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K. A. BROOKS
WIRE WRAPPING TOOL
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3,077,211

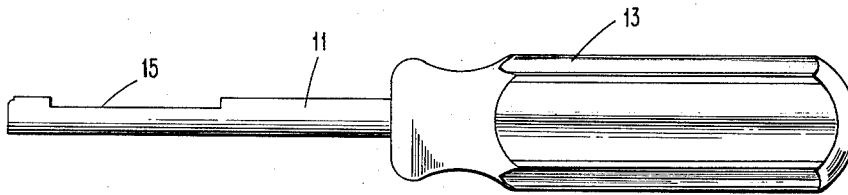


FIG. 1

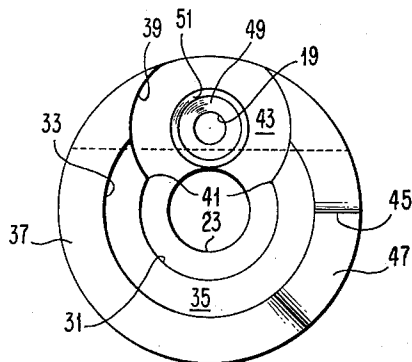


FIG. 6

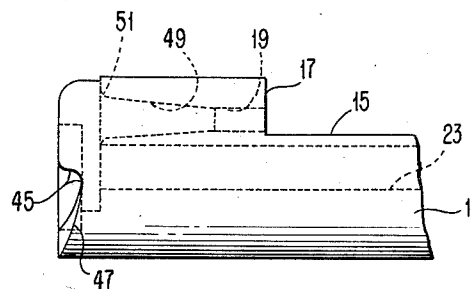


FIG. 5

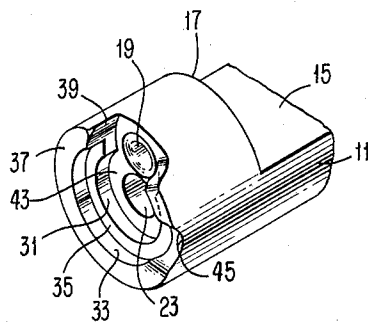


FIG. 2

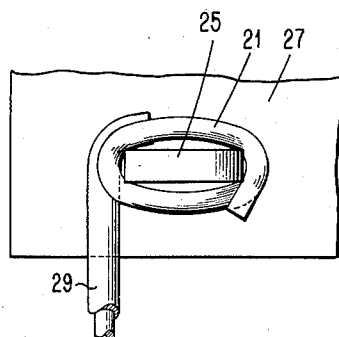


FIG. 4

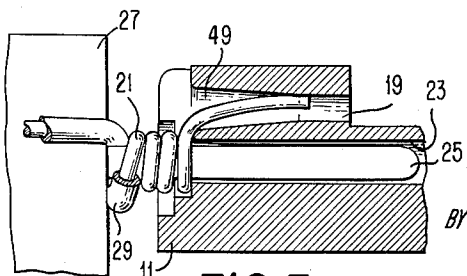


FIG. 3

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WIRE WRAPPING TOOL

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The present invention relates to tools for winding or wrapping wire about electrical terminals, and more particularly to a hand tool for making wrapped wire connections and for unwrapping these connections.

An object of the invention is to provide a generally improved and more satisfactory tool for making wrapped wire connections comprising a plurality of helically wound turns, wherein the first turn is of insulated wire, the succeeding turns of stripped wire are spaced properly from one another, and the end of the last turn of wire is formed closed to the surface of the electrical terminal.

Another object is the provision of a new and improved manually operated wire wrapping tool which wraps both clockwise and counterclockwise to make the connection and which also unwraps in both directions to loosen the connection so that the wire may be removed from the terminal.

Yet another object is to provide a new and improved tool for wrapping wire comprising a unitary bit designed to result in improved reliability, lower manufacturing costs and longer tool life.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawing, wherein:

FIG. 1 is a side view of a wire wrapping tool according to the invention;

FIG. 2 is a perspective view of the end of the bit of the tool to an enlarged scale;

FIG. 3 is a fragmentary diametrical cross-section taken longitudinally through the tool bit, the tool being shown inserted onto a terminal pin or post with the wrapped wire connection partially completed;

FIG. 4 is an enlarged end view of the completed wrapped wire connection;

FIG. 5 is a fragmentary side view of the tool bit; and

FIG. 6 is an end view of the tool bit drawn to an even larger scale.

