

Sept. 29, 1970

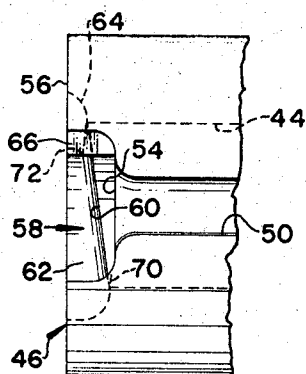
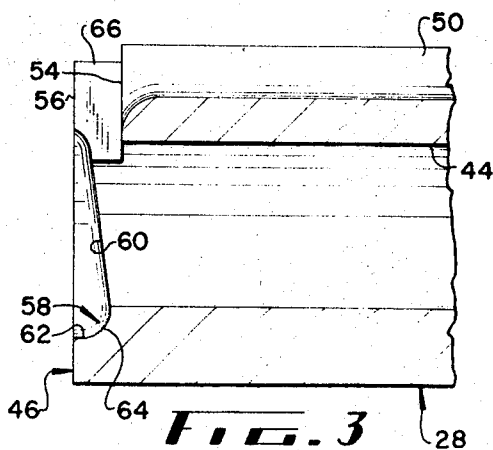
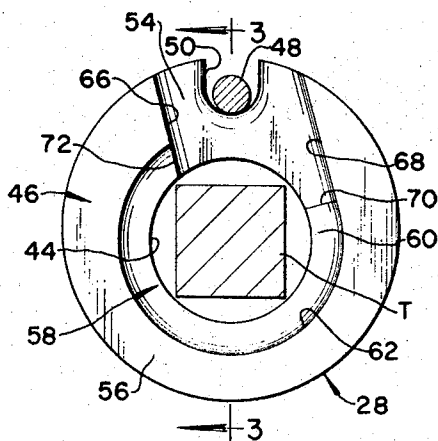
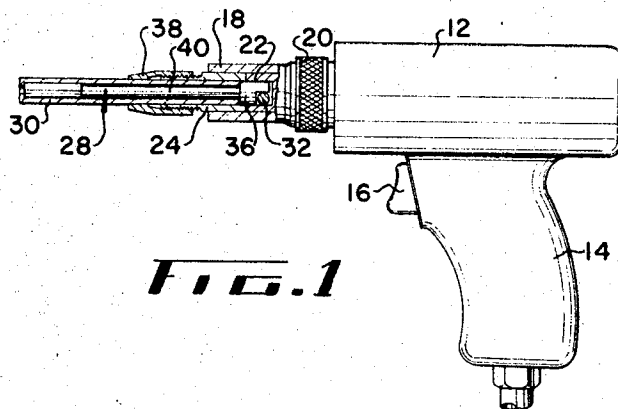
W. J. BAKER ET AL

