

Aug. 11, 1959

A. J. LOVECKY

2,898,952

WIRE UNWRAPPING AND REWRAPPING TOOL

Filed Dec. 28, 1956

2 Sheets-Sheet 1

FIG. 1

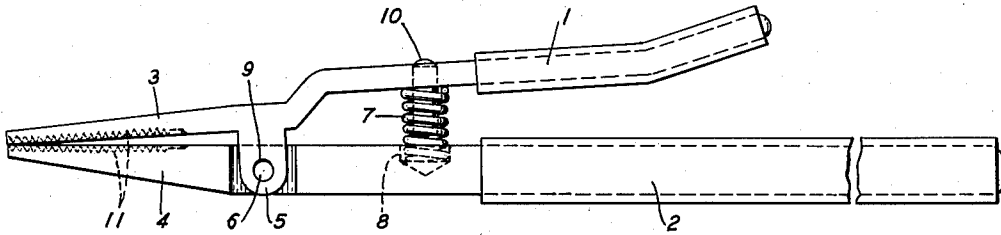


FIG. 2

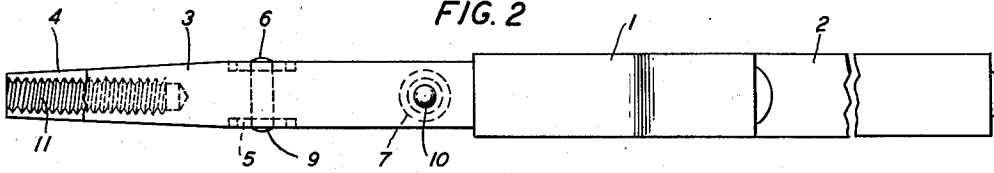


FIG. 3

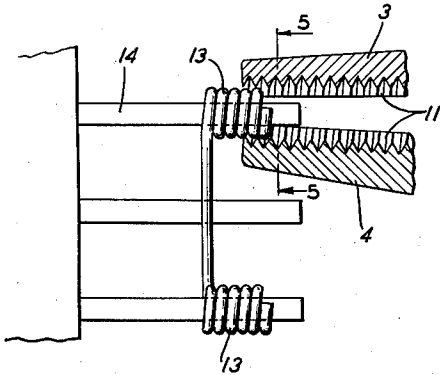


FIG. 4

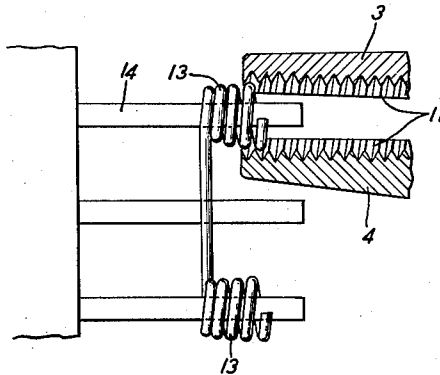


FIG. 5

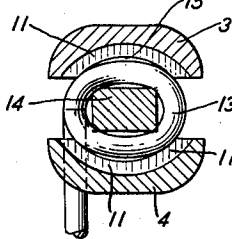
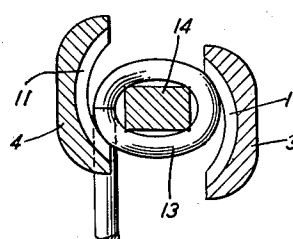


