

[54] **APPARATUS FOR REMOVING
 INSULATION FROM ELECTRICAL
 CONDUCTORS**

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 [51] Int. Cl. **H02g 1/12**
 [58] Field of Search **81/9.5, 9.51**

[56] **References Cited**

UNITED STATES PATENTS

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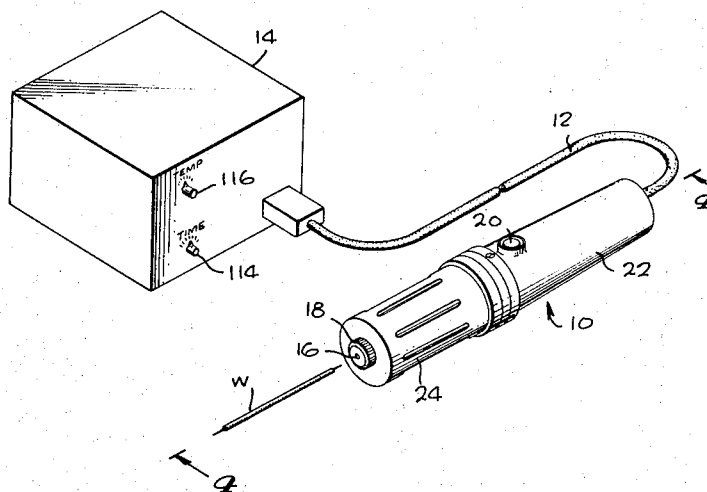
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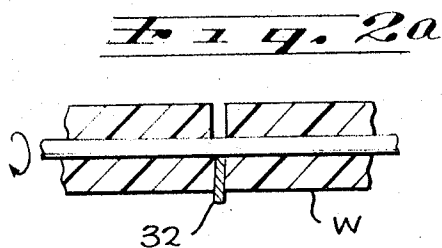
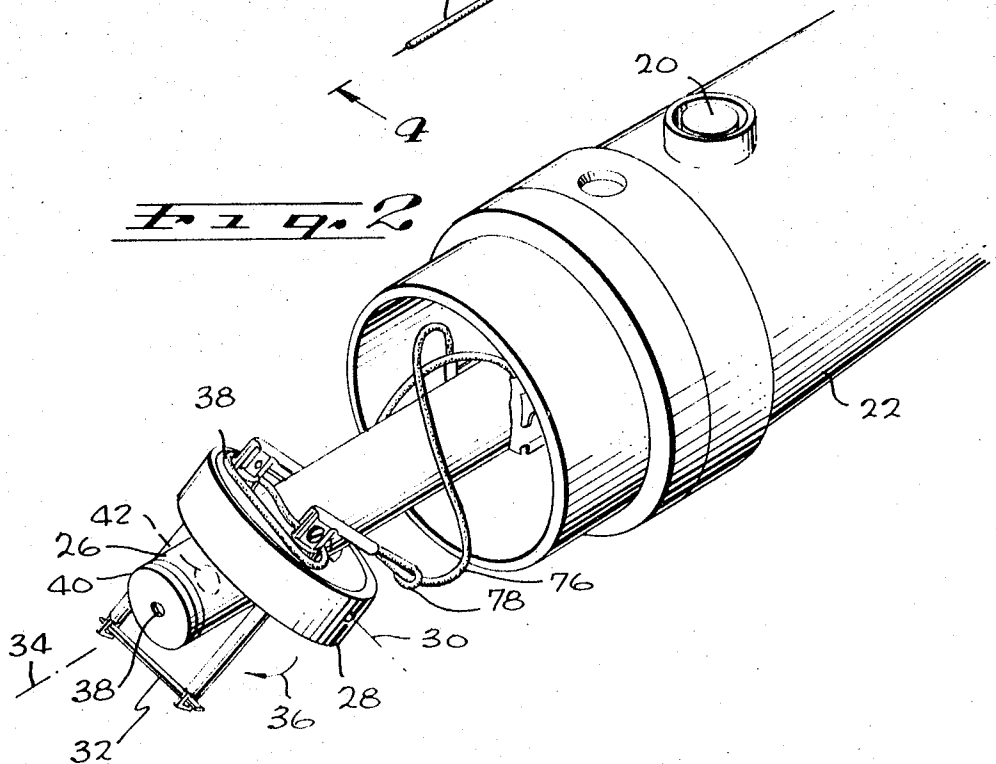
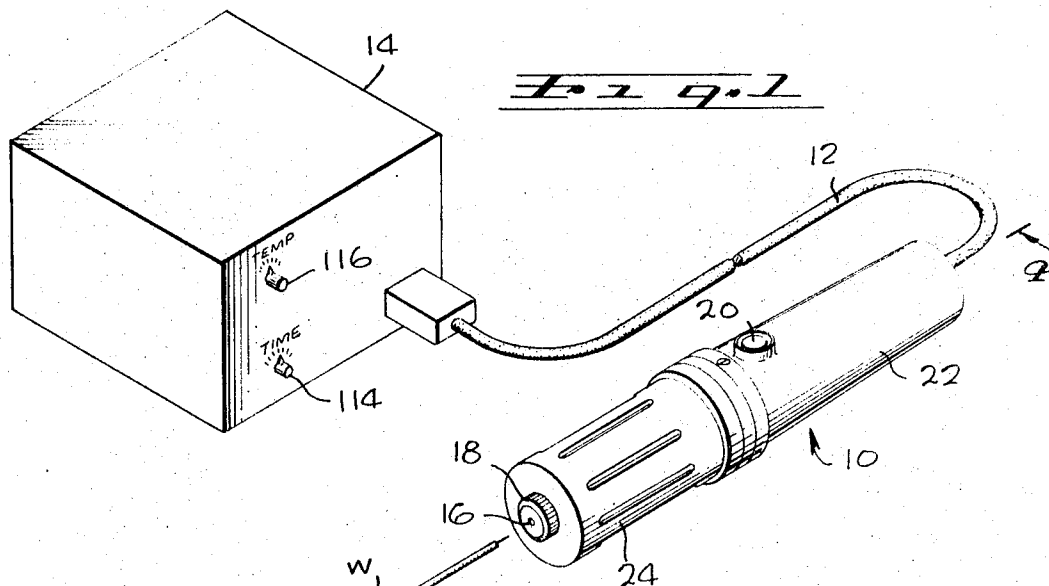
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[57] **ABSTRACT**

A wire stripper of the type wherein an electrically heated blade rotates about the wire to melt a circle of insulation so that an end piece of insulation can be pulled off. A circuit for energizing the device operates for a preset time at a predetermined current, to assure melting of insulation to the required depth without damaging the central conductor and to minimize the time of the operation. A blade support extends along a side of the blade opposite the side that contacts the wire, to support the blade against deflection, and to help confine heat to the blade. The blade is an easily replaceable element whose opposite end extends through apertures in a pair of spaced pins, and current is carried to the pins by a pair of slip rings and a pair of flexible wires that extend in helices about the shaft from the slip rings to the pins.