As shown in FIG. 1, the wire wrapping tool of the invention in its preferred embodiment is a hand tool comprising a tool bit or shaft 11 secured to a handle 13. The handle 13 may be of any suitable construction, and is similar to an ordinary screwdriver handle. The tool bit 11 is desirably an elongated cylindrical shaft having a bit end configuration as shown in FIG. 2. A short distance to the rear of the bit end or face, the shaft 11 has a flat section 15 providing an intermediate peripheral recess formed on a chord of its cross-section and defining at one end a forward shoulder 17.

Referring also to FIG. 3, the face of the tool bit 11 has a longitudinally extending wire receiving bore 19 extending through the shoulder 17 to the intermediate recess and offset from the center of the tool bit. The wire to be connected to the terminal as herein described is insulated wire from which the insulation has been stripped for a short distance from its end. The end of the stripped wire portion 21 of the wire is adapted to be inserted through the bore 19 extending rearwardly across the flat section 15 where it may be initially held in place by the hand of the operator preparatory to starting the wrap in a manner to be explained later. The tool bit 11 has a second longitudinally extending bore 23 which is centrally located with respect to the axis of the shaft

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and is of sufficient length to fully receive a terminal pin or post 25 about which the wire 21 is to be wrapped. The terminal 25 illustrated is the flat type, however it will be understood that the tool bit according to the present invention may be modified to make wrapped wire connections about terminals of various other cross-sections. The flat type terminal 25 shown is attached to a terminal block 27.

A wrapped wire connection is seen in FIGS. 3 and 4 to comprise a plurality of helically wound turns of wire, the individual turns of wire lying close to one another without overlapping or being superimposed upon one another. The stripped wire 21 is wound tightly about the terminal 25 so as to bite into or score the corners of the terminal to provide good electrical contacts. In accordance with the invention, the first turn or a substantial portion of the first turn is made of insulated wire 29, the remaining turns of course being of the bare or stripped wire 21. Furthermore, proper spacing of the succeeding turns of wire is assured, and the end of the last turn of wire is formed close to the surface of the pin 25 without projecting outwardly an undue amount.

Turning now to the configuration of the bit end, and referring particularly to FIGS. 2, 5, and 6, there is concentric with the central terminal receiving bore 23 a counterbore 31 which extends to a relatively considerable depth into the bit end. Concentric with these two bores is yet another counterbore 33 extending inwardly to a lesser depth than the counterbore 31, to provide a ledge 35 lying in a plane approximately perpendicular to the longitudinal axis of the tool bit. The end surface of the tool bit or shaft lying radially outwardly of the counterbore 33 is designated by the numeral 37.

The wire receiving bore 19 has a concentric counterbore 39 which extends to the depth of the previously mentioned counterbore 31. The two counterbores 31 and 39 intersect to provide a V-shaped abutment 41 which in view of its function will hereafter be known as the unwrapping abutment. A recessed inner end surface 43 formed due to the fact that the counterbores 31 and 39 extend inwardly to the same depth surrounds the bores 19 and 23 within the confines of these two counterbores and is approximately flat in a plane perpendicular to the longitudinal axis of the bit shaft. It will be noted that the counterbore 39 is sufficiently large in diameter to intercept the ledge 35 and the end surface 37 over a substantial portion of their peripheries. A notch 45 is cut inwardly from the end surface 37 of the shaft at a point in its circumference spaced clockwise from the intersection with the counterbore 39 when viewing the end of the bit directly. The maximum depth of this notch is approximately at the level of the ledge 35. One side of the notch 45 extends generally axially whereas the other side of the notch has a gradual circumferential slope 47 serving as a cam surface in a manner to be explained.

It will be recalled that the wrapped wire connection to be made by the tool according to the invention has the first turn or a substantial portion of the first turn of insulated wire 29. For this purpose, the wire receiving bore 19 has a forward tapered portion 49 which becomes larger in diameter progressively towards the end of the bit shaft. At the intersection of the tapered portion 49 with the recessed end surface 43 is a rounded radius 51 presenting a forwardly and outwardly flaring rounded surface as viewed from the end of the tool bit. In use, the stripped portion 21 of the wire to be wrapped is inserted through the bore 19 extending onto the flat section 15 until the end of the insulated portion 29 of the wire wedges or jams in the tapered bore portion 49. The degree of taper of the tapered bore portion 49 is regulated so as to assure that first turn or a substantial portion of the first turn is of insulated wire. This

is desirable to avoid overstress and exposure to breakage at the first turn. Thus assurance that the first turn shall be insulated wire is automatically achieved by proper insertion of the wire in the tool. For different wire sizes the degree of taper of the tapered bore portion 49 may be changed, although it has been found in practice that two adjacent wire sizes such as Nos. 20 and 22 AWG may be wrapped satisfactorily with the same degree of taper.