FIG. 6



INVENTOR
A. J. LOVECKY
BY *Hearnio*
ATTORNEY

Aug. 11, 1959

A. J. LOVECKY

2,898,952

WIRE UNWRAPPING AND REWRAPPING TOOL

Filed Dec. 28, 1956

2 Sheets-Sheet 2

FIG. 7

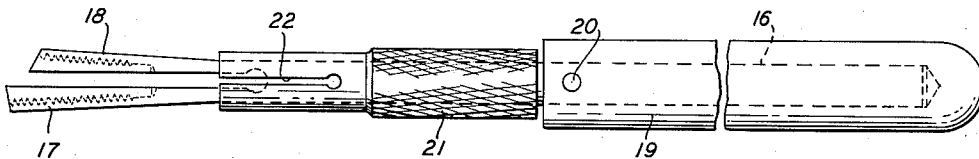


FIG. 8

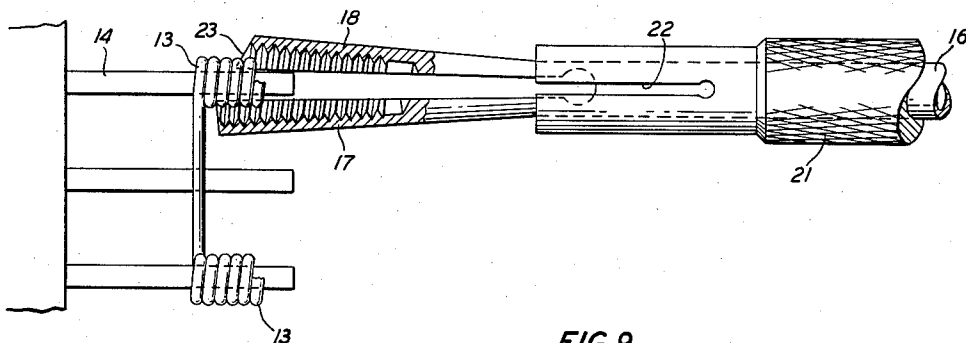


FIG. 9

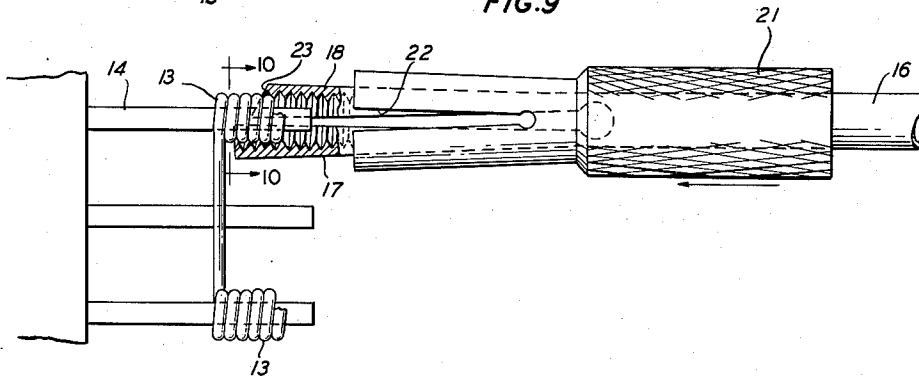
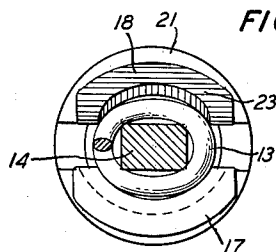


FIG. 10



INVENTOR
A. J. LOVECKY
BY *[Signature]*
ATTORNEY

1

2,898,952

WIRE UNWRAPPING AND REWRAPPING TOOL

Albert J. Lovecky, Flushing, N.Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Application December 28, 1956, Serial No. 631,149

2 Claims. (Cl. 140—124)

This invention relates to a tool for unwrapping and rewrapping wrapped wire connections.

The connection of a wire to a terminal, or the joinder of two wires by wrapping only, is frequently employed as an alternative to other methods of joining electrical conductors such as, for example, soldering. The theory and advantages of such wrapped wire connections, for example, in which a wire is helically wound on another wire or terminal, are shown in Patent 2,759,166 which issued to R. F. Mallina on August 14, 1956. These connections can be made with the addition of solder in order to give the connection added mechanical strength. In particular circumstances, however, for example where the terminal to be wrapped and the wrapping wire are within certain advantageous limits of size, the bond created by wrapping alone is a physical connection sufficiently intimate to insure both mechanical strength and good electrical contact.