13 Claims, 12 Drawing Figures





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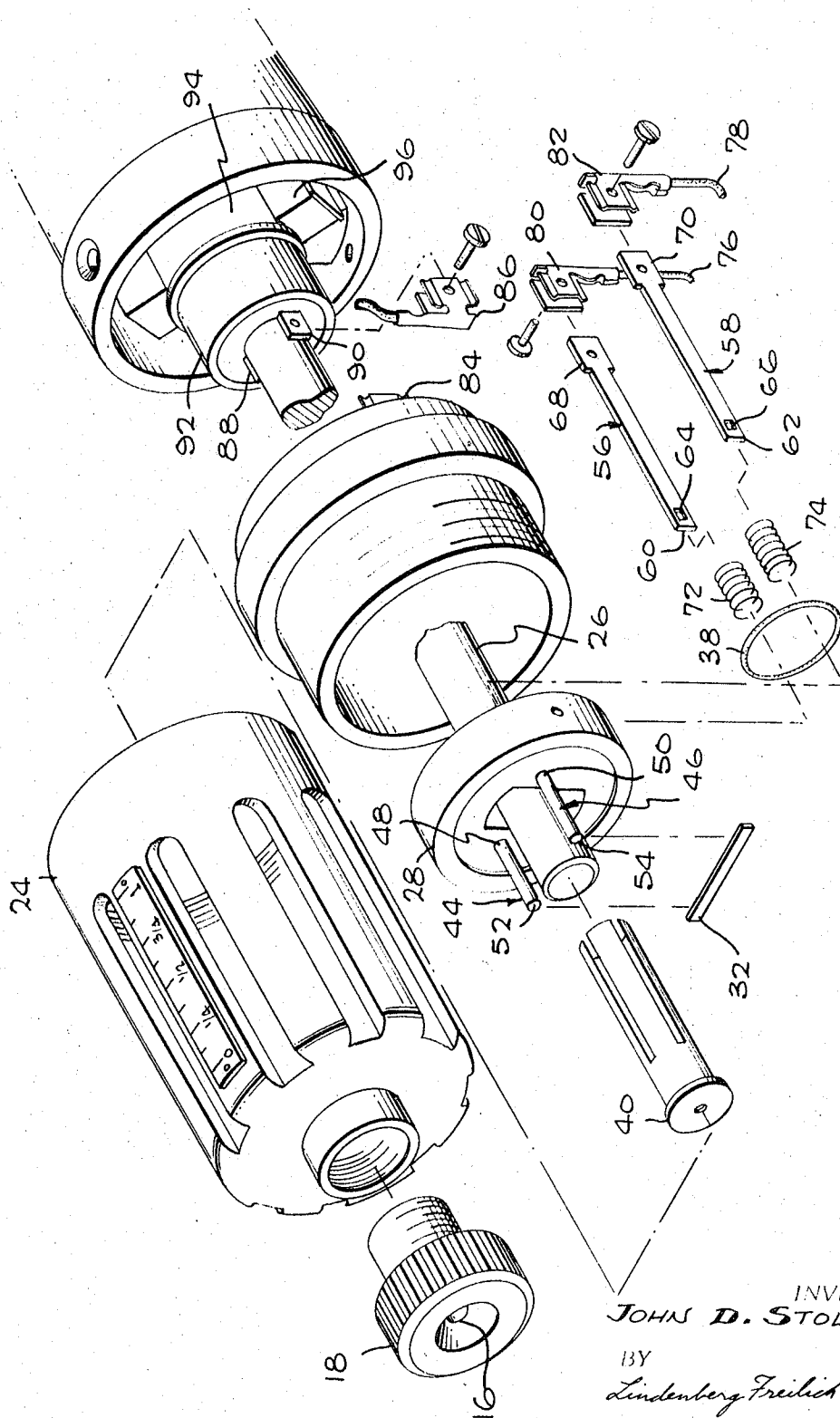