The insulated wire 29 having been wedged into the tapered bore portion 49, the stripped end 21 of the wire is held down with the finger against the flat section 15 while the remainder of the hand grasps the handle 13. The other end of the insulated wire projecting forwardly from the bit end is bent across the radius 51 downwardly at approximately a 90° angle and pressed into the notch 45. The notch 45 should be located angularly with respect to the wire receiving bore 19 such that the insulated wire 29 lies adjacent or close to the edge of the terminal receiving bore 23. Clearance is thus left for the terminal pin 25 to be inserted into the central bore 23. At this time the hold of the stripped wire 21 against the flat 15 may be let go, and the free end of the insulated wire 29 is grasped or pressed against the terminal block 27 so that the beginning of the wire wrapping may commence by rotary motion of the handle 13.

Assuming that a clockwise wrap is to be made, it can be seen as shown in FIG. 3 that the stripped wire 21 is pulled out of the bore 19 across the radius 51 as the winding begins. Initially the wire 29 is cammed out of the notch 45 by riding along the sloping side 47 and thereafter slides along the end surface 37 until the first turn is complete and the tool has advanced axially to the point where the turns are formed within the counterbore 31, assuming that some inward pressure is maintained on the handle 13. Subsequent turns of wire are formed on the recessed end surface 43, within the confines of the counterbore 31 which is concentric with the axis of rotation of the tool. In this manner the first insulated turn of wire is automatically spaced properly from the first stripped wire turn, without overlapping of the stripped wire on the insulation. Succeeding turns of stripped wire are spaced closely to one another, although it should be noted that greater spacing needed for the first insulated turn is provided for. As the wrapping proceeds, the inward pressure exerted by the operator presses the recessed end surface 43, that is, that portion of this end surface surrounding the central bore 23, against the bottom of the wire in the last turn being formed. "Over-wrapping" or the tendency of the succeeding turns to climb on the preceding turn or overlap is eliminated by the present tool by choosing the diameter of the counterbore 31 such that there is room for only one turn around the terminal pin. Even though the wire wrapping tool is pushed toward the terminal block 27 with relatively large amounts of force, the last turn is always grounded against the recessed end surface 43, and only one turn can form in the counterbore 31, thus assuring that there is no overwrapping.

This is accomplished by making the diameter of the counterbore 31 slightly greater than the longest dimension of the completed wrapped wire connection. As can be seen in FIG. 4, the turns of wire for the flat-type terminal pin 25 are oval-shaped, and the diameter of the counterbore 31 is greater than the length of the turns of wires by an amount not exceeding two wire diameters (one at either side) in order that the turn being formed cannot be formed around or overlapping the previous turn. Stating it otherwise, the radius of counterbore 31 must not be more than one wire diameter larger than half the greatest dimension of the turns of wire. In the preferred embodiment being described, it is desired to have one tool bit accept two adjacent wire sizes, Nos. 20-22 AWG. In this case, the diameter of counterbore 31 is slightly larger than the long dimension of the

turns of stripped wire No. 20 about the terminal 25. At the same time the diameter is not larger than more than two wire diameters of the No. 22 wire added to the long dimension of the turns of No. 22 wire about the terminal pin.

It is desirable to provide the maximum possible tight electrical joint without overstressing of the wire to the point that fractures may occur. To achieve a good electrical connection it is necessary that the stripped wire 21 press into or score the terminal pin 25 in a plurality of places. This is achieved in the present design by the proper balance of the two bores 19 and 23, and the proper choosing of the radius 51 at the exit of the wire receiving bore. For instance, in a tool bit designed to use either number 20 or 22 AWG solid wire, the radial offset of the bore 19 from the central bore 23 is .05 inches, the tapered portion 47 has a taper of 5°, and the dimension of the radius 51 is .025 to .030 inches. For this example the counterbore 31 has a .130 inch diameter, the bore 23 has a .068 inch diameter, and the counterbore 39 has a .156 inch diameter.

As the wrapped wire connection is completed, the end of the stripped wire is drawn out of the wire receiving bore 19 and wiped reasonably closely against the surface of the pin by a portion of the counterbore 31 near the abutment 41. Assurance is thereby obtained that the end of the last turn of wire is automatically formed close to the surface of the terminal pin 25. It will be noted that this feature is achieved mainly by the choosing of the diameter of the counterbore 31 to closely surround the turns of wire as they are being formed in the manner previously described.