Heretofore, however, the removal and reestablishment of a wrapped wire connection has presented problems not satisfactorily met by tools known in the art. Removal of an unsoldered wrapped connection usually requires a complete and literal unwrapping of the wire-formed helix or results in the unwinding of a sufficient number of the coils of the helix so that the form of the remaining coils of the helix is lost. Also in these operations, with tools presently in use, the helical form of a wrapped wire connection is distorted further during removal through a twisting of the wire.

Once the helix of a wrapped wire has been completely unwound or substantially deformed, a satisfactory rewrapping of the wire on a new terminal is virtually impossible. New deformations of the unwrapped wire are usually insufficient to make good contact on a second terminal if prior deformations remain as flaws in the wrapped structure. Work hardening of the wire causes embrittlement in the case of undue deformation. A further difficulty arises in that known wire-wrapping tools normally used to make a wrapped connection are designed for straight smooth wire free from kinks and will not satisfactorily accommodate wires deformed by prior wrapping and unwrapping processes. Consequently, if a new connection is to be made, that portion of the wire previously wrapped must be removed and a new end length of the wire must be prepared for wrapping.

It is an object of the present invention to provide a convenient, efficient tool for unwrapping and rewrapping wrapped wire connections.

It is a further object of this invention to provide such a tool which permits a rewrapping of an unwrapped wire without the need for removal of the previously wrapped end and the preparation of a new end length.

A further object of the invention is to provide such a tool which permits the removal of a helical wire wrapping from a terminal and the replacement of the same helical wrapping on a second terminal with a minimal distortion of the original helical form.

In accordance with the principles of the invention, the

2

removal of a wrapped wire from a terminal is brought about not by a literal "unwrapping" of the wire but rather by a slight expansion of the individual coils of the helix to a diameter sufficient to permit slipping the expanded helix off the member on which it has been wrapped. Re-establishment of a new connection involves slipping the expanded helix over a second member or terminal and constricting the coils of the helix thereon until adequate mechanical and electrical contact is made.

A feature of the invention is the arrangement of a pair of jaws by which the helix of a wrapped connection may be grasped in such a fashion that expansion of the helical winding is provided for while the jaws are in grasping relation to the helical coil.

A further feature is a particular machine-threading arrangement on the grasping surfaces of the jaws which brings about an optimum exertion of force on the helical winding to be grasped so that the helical winding may be removed or replaced without significant deformation or cutting of the wrapped wire.

These and other objects and features of the invention will be more fully understood from the following detailed description and drawings in which:

Fig. 1 is a side elevation of one embodiment of the wrapping and unwrapping tool treated herein;

Fig. 2 is a plan view, partially in section, showing the same embodiment as Fig. 1 and illustrating particularly the configuration of one of the threaded jaws;

Fig. 3 is an enlarged side elevation of the embodiment shown in Fig. 1 illustrating particularly the relationship of the threaded jaws to the helical winding of a connection during the wrapping process;

Fig. 4 is the same as Fig. 3 operating as an unwrapping device;

Fig. 5 is a cross section view of the same embodiment shown in Fig. 4, taken in the plane of the line 5—5 illustrating particularly the relationship of the grasping jaws to a helically coiled wire before twisting force has been applied to the tool to effect removal of the connection;

Fig. 6 is the same view as Fig. 5 with the exception that the disposition of the jaws is shown after twisting force has been applied to the tool;

Fig. 7 is a second embodiment of the invention disclosing a tool in which closing of the jaws is effected by a sliding sleeve member;

Fig. 8 is the tool of Fig. 7 shown with its sleeve in a withdrawn position and its jaws in grasping relation to a wire helix connection;

Fig. 9 is the tool of Fig. 7 shown with its sleeve in the fully advanced position exerting closing force on the jaws; and

Fig. 10 is a cross section of Fig. 7 taken in the plane of the line 10—10 in the direction of the small arrows.