Fig. 3

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Fig. 4

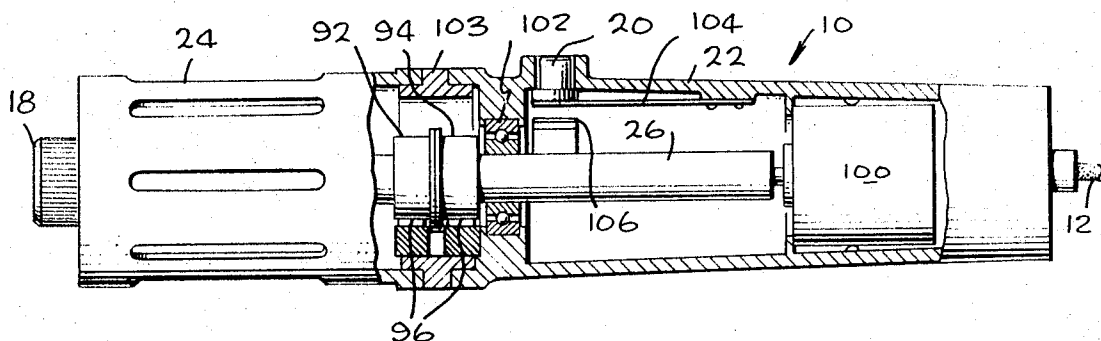
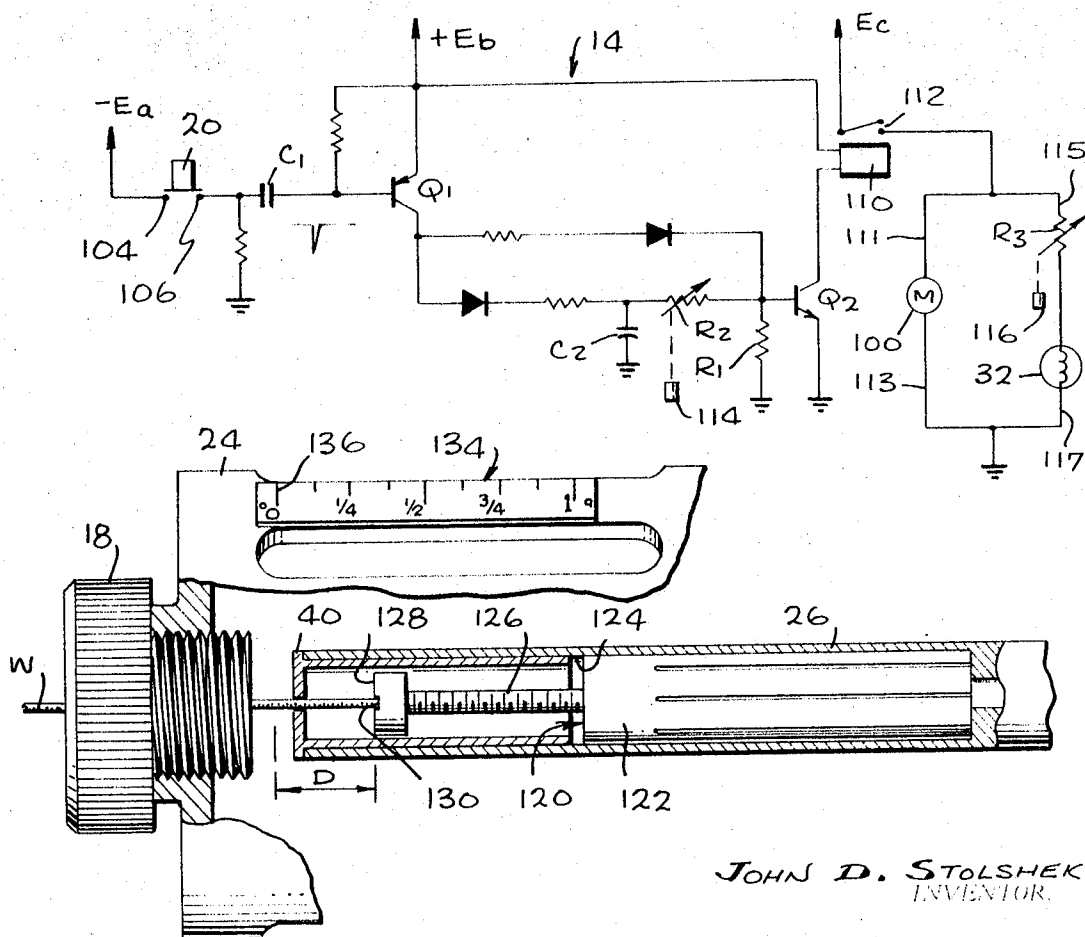


Fig. 5



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Fig. 6

Fig. 7

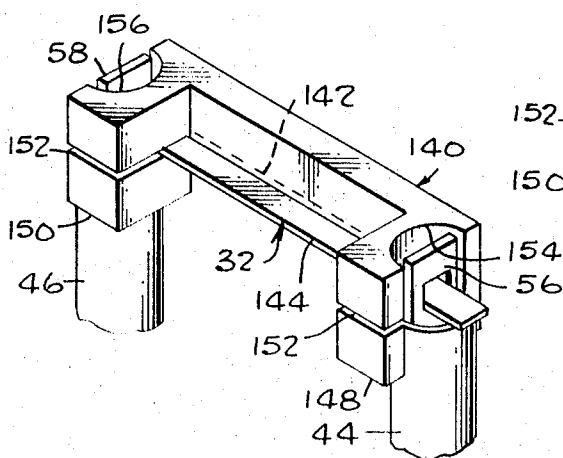


Fig. 8

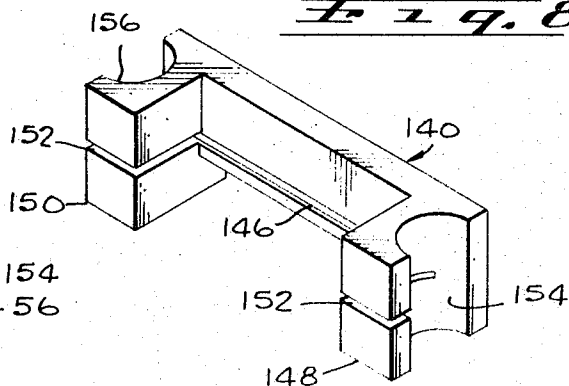


Fig. 9

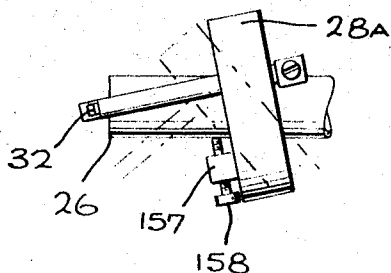


Fig. 10

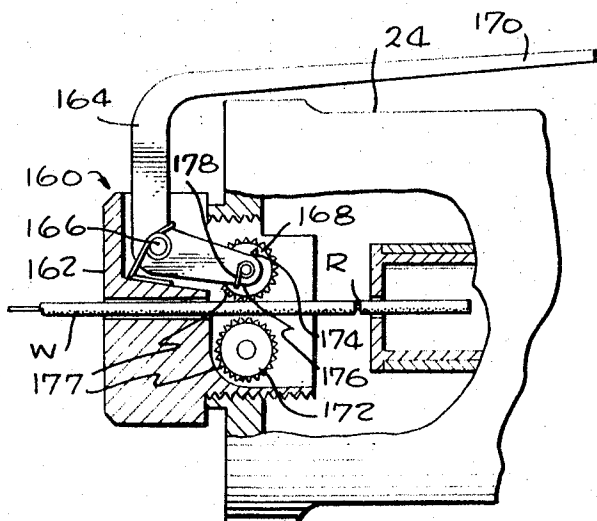
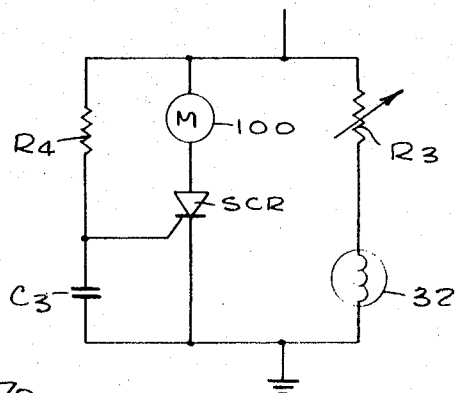


Fig. 11

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APPARATUS FOR REMOVING INSULATION FROM ELECTRICAL CONDUCTORS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for removing insulation from electrical wires, and more particularly, to apparatus of the type which employs a heated element that revolves about the insulation while bearing against it.

