which comprises a resistive heater element having a first end, a second end, and a coil formed between the first end and the second end. The coil has an inner diameter that is large enough to receive a section of the insulated wire. The apparatus further comprises an electronic circuit connected to the first and second ends to deliver power to the resistive heater element such that the coil uniformly distributes heat about the section of the insulated wire to thermally decompose the insulation on the section of insulated wire.

In another aspect, an apparatus for stripping an insulated wire comprises a handle, an electrical connector disposed in the handle, and a resistive heater element having first and second ends coupled to the electrical connector and a coil formed between the first and second ends. The coil has an inner diameter large enough to receive a section of the insulated wire. The coil uniformly distributes heat about the section of the insulated wire so as to thermally decompose the insulation on the section of insulated wire. The apparatus further comprises a control system which delivers power to the resistive heater element through the electrical connector.

In yet another aspect, the invention relates to a method of stripping an insulated wire which comprises inserting a section of the insulated wire into a coil of a resistive heater element, delivering power to the resistive heater element to heat up the coil, using the coil to uniformly distribute heat about the section of the insulated wire for a predetermined time sufficient to thermally decompose an insulation on the section of the insulated wire, removing the section of the insulated wire from the coil, and removing the thermally-decomposed insulation from the section of the insulated wire.

Other features and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1A** is a schematic of a thermal stripper according to an embodiment of the invention.

FIG. **1B** is a top view of a stripper control box according to an embodiment of the invention.

FIG. **1C** is a side view of the stripper heater element shown in FIG. **1A**.

FIG. **2** is a cross-section of an electrical conductor mounted inside the stripper handle shown in FIG. **1A**.

FIG. **3** is a thermal stripper wiring diagram according to an embodiment of the invention.

DETAILED DESCRIPTION

The invention will now be described in detail with reference to a few preferred embodiments, as illustrated in accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art, that the invention may be practiced without some or all of these specific details. In other instances, well-known features and/or process steps have not been described in detail in order to not unnecessarily obscure the invention. The features and advantages of the invention may be better understood with reference to the drawings and discussions that follow.

For illustration purposes, FIG. **1A** shows a thermal stripper **100** according to one embodiment of the invention. The thermal stripper **100** includes a stripper heater element **102** and a stripper handle **104**. The stripper handle **104** includes a cable **105** for connection to a stripper control box (**106** in FIG. **1B**). The stripper heater element **102** is made of a resistive heater material, such as Nichrome or Inconel. The stripper heater element **102** includes a coil **108** made of a predetermined number of turns to achieve a desired resistance. As shown in FIG. **1C**, the coil **108** has an inner diameter **109** large enough to receive a magnet wire **110**. Returning to FIG. **1A**, power is delivered to the stripper heat element **102** through the cable **105**. This power causes the stripper heater element **102** to heat up and distribute heat

uniformly about the section of the magnet wire **110** inserted in the coil **108**. The heat is delivered until the insulation on the section of the magnet wire **110** inserted in the coil **108** thermally decomposes. The magnet wire **110** is then removed from the coil **108**. The thermally-decomposed insulation can be removed easily, e.g., by wiping it with a rag or by sanding it off with a fine sand paper.

In one embodiment of the invention, two electrical conductors (not shown in this figure) are situated at the upper end **112** of the stripper handle **104** to allow an electrical connection to be made between the stripper heater element **102** and the cable **105**. FIG. **2** shows a cross-section of one of these electrical conductors, indicated by reference numeral **200**. The electrical conductor **200** includes an aperture **202** for receiving one of the ends (**114** or **116** in FIG. **1**A) of the stripper heater element (**102** in FIG. **1**A). A screw (not shown) can be inserted through an opening **204**, which intersects with the aperture **202**, to secure the uncoiled end of the stripper heater element to the electrical conductor **200** and ensure electrical contact between the stripper heater element and the electrical conductor **200**. However, the invention is not limited to a screw-type connection between the stripper heater element and the electrical conductor **200**. A crimp-type connection or other suitable electrical connection could be used, for example. The screw can also be used to secure the electrical conductor **200** to the stripper handle (**104** in FIG. **1**A). The electrical conductor **200** includes another aperture **206** for connecting the electrical conductor **200** to the electrical cable **105**.

FIG. **3** shows a thermal stripper wiring diagram according to an embodiment of the invention. In the wiring diagram, the ends **114**, **116** of the stripper heater element **102** are coupled to a transformer **300** through a connector **302**. The connector **302** could be provided by two of the electrical conductors **200** in FIG. **2** or other suitable electrical connection means. The step-down transformer **300** is connected to selected pins on a relay timer **304**. The relay timer could be a programmable one-shot relay timer, for example. The relay timer **304** is connected to a contact switch **306**, which is operable by a "START" pushbutton (**120** in FIG. **1**B) on the stripper control box (**106** in FIG. **1**B). The relay timer **304** is connected to AC power via a connector **308**. Typically, 120V AC power is delivered to the transformer **300** through the relay timer **304**, and the transformer **300** steps this power down to 5V prior to delivering it to the stripper heater element **102**. Delivery of AC power to the connector **308** can be turned on or off via a power switch (**118** in FIG. **1**B) on the stripper control box. For safety reasons, a circuit breaker **310** is provided in the connection between the relay timer **304** and the connector **308** to prevent current flow through the circuit should the circuit become overloaded. A power "ON" indicator **312** (**122** in FIG. **1**) is coupled to the step-down transformer **300** to indicate when power is being delivered to the stripper heater element **102**.