Referring to Figs. 1 and 2 it will be noted that the embodiment illustrated comprises handle 1 and handle 2 which terminate respectively in jaw member 3 and in jaw member 4. Jaw 3 is pivotally related to jaw 4 by means of yoke 5, integrally related to jaw 3 and handle 1, the yoke being axially mounted on pin 6. Jaw members 3 and 4 are screw threaded and concave on their opposing faces. Spring 7, mounted on pin 10, acts to keep jaw members 3 and 4 normally closed. Opening the jaw members is effected by exerting hand pressure on handles 1 and 2 which in turn acts to compress spring 7.

Fig. 3 illustrates the use of the tool in wrapping previously unwrapped helical connection 13. In the unwrapping process the helical connection is extended radially sufficiently to permit removal from its terminal without significant distortion of the helical form. In effecting the rewrapping process jaws 3 and 4 must be

3

opened sufficiently to grasp the full length of the radially expanded wire helix.

As shown by Fig. 1, when jaws 3 and 4 are in the closed position, their inner surfaces diverge away from their meeting point at the jaw ends. As a result of this divergence, created by the tapered design of jaws 3 and 4 the only firm gripping contact established, when the tool jaws are closed about the full length of wire helix 13, is on the two convolutions nearest the base of terminal 14. Accordingly, there is sufficient clearance between jaws 3 and 4 and the remaining coils of helix 13 so that a part of the tightening force exerted on the grasped convolutions when the tool is rotated will be transmitted freely to the relatively unconfined convolutions.

Immediately prior to the actual coil tightening process, hand pressure on handles 1 and 2 which tends to compress spring 7 is released. Hence, full spring pressure acts to keep jaws 3 and 4 in close contact with the convolutions grasped.

To effect tightening of helical coil 13 about terminal 14, the tool is rotated in a clockwise direction, looking toward the base of terminal 14. As the tool is twisted, a number of elements cooperate to increase its gripping action. The first of these stems from the particular relationship of the pitch defined by helical coil 13 to the pitch defined by the threaded portion of opposing jaws 3 and 4.

Wire closely wound helically about a terminal will form a thread whose pitch is determined by the diameter of the wire used. In turn, the pitch defines the angle which any loop of the coil makes relative to the longitudinal axis of the terminal. Similarly, the pitch of the tool thread defines the angle of inclination of any thread to the longitudinal axis of the jaw. If the pitch on the tool and the pitch defined by the wire helix were identical, the tool would simply advance or retreat on the wire coil as the tool is rotated since the loops of the coil would mesh perfectly with the threaded tool.

If the pitch is different, however, in accordance with the principles of the invention, the threads of the tool will mesh only partially with the wire coil. The threads of the tool and the threads of the coil will be crossed, the degree and frequency of the crossing being dependent upon the difference in the two pitches. A relatively large difference between the pitch of the coil and the pitch of the jaw threads would result in considerable thread crossover which in turn would cause undue deformation of the wire helix, wire cutting and the production of minute metal shavings. Experiments have shown that the optimum relationship between the pitch of the coil and the pitch of the tool threads is established by designing the pitch of the tool threads slightly greater than the pitch defined by the helical coil. For example, in the wrapping and rewinding of 24-gauge wire, having a diameter of .020 inch, the most effective tool threading is 40 threads per inch. The nominal pitch of the wire when wrapped into a helix is 50. However, inability to wrap successive coils with a complete absence of space between the coils probably reduces the pitch to about 48. This pitch relationship produces the best possible compromise between effective gripping action and the avoidance of cuts in and deformation of the helical coil.

A further element contributing to the gripping action of the tool is best illustrated by reference to Figs. 5 and 6. In Fig. 5 it will be noted that the curvature of the opposing concave jaw surfaces is such that when the relatively flat sides of helical coil 13 are grasped, only the outside edges of the jaws are in contact with the turns of the helix. A slight open space 15 is shown between the wire coil and the tool jaws except at the outer jaw edge contact points. These outer jaw edges are slightly rounded in order to promote increased friction as opposed to cutting action. Twisting the tool concentrates a grabbing-like friction force along the outer edges of the two jaws thus increasing the tendency of the tool to hold the helix firmly.