2. Description of the Prior Art

One type of wire stripping device utilizes a heated element which rapidly rotates about a wire while being urged against it by centrifugal forces. The heated element can melt or char a narrow circle of insulation near one end of a wire to allow the end of the insulation to be removed. One example of such a device is described in U.S. Pat. No. 3,232,147 by Kureth entitled, "Insulation Remover for Electrical Conductors", wherein an operator can insert a wire, hold down a switch button to simultaneously energize a motor that rotates the heated element while supplying heating current to it, release the switch, and pull off insulation from the wire.

The above-described stripping device could be especially useful for critical applications, where there must be substantially no damage to the underlying conductor during stripping. Damage can be avoided by using a low heating current, so that there is no discoloration of the conductor due to the heated element contacting it. However, this requires longer periods, which decreases productivity, particularly for high melting temperature insulations. Increased productivity can also be obtained by utilizing heating elements which are very thin. However, when the elements are heated they readily warp or deform, so relatively thick elements have been proposed to assure strength.

The heated element is generally pivotally mounted on a rotating shaft, and a pair of slip rings can be utilized to carry current to points on the rotating shaft. However, the fact that the heated element pivots with respect to the shaft complicates electrical coupling of the slip rings to it. If a flexible conductor is used which extends in a slight curve to accommodate changes in required length as the heated element pivots, then centrifugal forces on the flexible conductor can cause it to bow out so far that it hits the housing. The heated element is preferably held in a manner that assures good electrical connections, yet which allows an inexpensive and easily replaceable heated element to be employed.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide apparatus for removing insulation from electrical conductors quickly and with a minimum of damage to the conductor.

Another object is to provide a reliable and efficient insulation-removing tool which utilizes a low cost replaceable thermal element.

In accordance with one embodiment of the present invention, an insulation removing tool is provided of the type which rotates an electrically heated blade about a wire to melt a circle of insulation so that an end piece of insulation can be pulled off. The blade is held on a bracket that is pivotally mounted on a motor-driven shaft. A circuit for energizing the motor and supplying heating currents to the blade operates for a preset time at a predetermined heating current, to assure melting of insulation to the required depth without damaging the central conductor. A duration for the motor and heating currents may be chosen which causes melting to a level just short of the blade touching the conductor to eliminate any conductor discoloration, or to a level wherein the insulation is completely severed. In any case, an operator spends a minimum amount of time on each stripping operation.

In order to enable a thin blade to be utilized without excessive warping or deflection even when the blade is heated to a high temperature, a blade support is provided. The blade support is constructed of material which is stable at high temperatures, and it extends along a side of the blade opposite the side

which contacts insulation. The blade support is constructed of material which reflects infrared rays, so that in addition to supporting the blade, it reflects heat emanating from the blade back to the region where the blade contacts the insulation. This increases heating at that region to minimize the time required for the blade to pass into the insulation.

The bracket assembly on which the blade is held is constructed to allow a replaceable blade to be employed. The assembly includes a pair of spaced parallel tubes with inner ends fixed to a bracket, and a pair of pins extending through the outer ends of the tubes. Each pin has an aperture for receiving one end of the blade. A pair of springs bias the pins to withdraw their outer ends into the tubes, so that the ends of the blades are securely held against the outer ends of the tubes. This construction allows quick replacement of a blade, by merely pushing on the pins, and assures good electrical contact between the pins and the blade.

Currents for heating the blade are supplied through a pair of slip rings mounted on the shaft. The slip rings are electrically connected to the blade-holding pins by a pair of flexible conductors, to allow for pivoting of the bracket. The flexible conductors extend from the slip rings in a helix about the shaft, to enable a substantial change in distance between the slip rings and pins while preventing the flexible conductors from flying so far out by centrifugal forces that they would hit the housing of the tool. One flexible conductor extends in a right-handed helix and the other in a left-handed helix, so that centrifugal forces on the flexible conductors aid in pivoting the bracket to move the blade against a wire which lies at the axis of the shaft.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an insulation removing tool and control circuit constructed in accordance with one embodiment of the present invention;

FIG. 2 is a partial perspective view of the tool of FIG. 1, with the guard removed;

FIG. 2A is a partial sectional view of the tool of FIG. 1, shown during the removal of insulation;

FIG. 3 is a partial perspective exploded view of the tool of FIG. 2;

FIG. 4 is a sectional view taken on the line 4—4 of FIG. 1;

FIG. 5 is a simplified schematic diagram of the control circuit of FIG. 1;

FIG. 6 is a partial sectional view of the tool of FIG. 1, showing the stop and gauge devices thereof;

FIG. 7 is a partial perspective view of the tool of FIG. 1 with a blade support thereon;

FIG. 8 is a perspective view of the blade support of FIG. 7;

FIG. 9 is a partial side elevation view of another type of bracket which can be used in the tool of FIG. 2 to prevent breakage of thin wires;

FIG. 10 is a partial schematic diagram of a circuit for enabling preheating of the blade; and

FIG. 11 is a sectional view of a slug removal mechanism which can be employed with the tool of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates an insulation removing tool 10 designed to be held in the hand, and which is connected by a flexible cable 12 to a control circuit 14. In order to strip insulation from the end of a wire W, an operator inserts the end of the wire through an aperture 16 in an outer guide 18 until the wire hits a stop within the tool. The operator then depresses a button 20 at the side of the tool and holds the tool and wire steady. The tool removes a narrow ring of insulation around the central conductor of the wire at a position spaced from its end, and then turns itself off. The operator removes the wire W and pulls off the slug of insulation to leave a wire with a bared end.

The tool includes a housing 22 which is held by the operator, and an outer guard 24 mounted on the housing to protect the operator from the operating mechanism. FIG. 2 illustrates details of the operating mechanism which performs the insulation removal or stripping. The insulation removing mechanism includes a shaft 26 which can be rapidly rotated by a motor in the housing 22. A bracket 28 is pivotally mounted on the shaft 26 about an axis 30. A thermal element or heated blade 32 is mounted on the bracket so that as the bracket pivots about its axis 30, the blade can move towards and away from the axis of rotation 34 of the shaft. The bracket 28 is weighted on one side so that when it is rapidly rotated, centrifugal forces urge it to pivot in the direction of arrow 36, to move the blade 32 towards the axis of rotation 34 of the shaft 26. When the shaft stops rotating, an elastomeric ring 38 urges the bracket 28 to pivot in a direction opposite to arrow 36 to move the blade 32 away from the axis of rotation 34 of the shaft.