Unwrapping the wrapped wire connection involves loosening of the turns of wire so that the wire may be removed from the terminal pin. Assuming that a clockwise wrap has been made, the tool bit 11 is moved to insert the terminal pin 25 in the central bore 23, with the last turn of wire seated in the counterbore 31. The handle 13 is rotated counterclockwise until the slightly projecting end of the stripped wire 21 engages the unwrapping abutment 41 provided by the intersection of the two counterbores 31 and 39. More particularly, the end of the stripped wire 21 is engaged by the counterbore 39 near the intersection. The abutment 41 thereby grabs the end of the stripped wire 21 and progressively loosens the turns of wire as the counterclockwise motion is continued. The end of the stripped wire 21 remains engaged with the counterbore 39 until the last turn of wire has been loosened, and the wire may be removed from the terminal by pulling on the insulated wire portion 29. In this regard, the diameter of the counterbore 39 is chosen so that abutment 41 is properly located, and is normally slightly larger than the counterbore 31.

The tool bit 11 may also be used for making counterclockwise wound wrapped wire connections. The performance and operation of the tool are substantially the same as that which has been described for the clockwise wrap. The operator proceeds as before by inserting the stripped end of the wire through the bore 19 to be held in place by the finger of the operator against the flat section 15, the insulated wire portion 29 being bent through approximately 90° to rest in the notch 45. Since the motion of the tool is now in a counterclockwise direction, it can be seen that the insulated wire portion 29 must ride up over the steep portion of the notch 45 and travel to the opposite side of the end surface 37, relatively speaking, before the first turn begins. In actual practice, of course, it is the tool that is rotating relative to the wire. The operator simply watches his pressure until the wire has grounded on the surface 37 and the first turn has begun. Succeeding turns are properly spaced from one another as described before since in the same manner the counterbore 31 can accept only one turn and the tool cannot be inserted beyond the point where the

last turn of wire is flat against the recessed end surface 43. For unwrapping a counterclockwise wrap, the tool is inserted on the terminal pin 25 and rotated in the opposite clockwise direction to engage the end of the stripped wire 21 against the abutment 41 and progressively loosen the turns of wire as described previously.

Although it is contemplated that the clockwise rotation of the tool for making a clockwise wrap is the most usual mode of operation, the counterclockwise wrap may be more desirable for left-handed persons and in a tight situation where the available space is such that it is easier or possible only to make the counterclockwise wrap. Furthermore, although the wire wrapping tool of the invention has been described in its preferred embodiment as being a manually operated hand tool, tool bit 11 is readily adaptable to be driven by a portable power drive of the electric or pneumatic type, or to be assembled in at a fixed location as part of an automatic wire wrapping machine.

Two or more wrapped wire connections may be made on the terminal pin 25 located longitudinally from one another. For this type of clockwise-wound connection, the wire 21 is inserted as before into the bore 19 and the insulated portion turned through 90° and pressed into the notch 45. The fact that the insulated wire lies adjacent the bore 23 allows the tool to be inserted on the pin 25 only to the point where the insulated wire abuts the last turn of the preceding wrap. This automatically provides the proper spacing of the insulated turn of the second wrapped connection from the final stripped wire turn of the first wrapped connection. There is no tendency for these turns to overlap one another. This automatic spacing feature is lost when the wrap is made counterclockwise.

Summarizing the advantages, the wire wrapping tool according to the invention is especially designed to result in improved reliability, lower manufacturing costs and a longer tool life. Lower manufacturing costs result from the unitary bit and the relative ease with which the configuration of the bit end may be machined, as well as the feature that a single tool may be used for at least two wire sizes. An improved wrap is obtained by the assurance that the first turn shall be insulated wire, thus avoiding overstress and exposure to breakage at the first turn. Proper spacing of the first insulated turn from the first stripped wire turn is obtained, as is the subsequent proper spacing of the succeeding turns from one another without any tendency to overwrapping or overlapping. The end of the last turn of wire is desirably formed close to the surface of the pin, eliminating a separate operation to press it down into place. A maximum possible tight electrical joint without overstressing of the wire to the point that fracture may occur is achieved.