4

An additional element in the effective gripping action of the tool is contributed by the design of jaw pivot pin 6 which includes an arrangement permitting a slight amount of lateral movement or sideways play between the two jaws. As the tool is rotated, frictional drag displaces the upper jaw sideways causing a greater angular difference between the threads of the upper jaw and the thread defined by the wrapped wire. The increased thread crossover between the tool and the wire helix decreases the tendency of the tool threads to slip over the threads defined by the helix. To create this increased thread crossover only a slight arc need be described by the free movement of the tool's upper jaw relative to the lower jaw, less than a few degrees on either side of the median aligned position. A sideways motion in the order of .010 inch is effective for this purpose. This sideways play of the upper jaw relative to the lower jaw is brought about by the design of yoke 5, the center hole in which is made slightly larger than would be necessary for a snug fit around axial pin 6.

The feature of sideways play in upper jaw 3 relative to the lower jaw 4 makes a contribution to gripping action in addition to that created by the increased thread crossover. In Fig. 6 it will be noted that the twisting of the tool and the resulting lateral displacement of tool jaws 3 and 4 produces contact between jaw 3 and coil 13 only along the right-hand edge of jaw 3 and contact between jaw 4 and coil 13 only along the left-hand edge of jaw 4. Consequently, a leverage element is introduced which tends to increase the gripping action of the jaws and which tends to tighten the convolutions of the wire helix.

A further element contributing to jaw gripping action is the force exerted by spring 7. With proper selection of spring stiffness, the jaws of the tool grip the wire convolutions firmly and yet will permit the jaws to open against spring pressure at a point before damaging coil deformation can result. An overly stiff spring would, of course, create an undesirably forceful gripping action which in turn would result in unacceptable coil deformation and a spring with insufficient strength would provide inadequate gripping force for the tool to function properly.

Returning to Fig. 3 it will now be appreciated that the various elements contributing to the gripping action of the tool cooperate so that a twisting of the tool anchors the first coil farthest from the free terminal end and further clockwise rotation contracts successive coils on the terminal to establish a connection similar in appearance to the original wrapping. As each convolution is tightened, the opening of the tool jaws decrease, spring pressure decreases and the tool, as it is twisted, progresses to the next convolution toward the free end of terminal 14. As a consequence of the tapering feature of jaws 3 and 4, clearance exists between the jaws and the convolutions of the helix other than those convolutions being securely grasped. This clearance is sufficient so that, as the tool is rotated, a part of the tightening force exerted on the grasped convolutions is transmitted freely to the relatively unconfined convolutions. In Fig. 3, the tool is shown as it tightens the final two convolutions of helix 13.

In unwrapping a previously wrapped connection, essentially the reverse of the wrapping process takes place. The unwrapping action may best be compared to the action resulting from counterclockwise rotation of the coils at one end of a clockwise wound spring. If the coils at the opposite end of the spring are rigidly fixed, those coils capable of movement and so rotated counterclockwise will tend to increase in diameter without, however, necessarily tending to lose the over-all helical form.

Referring to Fig. 4, an illustration of the unwrapping process, jaws 3 and 4 of the tool are attached over the two or three turns of coil 13 at the end of the wrapped wire nearest to the free end of terminal 14. From the free terminal end a wrapped wire connection normally appears clockwise wound. By a counterclockwise twisting of the tool, the coils gripped by the tool are extended

5

slightly in diameter, freeing themselves from terminal 14. By continued twisting, successive coils of the helix are extended, progressing toward the wrapped wire coil farthest from the free terminal end. When the twisting force reaches the last fixed coil, loosening it, the helix is freed from the terminal, permitting free rotation of the entire helix, at which point it may be slipped off the free terminal end. The wrapped wire so removed retains its helical form and hence may be rewrapped as described hereinabove.