When an operator inserts a wire into the tool, it passes through an aperture 38 in an internal guide 40 until it hits a stop 42 within the shaft. When the operator then presses the button 20 to start the stripping operation, the shaft 26 rotates rapidly so that the blade 32 moves against and repeatedly rotates about a location on the insulation. At the same time, the blade 32 is supplied with current that heats it so that it can melt the insulation. The edge of the blade 32 is thin, but not sharp, and it is intended to melt rather than cut into insulation. After the tool operates for a predetermined period, the flow of blade heating and motor energizing currents is terminated. As the shaft 26 slows down, the blade 32 moves away from the wire so that the wire can be removed from the tool. The operator can then remove a slug of insulation at the end of the wire by merely pulling it off.

As also shown in FIG. 3, the assembly which holds the blade 32 on the shaft 26 includes a pair of parallel, spaced tubes 44, 46, which are mounted on the bracket 28. The tubes have inner end portions 48, 50 fixed to the bracket, and outer ends 52, 54 spaced from the bracket. The bracket 28 is constructed of electrically insulative material, at least at the regions which hold the tubes, so that the tubes are electrically insulated from the shaft 26. A pair of pins 56, 58 project completely through the tubes 44, 46. The pins have outer end portions 60, 62 with blade-receiving apertures 64, 66 that normally extend beyond the outer ends of the tubes, and inner end portions 68, 70 that normally extend behind the inner end portions of the tubes. A pair of springs 72, 74 which lie within enlarged-diameter regions of the inner end portions 48, 50 of the tubes, urge the inner ends of the pins to withdraw further from the tubes, but they are prevented from doing so by the blade 32.

The opposite ends of the blade 32 extend through the apertures 64, 66 in the pins. The pins hold the blade 32 against the extreme outer ends 52, 54 of the tubes. Friction between the blade and the tubes and pins keeps the blade in place. This manner of mounting the blade enables a simple rectangular blade to be employed, and facilitates rapid replacement of blades. It also allows a thin blade to be used because the blade is subjected to a minimum of stress. When the blade is heated, it tends to bow up. If the ends of the blades were rigidly held against changing their angle of orientation, the blade would be more highly stressed. Because of the high temperatures, the blade would tend to become deformed and would have to be replaced sooner. By holding the blade only with spring forces, the blade can change its angle of orientation and even twist about its length, with a minimum of stress. Whenever blade replacement is required, this is accomplished by the operator pushing against the inner ends 68, 70 of the pins to allow the previous blade 32 to fall out, inserting a new blade 32 in position, and releasing the pins 56, 58.

Heating currents are supplied to the blade 32 through the pins 56, 58 and are supplied to the pins 56, 58 through a pair of flexible insulated conductors, or wires 76, 78. Each wire has one end engaged with a coupling 80, 82 that is fixed to the inner end of a pin, and another end fixed to a coupling 84, 86 that is electrically coupled through connectors 88, 90 to different slip rings 92, 94. Brushes 96 carry currents to the slip rings 92, 94 for heating the blade 32.

The use of the flexible wires 76, 78 to couple the slip rings 92, 94 to the blades 32 enables smooth pivoting of the bracket 28. Each of the wires 76, 78 extends more than one-half turn (180°) about the shaft 26, in a helix. The helical configuration of the flexible wires 76, 78 prevents them from flying outwardly and hitting the guard 24 by reason of centrifugal forces, and minimizes tension in the wire, as compared to the case where an almost straight flexible wire might be used. It may be noted that wire 76 extends in a left-handed helix, while wire 78 extends in a right-handed helix. This causes both wires to urge the bracket 28 to pivot in the direction of arrow 36 so that it moves the blade 32 toward the axis of rotation 34 of the shaft, instead of opposing such pivoting. Also, the wires 76, 78 extend symmetrically on each side of the bracket 28 so they do not tend to twist the bracket 28 on its axis of pivoting.

FIG. 4 illustrates additional details of the tool 10. The housing 22 contains an electrically energizable motor 100 whose shaft is fixed to the shaft 26 on which the blade-supporting bracket 28 is mounted. The housing 22 also carries a ring 103 on which the guard 24 is threadably mounted. A bearing 102 rotatably supports the shaft 26, in conjunction with the motor shaft. Three pairs of electrical conductors (not shown) extend through the cable 12 that electrically connects the tool 10 to the control circuit 14. One pair of conductors is connected to the motor 100 to energize it. Another pair of conductors is connected to the brushes 96 to supply heating currents. The third pair of conductors is connected to a conductive leaf 104 which can be deflected by pressure on the pushbutton 20, and to a contact 106.

When an operator depresses the button 20, a pulse flows through the contacts 104 and 106 to command the control circuit 14 to supply currents for performing a cycle of insulation removal. The control circuit 14 immediately provides motor energizing current to the motor 100 and provides a predetermined level of heating current to heat the blade 32. After a predetermined time during which such currents are provided, both currents stop. FIG. 5 is a schematic diagram showing a simple circuit that can be used to energize the motor 100 and heated blade 32 for a predetermined time after the pushbutton 20 is depressed. The circuit includes a capacitor C_1 which transmits a negative pulse from a voltage source $-E_a$ to the base of a transistor Q_1 when the pushbutton 20 is first depressed. This pulse turns on the transistor Q_1 so that current flows through it to charge a capacitor C_2 . While transistor Q_1 is conducting, current flows through a resistor R_1 , thereby raising the gate potential at another transistor Q_2 and turning it on. Current flowing through the transistor Q_2 passes through a relay 110 to close its contacts 112. Current then flows from a source E_c through conductors 111, 113 of a motor energizing circuit to the motor 100 and through conductors 115, 117 and resistor R_3 of a heating circuit to the heated blade 32, to begin an insulation removal cycle.