3,531,056

CONDUCTOR WRAPPING BIT

Filed Nov. 16, 1967

2 Sheets-Sheet 1



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CONDUCTOR WRAPPING BIT

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2 Sheets-Sheet 2

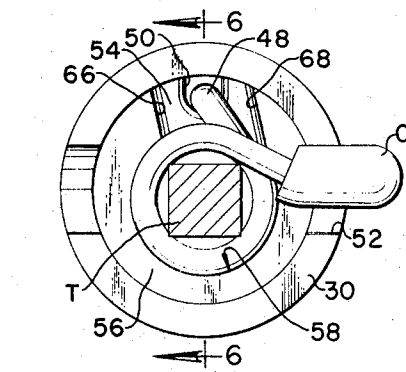


FIG. 5

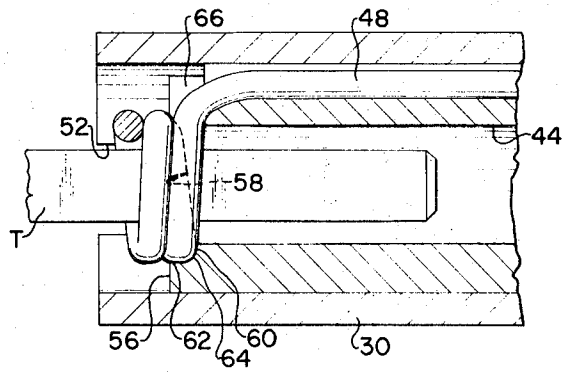


FIG. 6

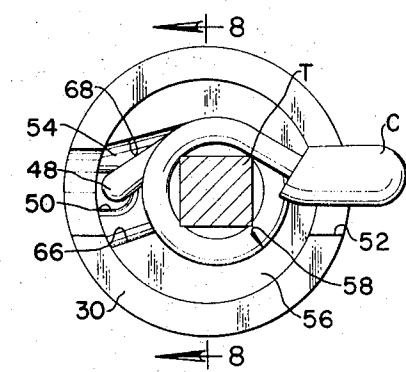


FIG. 7

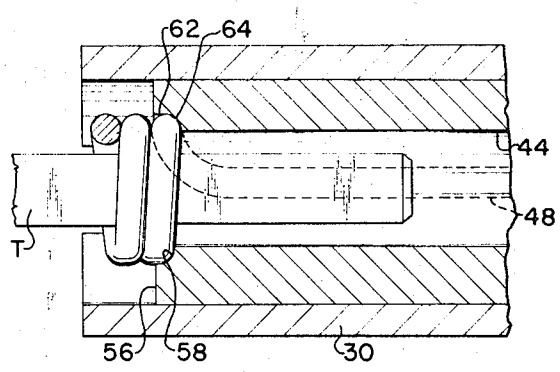


FIG. 8

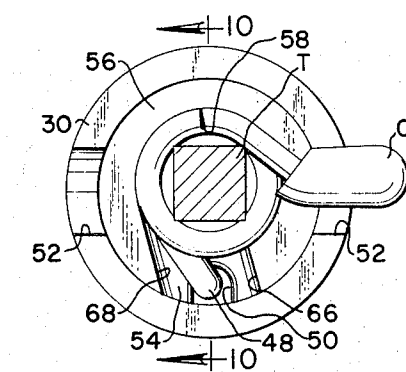


FIG. 9

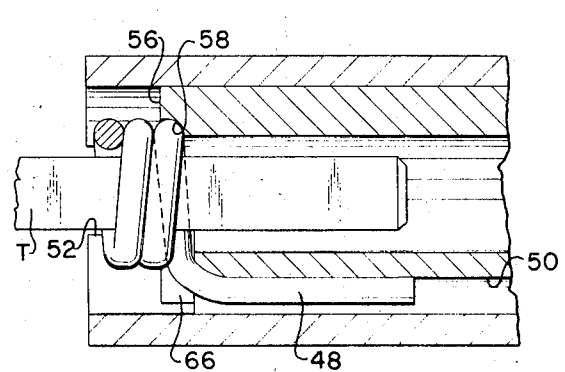


FIG. 10

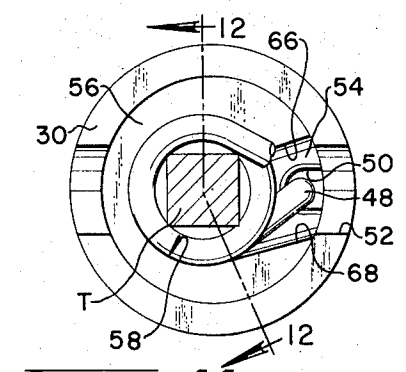


FIG. 11

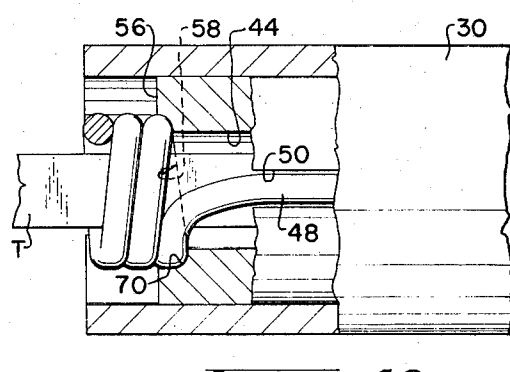


FIG. 12

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3,531,056

CONDUCTOR WRAPPING BIT

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7 Claims

ABSTRACT OF THE DISCLOSURE

A rotary bit for wrapping a wire conductor about a terminal in helical convolutions to form an electrical connection. The terminal-receiving bore is provided with a counterbore having surface portions, including a helical bottom wall, which are in intimate contact with a major portion of each successive wire convolution as it is formed about the terminal.

BACKGROUND OF THE INVENTION

Conductor-wrapping tools commonly incorporate a bit which is connected with a rotary motor and is journaled in a surrounding stationary sleeve. The bit is usually provided with a longitudinal bore for receiving an electrical terminal and a radially offset groove for receiving a stripped end portion of a wire which is to be wound in helical convolutions about the terminal upon rotation of the bit.