In operation, the magnet wire **110** is inserted in the coil **108** of the stripper heater element **102**. The contact switch **306** is then closed to activate the relay timer **304** When the relay timer **304** is activated, power is delivered to the stripper heater element **102** via the step-down transformer **300**. The coil **108** distributes heat uniformly about the section of the magnet wire **110** within the coil **108** as previously discussed and thermally decomposes, i.e., volatizes or carbonizes, the insulation on the section of the magnet wire **110**. The time for which the relay timer **304** is ON is set through a timer setting dial (**124** in FIG. **1**B) on the stripper control box (**106** in FIG. **1**B). When the set time expires, the contact switch **306** opens, cooling the stripper heater element **102**, including the coil **108**, and the magnet wire **110**. The magnet wire **110** is then removed from the stripper heater coil **108**, and the thermally-decomposed insulation is removed from the magnet wire **110**, e.g., by wiping the insulation off with a rag or by sanding the insulation off with a fine sand paper. The gripping action provided by sanding is generally convenient for further handling of the magnet wire. In general, the ON-time of the relay timer **304** is set to an amount such that the insulation on the magnet wire is fully decomposed without significant damage to the underlying conductor wire. Some calibration may be necessary to determine the ON-time of the relay timer **304**. For a Nichrome stripper heater element having a resistance of 1.2 Î©, an ON-time of approximately 5 seconds has been found to be adequate.

The invention provides one or more advantages. The thermal stripper removes insulation on a conductor wire by thermally decomposing the insulation without damaging the conductor wire. The invention does not involve severing the insulation with blades, a process that could damage the conductor wire, especially when the insulation layer is very thin, such as for wires having sizes smaller than 30 AWG, or use of chemicals, which can contaminate or corrode the conductor wire. The thermal stripper can be used to safely and easily remove the insulation regardless of the diameter and accessibility of the insulated wire. For example, the thermal stripper can be used to remove insulation even when the insulated wire is in a confined space, such as after winding or wrapping the insulated wire in electrical or electronic equipment. The stripper heater element included in the thermal stripper can be positioned with relative ease, providing accurate control of the wire length to be stripped. Further, the heating duration and diameter of the stripper heater coil can be accurately controlled to allow stripping of an insulated wire of any diameter. Further, a single stripper heater coil can be used for several wire gauges as long as the diameter of the heater coil is large enough to receive the wire gauge.

It is worth noting herein that the stripper heater element described above is not intended for use with insulated wires having insulation that is likely to melt at the operating temperature of the stripper heater element. Melting of the insulation is undesirable because the melted insulation may stick to the stripper heater coil, making it difficult to remove the wire from the stripper heater coil and to reuse the stripper heater coil for stripping. Preferably, the stripper heater element is used with magnet wires or other insulated wires having insulation that volatizes or carbonizes easily without melting.

It is also worth noting herein that various kinds of electronic circuits can be used to deliver power to the stripper heater element. In other words, the invention is not limited to the electronic circuit shown in FIG. **3**.

For the purposes of this specification it will be clearly understood that the word "comprising" means "including but not limited to", and that the word "comprises" has a corresponding meaning.

What is claimed is:

1. An apparatus for stripping an insulated wire, comprising:

a resistive heater element having a first end, a second end, and a coil formed between the first end and the second end, the coil having an inner diameter large enough to receive a section of the insulated wire; and

an electronic circuit connected to the first and second ends to deliver power to the resistive heater element such

that the coil uniformly distributes heat about the section of the insulated wire to thermally decompose insulation on the section of insulated wire

wherein the electronic circuit comprises a relay timer adapted to deliver the power to the resistive heater element through a transformer for a predetermined time sufficient to thermally decompose the insulation.

2. The apparatus of claim **1**, wherein the insulated wire is a magnet wire.

3. An apparatus for stripping an insulated wire, comprising:

a handle;

an electrical connector disposed in the handle;

a resistive heater element having first and second ends coupled to the electrical connector and a coil formed between the first and second ends, the coil having an inner diameter large enough to receive a section of the insulated wire, the coil for uniformly distributing heat about the section of the insulated wire so as to thermally decompose an insulation on the section of the insulated wire; and

a control system which delivers power to the resistive heater element through the electrical connector.

4. The apparatus of claim **3**, wherein the control system comprises a relay timer for triggering delivery of power to the resistive heater element.

5. The apparatus of claim **4**, wherein the control system further comprises a transformer for controlling amount of power delivered to resistive heater element.

6. A method of stripping an insulated wire, comprising:

inserting a section of the insulated wire into a coil of a resistive heater element;

activating a relay timer and delivering power to the resistive heater element through a transformer to heat up the coil;

using the coil to uniformly distribute heat about the section of the insulated wire for a predetermined time sufficient to thermally decompose an insulation on the section of the insulated wire;

removing the section of the insulated wire from the coil; and

removing the thermally-decomposed insulation from the section of the insulated wire.

7. The method of claim **6**, wherein removing the thermally-decomposed insulation comprises wiping the thermally-decomposed insulation off the section of the insulated wire.

8. The method of claim **6**, wherein removing the thermally-decomposed insulation comprises sanding the thermally-decomposed insulation off the section of the insulated wire.

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