When the capacitor C_2 has charged to a high enough voltage, not enough current flows through the transistor Q_1 to maintain it in an ON state and it turns off. Transistor Q_2 then turns off and allows the relay 110 to open to end the stripping cycle. The time required for the capacitor C_2 to reach the turn off voltage is largely determined by the resistance of a resistor R_2 which constantly discharges the capacitor and draws load current from transistor Q_1 . Thus, the duration of a stripping cycle can be varied by changing the resistance of resistor R_2 . A variable resistor is employed whose resistance level can be changed by turning a knob 114 which is accessible from the outside of the cabinet which holds the control circuit 14. The current through the blade 32 is adjustable by varying the resistance of the resistor R_3 , by turning a knob 116. It may be noted that the circuit of FIG. 5 is only one simplified example of a circuit which may be utilized to drive the tool, and a variety of other circuits well known in the art can be employed.

The control circuit 14 is generally set up to enable stripping to be performed in the shortest period of time without damage to the conductor or remaining insulation of the wire. Generally, the operator utilizes a chart showing the best tem-

perature to employ for a given type of insulation. The temperature (determined by the current to the heated blade) which is chosen is generally the highest which can be applied without damage to surrounding insulation. The operator may try different time settings until the minimum period is found which effects a complete separation of a slug of insulation from the rest of the insulation. Once this setting is found, identical wires can be stripped at a high production rate. In many cases, an operator may have to strip wires with several different types of insulation. However, once a setting is found for each of the several types of wires, the time and temperature can be rapidly reset for any one of them. In a typical electronic production shop, temperatures ranging between 600° F. and 2,000° F. may be used, with time periods varying between 1 1/2 and 15 seconds.

Stripping is generally accomplished by allowing the blade 32 to bear against the wire long enough to completely pass through the insulation. However, in some applications where extreme reliability of connections is required, the time of a cycle may be chosen so that the blade 32 does not quite pass completely through the insulation. This prevents discoloration of the conductor. The fact that the cycle continues for only a particular preset time, rather than merely so long as the operator holds down a button 20, not only enables higher production rates by stopping the cycle when stripping is complete, but also enables a period to be chosen which prevents complete separation of the insulation to prevent discoloration of the conductor. As noted earlier, even if the operator holds down the pushbutton 20, the cycle will automatically stop at the end of the preset time. A new cycle can be initiated only by letting up on the button 20 and again depressing it.

It is generally desirable to melt a circle of insulation at a particular distance from the end of the wire. FIG. 6 shows the details of a stop mechanism 120 which is received within the shaft 26 to enable a setting of the distance from the end of the wire where stripping will occur. The stop mechanism 120 includes a nut 122 which fits within a hollow passageway 124 formed in the shaft 26. A screw 126 is threadably engaged with the nut 122, the outer stop portion or face 128 of the screw 126 normally lying within the shaft passageway 124 to abut the end of a wire W which has been inserted through the outer guide 18. The screw 126 can be turned to vary the distance D from the end of the wire where stripping will occur.

In order to facilitate adjustment of the stop mechanism 120, the screw 126 is provided with a slot 130 at its outer end which can be engaged by a screwdriver when the inner guide 40 is pulled off. The slot 130 is made very shallow so that the distance D does not vary much if the end of the wire is received in the slot 130 or abuts the rest of the face 128 of the screw 126. Typically, a slot 130 of a depth such as 15 thousandths inch is sufficient to enable easy turning by a screwdriver without noticeably changing the distance of the stripping circle from the end of the wire.

In some situations, different stripping distances may be chosen each time the tool is used, and it is desirable to provide means for enabling rapid choice of stripping distance. In this situation, the screw 126 can be turned all the way in and a stripping gauge 134 which is mounted on the guard 24 may be used to accurately choose the stripping distance. The gauge 134 has an initial or zero indication 136 even with the location where the heated blade contacts the insulation. Additional markings are provided at locations spaced inwardly from the initial marking 136 to indicate different depths, the markings typically being in inches or millimeters. In order to choose a particular stripping length, an operator first extends the end portion of the wire along the gauge 134 until the extreme end of the wire lies on the marking which corresponds to the desired stripping distance. While holding the wire at a location even with the end of the outer guide 18, the operator inserts the wire through the guide 18 until his fingers abut the guide 18. He then strips the wire. This method of choosing the stripping distance is readily understood and can be easily practiced. Of course, one or more additional gauges similar to

gauge 134 can be mounted on the guard at different locations about its circumference to facilitate gauging.

The blade 32 which melts through insulation must withstand adverse conditions, inasmuch as it may be heated to a temperature such as 2,000° F. while bearing against insulation or a copper conductor. FIGS. 7 and 8 illustrate a stripping element support or backing member 140 which helps to support the blade 32, so that a thin blade 32 may be used which has a relatively long life. The backing member 140 is designed to engage an edge or side 142 of the blade 32 opposite the side or edge 144 which engages the insulation on a wire. As the blade 32 bears against insulation, the member 140 resists backward deflection and some upward deflection of the blade 32, to reduce warping and to strengthen the blade so that a thin blade 32 will not deflect excessively. The member 140 is constructed of a material which can resist high temperatures, such as an asbestos-phenolic composition. The backing member has a shallow slot 146 which receives the edge 142 of the blade 32 to enable the support to resist bowing of the blade, as well as backing it.

The backing member 140 is constructed so that it can be held in place in a simple manner without seriously impeding the ease with which blades 32 can be replaced. To facilitate mounting of the backing member 140, it is provided with blocks 148, 150 at opposite ends thereof, the blocks 148, 150 having slots 152 for facilitating the insertion of a blade 32, and having recesses 154, 156. The recesses 154, 156 partially encompass the tubes 44, 46 through which the blade-holding pins 56, 58 extend, to prevent lateral movement of the backing member 140. When a blade 32 extends through the slots 152 in the backing member 140 and is held by the pins 56, 58, the blade 32 prevents up and down movement of the backing member 140. Thus, the backing member 140 is firmly held in place when the blade is installed and while the backing member 140 closely backs the blade 32 it can be easily removed and does not seriously hamper removal and replacement of a blade 32.

In addition to supporting the blade 32, it has been found that the backing member 140 increases the efficiency of the tool by reducing the time required for the blade 32 to pass through wire insulation. This reduction is partially due to the reflection of infrared rays emanating from the heated blade 32 back towards the edge portion 144 of the blade 32 which is contacting the insulation. Such reflection of heat reduces cooling of the blade 32 caused by its contact with the cooler insulation, and therefore decreases the time required to effect stripping. The backing member 140 also helps to cool the edge portion 142 of the blade 32 which does not contact the insulation and which does not have to be at such a high temperature. By cooling the edge portion 142, the blade is somewhat strengthened.