The feature of tapering the jaws, described hereinabove in relation to the wrapping process, also contributes to the efficiency of the unwrapping process. During unwrapping, the tool, as it is twisted, advances at least a part of the way from the free terminal end toward the base of the terminal. The extra jaw clearance existing in the direction of the jaw pivot point insures that partially loosened convolutions of the helix will be free to expand further without confinement.

To persons skilled in the art it will be apparent that the principles of the invention may be employed most effectively within certain limits of wire size, terminal size and coil configuration. The tool may be employed with particular advantage when the wrapped terminal is of such dimension that the tool jaws need not be opened fully when gripping the wire helix. The grasping surface of the jaws will then be essentially elliptical. Further, the coils on the terminals are rarely true circular helices, but are roughly of the same polygonal shape as the terminals on which they are wrapped. These two circumstances have the result that in a wrapping or unwrapping operation the wire is grasped by the tool at only a few points on the coil rather than being completely surrounded by the jaws. The limited contact between the tool and the coil readily permits the coil to expand in diameter without confinement during the unwrapping process or to contract freely during the wrapping process.

Particularly advantageous tool and coil dimension relationships occur, for example, where a 24-gauge, .020 inch diameter wire is wrapped on a conventional rectangular wire spring relay terminal .050 inch by .031 inch. Such a wrapping results in a connection in the order of .090 inch by .071 inch. It will be appreciated that the particular dimensions noted are not critical for the successful employment of the tool but rather are exemplary of advantageous size relationships. It should be apparent, however, that the effectiveness of the tool will be decreased if wrapping or unwrapping is attempted with wire considerably less than .020 inch in diameter. Similarly, the features of the invention can be used with only limited efficiency in instances where the diameter of the wrapped wire is considerably in excess of .020 inch. In the case of particularly fine wire a helically wrapped connection will present insufficient stiffness to permit coil removal without undue deformation of the helical form. With wrapped connections of particularly heavy wire, the amount of force necessary to wrap or unwrap a connection will be more than can be conveniently applied by the tool. Nevertheless, the principles of the invention are effective for use with the great majority of wrapped connections inasmuch as the wire and terminal dimension limits which may be employed in making wrapped connections with acceptable properties of mechanical strength and electrical contact fall within the parameters of coil and terminal dimensions with which the tool may be used effectively.

A second embodiment of the invention is illustrated by Figs. 7, 8, 9 and 10. This embodiment may be employed with particular advantage in crowded wrapped terminal areas where but little space is available for tool insertion and jaw movement. As shown by the figures, the embodiment comprises rod member 16 terminating in jaw members 17 and 18. Handle 19 is secured to one end of rod member 16 by pin 20. Rod member 16 is housed in sliding relation to sleeve mem-

6

ber 21. Sleeve member 21 has a longitudinal slit 22 at the end nearest the tool jaws. With sleeve member 21 fully retracted, as shown in Fig. 7, the inner longitudinal edges of the jaws are essentially parallel. The jaws are tapered in the direction of their bases, however, which presents a flared jaw aspect. Jaw closure is effected by sliding sleeve 21 forward forcing the jaws together as illustrated by Fig. 9.

In Fig. 9 it will be noted that, as in the embodiment described heretofore, the space between the jaws when the jaws are in the closed position increases from the jaw ends toward the jaw base. Inasmuch as the movement of the jaws can be controlled readily in only one direction, the tool is most effective when used for unwrapping.

While in particular circumstances the tool may be employed successfully for wrapping, the dimensions of a coil will frequently have been expanded by unwrapping to a size that cannot be readily accommodated by the tool when the jaws are in the full open position. A feature designed to increase the flexibility of the tool, insofar as handling a variety of coil sizes is concerned, is the employment of one relatively long jaw 17 and one relatively short jaw 18. Placing long jaw 17 on the underside of a wrapped connection will enable the operator to spread the jaws slightly to accommodate the wrapped connection when such action is necessary. Extended jaw member 17 also serves as a guide and in this respect is helpful when working in an area of crowded terminals.