Each of the bits heretofore disclosed in U.S. Pats. 3,078,052 and 3,143,307 has a wire contacting end face having a cam surface which slidably engages and compressively urges successive wire convolutions radially into deforming engagement with the terminal. The resulting deformation or notching of the wire at the sharp corners of the terminal provides the finished connection with electrical and mechanical properties which are superior to those produced by noncamming bits which merely draw the wire about the terminal. It has been observed, however, that the cam surface of these prior art bits tend to wear rapidly or to spall due to the high instantaneous unit pressures obtaining between the cam surface and the wire. Such high unit pressures occur because each wire convolution takes the general shape of a helix while the cam surface which slidably contacts the wire is not complementary to the wire helix. Therefore, the wire surface and the cam surface are axially displaced from one another except at a single point, or at most a very small area, at which compression of the wire is effected by the overriding portion of the cam surface.

Another reason why the instantaneous unit pressure between the bit face and the helical wire convolution is conventionally of a very high order is that the small area of sliding contact therebetween must support the entire axial thrust necessarily applied to the bit to insure that the convolutions of the wrapped connection intimately contact one another.

Not only does the application of axial force by the bit against the wire contribute to the problem of shortened bit life, due to high unit pressures on the bit face, but this axial force tends to produce overwrapping of one wire convolution upon another. Special surface means formed on the bit face to restrain radial displacement of convolutions has been disclosed in U.S. Pat. No. 3,143,307; and, spring loading of bits to relieve excessive operator-applied axial force and mechanical means for retracting the bit from the terminal progressively during the wrapping operation have been incorporated in prior art wrapping devices.

Because cam surfaces of heretofore known bits contact a wire convolution at successive points about the periph-

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ery of the convolution, the instantaneous compressive force which pushes radially against the wire and the terminal is generally great enough to produce lateral deflection of the terminal. Not only is the deflection-producing portion of the camming force ineffective to compress the wire against the terminal, but such terminal deflection may have the bad effects of loosening previously applied connections on the same terminal or bending the terminal to such an extent that the application of another wrapped connection to that terminal is difficult.

The object of this invention is to provide a bit having an improved wire contacting end face which produces these advantages:

(1) Wearing at the bit face is greatly reduced due to decreased unit pressures between the bit face and the wire.

(2) Higher compression of the wire against the terminal is realized while terminal deflection is reduced or eliminated.

(3) Overwrapping of convolutions is eliminated, or at least greatly reduced, due to radial containment by the bit face of that convolution which is in direct axial thrusting relation with the bit face.

SUMMARY OF THE INVENTION

In accordance with the present invention the above enumerated advantages are achieved by an improved wrapping bit having a novel wire-contacting socket or counterbore which substantially surrounds the terminal-receiving bore. The socket has a bottom wall surface comprising a helix having a lead which matches the lead of the helical convolutions of the wrapped wire connection. The depth of the helical socket is selected so that the cylindrical side wall of the socket is capable of contacting a major portion of a complete wire convolution disposed inside the socket. The side wall and the bottom wall are connected by a curved surface having a radius preferably the same as that of the wire. As a helical convolution is formed, the wall surfaces of the socket bear directly upon a major portion of a wire convolution. Thus the socket is advantageously shaped so that the bearing pressure of the bit against the wire is distributed over a large area thereby affording reduced unit pressures and prolonged life of the bit face.

Because the socket embraceably contacts substantially a complete convolution as it is applied to the terminal, undesirable lateral deflection of the terminal during the wrapping operation is largely eliminated. Moreover, radial camming force exerted by the side wall of the socket upon the wire is fully utilized to compress the wire against the terminal rather than to deflect the terminal.

Because of the substantial bearing area provided between the wire and the socket surface, the bit tends to align itself with the terminal and well known bad effects of operator misalignment of the tool and the terminal are obviated to a great extent.