The present tool is a universal tool since it wraps both in the clockwise and counterclockwise direction, and furthermore unwraps in both directions. Consequently, maximum versatility of use is possible under any conditions. It has previously been mentioned that a single tool bit may be used for wrapping at least two similar wire sizes, such as number 20 and number 22 AWG solid wire. Another tool with the appropriate changes in dimensions may be used for wrapping and unwrapping other common wire sizes such as a single tool for numbers 24 and 26 AWG solid wire. If desired, two tool bits for different wire sizes may be mounted at either end of the handle 13. The dimensions of the bit end configuration may be easily changed for wrapping wire about terminals having other cross-sectional shapes than the flat type described.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A tool for making clockwise and counterclockwise wrapped wire connections with electrical terminal pins and for unwrapping these connections, each wrapped wire connection comprising a plurality of helically wound turns of wire of which the first turn is substantially of insulated wire and the remaining turns are of stripped wire, said tool comprising a generally cylindrical shaft of unitary construction having an intermediate peripheral recess, said shaft being rotatable about a longitudinal axis, one end of said shaft having a central terminal receiving bore and also a wire receiving bore radially offset therefrom and extending rearwardly into said intermediate recess, a first counterbore concentric with said terminal receiving bore and a second counterbore concentric with said wire receiving bore, said first and second counterbores intersecting to provide a pair of unwrapping abutments, said first counterbore having a diameter which is larger than the greatest dimension of the turns of stripped wire by an amount not exceeding two wire diameters, the forward end of said wire receiving bore being tapered and provided with a radius at its intersection with said second counterbore, and the end surface of said shaft radially outwardly of said first counterbore having a notch with a circumferentially sloping side.

2. A tool for making a wrapped wire connection with an electrical terminal, said tool comprising an elongated bit shaft having an intermediate peripheral recess, said shaft being of unitary construction and being rotatable about a longitudinal axis, one end of said shaft having a central terminal receiving bore and also a wire receiving bore radially offset therefrom and extending rearwardly into said intermediate recess, a first counterbore concentric with said terminal receiving bore and a second counterbore concentric with said wire receiving bore, said first and second counterbores intersecting to provide an unwrapping abutment, the forward end of said wire receiving bore being tapered outwardly and having a radius at its intersection with said second counterbore, the end surface of said shaft surrounding said first counterbore having a notch with a circumferentially sloping side, the stripped end of the wire to be connected to the terminal being adapted to be inserted into said wire receiving bore until the insulated portion thereof wedges in the tapered forward end and thereafter bent over into said notch, turning motion of said shaft after insertion on the terminal operating to cam said insulated wire portion out of said notch and thereafter form turns of wire within said first counterbore, rotary motion of said shaft in the opposite direction after the wrapped wire connection is completed causing the end of the stripped wire to be engaged by said abutment to unwrap the connection.

3. A tool for making a wrapped wire connection with an electrical terminal comprising a plurality of helically wound turns of wire, said tool comprising an elongated cylindrical bit shaft of unitary construction and having an intermediate peripheral recess, said bit shaft being rotatable about a longitudinal axis, one end of said shaft having a central terminal receiving bore and also a wire receiving bore offset therefrom and extending rearwardly into said intermediate recess, a first counterbore concentric with said terminal receiving bore and a second counterbore concentric with said wire receiving bore, said first counterbore having a diameter which is larger with respect to the greatest dimension of the helically wound turns of wire by an amount not exceeding two wire diameters, said second counterbore having a diameter slightly larger than that of said first counterbore, said first and second counterbores intersecting to provide an abutment, and a third counterbore about said first counterbore and extending to a lesser depth to provide an intermediate ledge, the end surface of said bit shaft

radially outward of said third counterbore having a notch with a circumferentially sloping side, said notch being located such that a wire initially inserted into the wire receiving bore and bent through approximately 90° lies at the side of said terminal receiving bore.

4. A tool for making wrapped wire connections with electrical terminal pins, said tool comprising an elongated generally cylindrical bit shaft of unitary construction, said shaft being rotatable about a longitudinal axis, one end of said shaft having an axially extending central terminal receiving bore and also a wire receiving bore radially offset therefrom, a first counterbore concentric with said terminal receiving bore and a second counterbore concentric with said wire receiving bore, said first and second counterbores intersecting to provide a pair of abutments, the bit shaft being rotatable both clockwise and counterclockwise to make, respectively, a plurality of helically wound turns about a terminal pin, rotation of the bit shaft in the respectively opposite direction causing the appropriate one of said abutments to engage the end of the wire to unwrap these connections,

and the radius of said first counterbore being greater than half the largest dimension of the turns formed by an amount not exceeding the wire diameter.

5. A construction as defined in claim 4 wherein the forward portion of said wire receiving bore is tapered and has a radius flaring forwardly and sidewardly at its intersection with said second counterbore, the wire to be wrapped having a stripped end portion which is initially inserted through the wire receiving bore extending into the intermediate recess until an insulated portion of the wire wedges therein, thereby assuring that substantially the first turn of wire of the wrapped wire connection is of insulated wire.

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