In Fig. 9 it will be noted that moving sleeve member 21 forward has resulted in an outward flaring of the two halves of the sleeve member defined by longitudinal slit 22. In this manner the sleeve exerts a resilient or spring-like closing force on the jaw members and thus serves the same purpose as spring member 7 illustrated in Fig. 1.

Gripping action of the embodiment disclosed by Figs. 7, 8, 9 and 10 is essentially the same as that employed in Figs. 1, 2, 3, 4, 5 and 6. One difference, however, is that in the embodiment of Fig. 7 lateral movement or sideways play of the jaw members is not provided for. A feature designed to compensate for the absence of the increased gripping action brought about by sideways play between the jaw members is the angular or bevel cut 23 made on the end of the shorter of the two jaw members 18. The resulting curve defined by the intersection of the cut and the inner jaw surface is slightly hooked inwardly at its outer ends. Consequently, the gripping action of jaw 17 is increased somewhat when the tool is rotated.

As in the embodiment described hereinbefore, the various elements contributing to the gripping action of the tool are designed to bring about gripping force which is sufficient to perform the wrapping or unwrapping task without shaving metal from the wrapped wire and without distorting its original helical form.

The principles of the invention may be employed in a variety of embodiments in addition to those described hereinbefore. For example, one advantageous arrangement which has been employed successfully is somewhat similar to that disclosed by Fig. 1. Movement of the movable jaw, however, is controlled by pressure against a spring loaded rod member which is housed in and is in sliding relation to the hollowed and extended end of the fixed jaw member. One end of the rod member is suitably linked to the movable jaw member so that axial movement of the rod member is translated into pivotal movement of the movable jaw member. Other variations have also been tested with some success including the employment of more than two jaw members.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of this invention. Numerous other arrangements

may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A tool for expanding and contracting an inelastic coil of wire spirally wrapped about a terminal, said tool comprising two jaws, means connecting said jaws in pivotal relation such that the opposing faces of said jaws when in the fully closed position meet only beyond a point relatively distant from said connecting means, and the space between said jaws in said position increases from said point toward said connecting means, said opposing faces being concave, screw-threaded and of substantially the same width, the threads per inch of said screw threading being slightly less than the turns per inch defined by the spirally wrapped wire, whereby rotation of said tool on said wire effects a gripping action between the screw threading and said wire turns, and means for opening said jaws, said connecting means permitting a relatively slight sidewise displacement of said jaws when said jaws are closed on said spirally wrapped wire and twisting force is applied to the tool.

2. A tool for expanding and contracting an inelastic coil of connector wire spirally wrapped about a terminal, said tool comprising two elongated jaws of substantially the same width, means connecting said jaws in juxtaposed pivotal relation such that in the closed position of

the jaws the spacing between the juxtaposed faces of the jaws decreases in the direction away from said connecting means, said connecting means holding said jaws in fixed longitudinal relation but permitting limited relative sidewise movement therebetween when said jaws are closed on said wire and twisting force is applied to the tool, means for opening said jaws, and spring means opposing the opening of said jaws, said juxtaposed faces being concave and of less than 180 degrees in arcuate extent and screw threaded, the threads per inch of the screw threading being slightly less than the turns per inch of the spirally wrapped wire whereby rotation of said tool on said wire effects a gripping action between said screw threading and said wire turns.

References Cited in the file of this patent

UNITED STATES PATENTS

360,623	Siden	Apr. 5, 1887
1,628,926	Short	May 17, 1927
1,748,346	Hollup	Feb. 25, 1930
1,803,518	White	May 5, 1931
1,815,500	Doan	July 21, 1931
1,866,782	White	July 12, 1932
2,448,342	Zagar	Aug. 31, 1948
2,719,445	Giebler	Oct. 4, 1955