When the tool is utilized to strip insulation from thick wires, the force of the blade 32 against the inner conductor of the wire can be easily withstood. However, when thin wires are stripped, the force applied by the blade 32 may be great enough to break the wire. FIG. 9 illustrates a bracket 28A which has a projection 157 with a stop in the form of a screw 158 for limiting the amount of bracket pivoting. The position of the screw 158 can be adjusted so the blade 32 cannot move past approximately the axis of the shaft 26. Although the inner conductor of a thin wire may be bent slightly by the blade 32, the screw stop 158 can be adjusted to prevent bending to a degree that can cause damage or breakage.

In high production applications, it is highly desirable to reduce the period required to complete a stripping operation, even if the reduction is only on the order of 1 second. A reduction in the cycle of operation of the tool can be accomplished by preheating the blade 32 before it contacts insulation, even though preheating does not start until the beginning of the cycle when the operator depresses the operating switch. Thus, for example, a cycle which normally requires three seconds may be reduced to 2 1/4 seconds by preheating the blade 32 for one-quarter second and then energizing the motor for the

remaining two seconds of the cycle. FIG. 10 illustrates a circuit portion which can replace the corresponding portion in the circuit of FIG. 5, to allow for preheating. In the circuit of FIG. 10, energization of the motor 100 is delayed by utilizing a silicon controlled rectifier (SCR) whose gate is connected to the junction of a resistor R_4 and a capacitor C_3 which form a time delay circuit. It is believed that preheating of the blade 32 allows it to quickly heat to a temperature where it can melt through insulation, instead of the initial heat being dissipated by the insulation without melting it.

After the blade 32 has melted or charred through the insulation, the operator can remove the wire and pull off the slug of insulation at the end of the wire with his fingers. However, an automatic slug removing mechanism can enable the insulation to be pulled off within the tool so that the wire comes out with a completely bared end. FIG. 11 illustrates a mechanism 160 which can be utilized in place of the guide 18, to enable automatic or semi-automatic removal of the slug of insulation. The mechanism 160 includes a housing 162 and a lever 164 pivotally mounted at 166 on the housing. A roller 168 is rotatably mounted at one end of the lever. When the operator depresses the opposite end 170 of the lever with his thumb, the roller 168 moves down against a wire W so that the wire is squeezed between the roller 168 and another roller 172. If the roller 168 is moved down and the wire W is pulled from the tool, both rollers will begin turning. However, after about three-quarters turn of the roller 168, a stop 174 on it will hit the end 176 of the lever and prevent any further rotation of the roller 168. A pair of gears 177 on the rollers allows roller 168 to also prevent further rotation of roller 172. The rollers 168, 172 then grip the insulation on the wire and can pull off the slug of insulation. If the lever 164 is released, a spring 178 will cause the roller 168 to rotate back to its initial position (where one end of the spring abuts a side of the lever).

To utilize the slug removing mechanism 160, an operator first inserts the wire W and depresses the switch 20 to allow the heated blade 32 to melt away a circle of insulation. When the operator notices that the motor 100 has stopped, he depresses the end 170 of the lever and then pulls out the wire W. The wire W will be gripped between the two rollers 168 and 172, but the rollers initially will not hamper removal of the wire. However when the stop 174 of the roller hits the lever end 176, the rollers 168 and 172 cannot turn any further and they resist outward movement of the wire. The stop 174 is positioned so that the roller 168 will stop turning when the ring R on the wire where insulation has been melted off, has just passed the nip between the two rollers 168, 172. The slug which has been removed will fall into the guard 24 and later fall to the ground.

Thus, the invention provides apparatus for removing insulation from electrical conductors, which is designed for highly efficient operation. A uniform manner of insulation melting is provided by utilizing a control circuit which provides a preset current for only a predetermined amount of time. Mounting of the thermal element or heated blade is accomplished in a relatively simple manner which allows a simple blade to be used that can be readily replaced. Current for heating the blade is carried through flexible wires which allow substantial pivoting of the bracket on which the blade is mounted while resisting tendencies of the flexible wires to fly out and hit the housing. Blade life and efficiency are increased by the use of a backing member which backs the blade to resist deflection and which reflect infrared rays from the heated blade, the backing member being formed so it does not interfere with easy blade replacement. The location at which a circle of insulation will be removed can be preset for a series of identical stripping operations by the use of an easily adjustable stop, and can be easily chosen for an individual operation by a gauge on the housing. Even faster cycles of operation are attained by the use of a circuit which preheats the blade before operating the motor to move the blade against the wire. Removal of the slug of insulation at the end of the wire is facilitated by apparatus which removes the slug prior to its withdrawal from the tool.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and, consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

What is claimed is:

1. Apparatus for severing the insulation on an insulated conductor by the use of a thermal element comprising: a shaft; an electric motor coupled to said shaft to rotate it; a thermal element; means mounted on said shaft for supporting said thermal element and causing said thermal element to rotate with said shaft, said means causing said thermal element to move towards and away from the axis of rotation of said shaft in response to rotation and cessation of rotation of said shaft; first coupling means coupled to said thermal element for supplying heating current to said thermal element; second coupling means coupled to said motor for supplying energizing current to said motor; power supply means for providing heating and energization currents; selectively settable timing control means coupled to said power supply means and to said first coupling means for providing heating current thereto and to said second coupling means for providing energization current thereto; said timing control means providing said heating and energization currents for a predetermined period of time; manually operable means coupled to said timing control means to set the duration of said predetermined period; and selectively operable switch means coupled between said power supply means and said timing control means which when operated causes heating current to be supplied to said thermal element and energization current to be supplied to said motor for the predetermined period to which said timing control means is set.

2. The apparatus as defined in claim 1 wherein: said switch means comprises a manually operable switch; the apparatus further comprising: time delay means coupled to said motor and to said second coupling means for delaying the application of energizing current to said motor when said manual switch is operated to thereby permit said thermal element to receive heating current and heat up prior to the application of energizing current to said motor.

3. Apparatus for severing the insulation on an insulated conductor comprising: a shaft; means for rotating said shaft coupled to said shaft; a bracket assembly having a first portion mounted on said shaft and a thermal element holding portion spaced therefrom; said bracket assembly first portion having a resilient means coupled to said shaft for urging said thermal element holding portion away from the axis of rotation of said shaft; said bracket assembly further having a mass positioned to urge said thermal element holding portion towards said axis of rotation of said shaft by centrifugal forces when said shaft rotates; a thermal element mounted on said thermal element holding portion; means coupled to said thermal element adapted to receive heating currents and transmit said heating currents to said thermal element to heat it; and a backing member constructed of material which is stable at high temperatures, disposed along a side of said thermal element opposite the axis of rotation of said shaft, said backing member providing support for said thermal element and serving to concentrate and direct the heat of said thermal element towards said shaft.

4. The apparatus as defined in claim 3 wherein: said shaft has a bore extending along its axis of rotation extending inwardly from a first end thereof; and said apparatus further comprising a stop disposed within said bore; said stop having an outer stop portion positionable adjacent the open end of said shaft to abut the end of a wire to be stripped; adjustment means coupled to said outer stop portion for varying the distance of said outer stop portion from said open end of said shaft.

5. Apparatus for severing the insulation on an insulated conductor by the use of an elongated thermal element comprising: a shaft; a motor coupled to said shaft for rotating said shaft; a bracket pivotally mounted on said shaft with its weight dis-

tributed to cause said bracket to pivot in a first direction due to centrifugal forces when said shaft rotates; means coupled to said bracket and to said shaft for biasing said bracket to pivot in a second direction opposite to said first direction; a thermal element having a predetermined length; a pair of tubes mounted on said bracket; said tubes being spaced apart by a distance less than the predetermined length of said thermal element; said tubes extending substantially parallel to each other, and each tube having first and second opposite ends; a pair of pins, each extending through one of said tubes; each pin having a first end portion with an aperture therein; said first end portion of each of said pins projecting beyond said first end of its respective tube; each said aperture in said first end portion of said pin being proportioned to receive therein an end of said thermal element; a pair of springs, one for each of said pins coupled between its associated pin and associated tube to bias its associated one of said pins in a direction to draw said first end portion into its associated tube; and means for carrying currents coupled to a second end portion of each of said pins adapted to be coupled to a source of current to pass current through said thermal element positioned in said apertures and held by said pins.

6. The apparatus as defined in claim 5 wherein: said means for carrying currents comprises a pair of slip rings mounted on said shaft; a pair of flexible conductors, each having a first and a second end; said first end of one of said pair of flexible conductors coupled to one of said pair of said slip rings and said second end of the same conductor coupled to one of said pins; said first end of the second of said pair of flexible conductors coupled to the other of said pair of slip rings and said second end of such conductor coupled to the second of said pins; each of said flexible conductors positioned about the shaft and extending at least 180° about said shaft between their respective first and second ends.

7. The apparatus as defined in claim 5 further comprising: a backing member having first and second ends; each of said first and second ends having a recess therein for receiving the associated first ends of said tubes; each of said first and second ends having a slot therein for passing opposite ends of said thermal element therethrough; said backing member being held in position when placed so as to receive said tubes in said recesses and said thermal element has been passed through said slots into said apertures in said pins; said backing member having a center portion for supporting said thermal element against deflection.

8. Apparatus for severing the insulation on an insulated conductor comprising: a shaft; means coupled to said shaft for rotating said shaft; a bracket pivotally mounted on said shaft, said bracket so constructed that it tends to pivot in a first direction with respect to said shaft due to centrifugal forces when said shaft rotates; means coupled to said bracket and said shaft for biasing said bracket to pivot in a second direction opposite to said first direction; a pair of thermal element supports mounted on said bracket each with an outer end for supporting a thermal element which extends between said outer ends of said pair of thermal element supports; said thermal element supports mounted to move a thermal element supported by said thermal element supports towards and away from the axis of rotation of said shaft as said bracket pivots in said first and second directions, respectively; a thermal element coupled to said pair of thermal element supports; said thermal element responsive to the application of heating currents thereto; first and second slip ring means mounted on said

shaft for carrying currents; and a pair of conductors, each conductor coupling one of said first and said second slip ring means to one of said pair of thermal element supports; at least one of said pair of conductors being flexible and extending at least partially about said shaft.

9. The apparatus as defined in claim 8 wherein: said flexible conductor is coupled to one of said thermal element supports at a location with respect to the axis of pivoting of said bracket which permits the centrifugal forces on said flexible conductor to urge said bracket to pivot in said first direction.

10. The apparatus as claimed in claim 8 wherein: both of the conductors of said pair of conductors are flexible, each conductor having a first and a second end; each of said conductors extending in opposite handed helixes about said shaft from said first ends to said second ends; each of said first ends of said conductors being coupled to one of said first and second slip ring means, and each of said second ends of said conductors being coupled to one of said pair of thermal element supports.

11. Apparatus for severing the insulation on an insulated conductor by the use of a thermal element comprising: a shaft; a motor coupled to said shaft to rotate it; a thermal element capable of being heated having first and second ends; a pair of thermal element supports, each of said thermal element supports having an aperture therein; said aperture in a first of said pair of thermal element supports receiving said first end of said thermal element and said aperture in a second of said pair of thermal element supports receiving said second end of said thermal element; biasing means, one for each of said pair of thermal element supports for biasing the associated first and second ends of said thermal element into intimate engagement with the walls of said thermal element supports defining said apertures to hold said thermal element in place while enabling some deflection of said thermal element; means for mounting said pair of thermal element supports on said shaft to permit movement of said thermal element on said pair of thermal element supports towards and away from the axis of rotation of said shaft; and means coupled to said thermal element for heating said thermal element.

12. The apparatus as defined in claim 11 comprising: a guard disposed about said pair of thermal element supports, said guard having a guide aperture therein through which an insulated conductor can be inserted; and gauge means for indicating the relationship between the depth of insertion of said insulated conductor through said guide aperture and the distance from the end of said insulated conductor to the region of engagement between said thermal element and the insulation of said insulated conductor.

13. The apparatus as defined in claim 11 further comprising: a bore in said shaft extending in the direction of its axis of rotation to receive an end of an insulated conductor and permit said thermal element to contact the insulation of a conductor inserted in said bore when said shaft is rotated to form an annular groove in said conductor insulation near said end; a guard disposed about said thermal element having a longitudinal aperture therein in alignment with said bore to permit an insulated conductor to pass through said aperture into said bore; and slug removing means coupled to said guard and positioned adjacent said bore for gripping the insulation of an insulated conductor inserted through said aperture into said bore on the side of said groove nearest the end of a conductor inserted in said bore prior to withdrawal of such conductor from said guard.

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