Other objects and advantages of this invention will be apparent from the following specification and claims when read in conjunction with the accompanying drawings in which:

FIG. 1 is a view partly in section of a conductor-wrapping tool suitable for driving a bit constructed in accordance with the present invention;

FIG. 2 is an enlarged end view of a bit;

FIG. 3 is a section taken along lines 3-3 of FIG. 2;

FIG. 4 is a top view of the end portion of a bit;

FIG. 5 is a view similar to FIG. 2 showing a wire being wound on a terminal;

FIG. 6 is a fragmentary sectional view taken substantially along lines 6-6 of FIG. 5;

FIG. 7 is a view similar to FIG. 5 showing the bit after 90° of counterclockwise rotation;

FIG. 8 is a fragmentary sectional view taken substantially along lines 8-8 of FIG. 7;

FIG. 9 is a view similar to FIG. 5 showing the bit after 180° of counterclockwise rotation;

FIG. 10 is a fragmentary sectional view taken substantially along lines 10-10 of FIG. 9;

FIG. 11 is a view similar to FIG. 5 showing the bit after 270° of counterclockwise rotation;

FIG. 12 is a fragmentary sectional view taken substantially along lines 12-12 of FIG. 11.

In the drawings, the numeral 10 generally indicates a rotary tool including a housing 12 for a suitable rotary driver, such as an electric or pressure fluid motor, an integrally formed handle 14, and a trigger 16 for operating a motor control device. A guide sleeve 18 is detachably secured to a forwardly projected portion of housing 12 by a nut 20. A rotatable bit-driving member 22 is journaled within guide sleeve 18 and engages a mating rotatable element (not shown) which is operatively connected to the motor disposed in housing 12; and, a collet 24 extends into the forward end of guide sleeve 18 and is held therein against rotational and axial movement. A conductor wrapping bit, generally designated by numeral 28, is insertable into a tubular bit sleeve 30. When in properly assembled relation with collet 24 and bit-driving member 22 as shown in FIG. 1, the bit 28 is rotated with the bit-driving member 22 by the interlocking engagement of a pin 32 with a notch in an enlarged shank portion 36 of the bit 28. The bit sleeve 30 is held against relative rotational movement with respect to collet 24 by a collet nut 38 which compressively engages the bit sleeve 30 at its forward end. While abutment of the extreme rear end of bit sleeve 30 and the front face of shank 36 of the bit prevents axial displacement of the bit 28 with respect to sleeve 30, the shaft portion 40 of the bit 28 is freely rotatable within the bore of the surrounding sleeve.

A cylindrical bore 44 extends into the forward end of bit 28 and has a diameter and length sufficiently great to freely receive an electrical terminal T about which a wire conductor C is to be wound. In the illustrative embodiment, the terminal T is shown as a square metallic post; however, in practice, the configuration and dimensions of the terminal will vary to suit particular wiring applications. The terminal may be fixed to an insulating board, not shown, which carries a number of closely spaced terminals. To receive the stripped portion 48 of conductor C, the bit is provided with a groove 50 which is closed by the overlying bit sleeve 30. The groove 50 is longitudinally relieved on the peripheral surface of the bit to open axially to the end face 46 of bit 28 and is disposed in radially offset relation to the terminal receiving bore 44. An end portion of bit sleeve 30 which projects beyond the end face 46 of the bit 28 is provided with a pair of radially opposed slots 52 a selected one of which receives and retains an insulated portion of conductor C which is bent rearwardly along bit sleeve 30.

The aforementioned bit face 46 include a flat inner surface 54 to which the wire receiving groove 50 opens and a flat outer surface 56 which defines the extreme forward end of the bit 28. The surfaces 54 and 56 are parallel with one another and are perpendicular to the longitudinal axis of the bit. A counterbore, generally designated by numeral 58, substantially surrounds the terminal-receiving bore 44 in coaxial relation and comprises a bottom wall 60, a forwardly extending side wall 62 and a curved surface 64 connecting the walls 60 and 62. The inner and outer surfaces 54 and 56, respectively, are connected by walls 66 and 68 disposed on either side of the wire-receiving groove 50. As viewed in FIG. 5, for example, the inner face 54 and the walls 66 and 68 define an axial relief or slot in the bit face 46 which provides an opening into the counterbore 58 for accommodating the passage of wire from the groove 50 into the coun-

terbore for application to the terminal T in a manner to be described.

An important structural feature of this invention resides in the provision of a wire-contacting counterbore 58 having a bottom wall surface 60 which is helically arranged about the longitudinal axis of the terminal-receiving bore 44. FIGS. 2, 3 and 4 show that the helix of the bottom wall 60 advances axially forwardly from the inner surface 54 toward the outer surface 56 and surrounds a substantial portion of the perimeter of the wire-receiving bore 44. The beginning point or low point of the bottom wall helix, indicated at numeral 70, occurs in a line of intersection of the bottom wall 60 with inner surface 54, and the bottom wall helix rises to and terminates at a high point occurring at the intersection of the bottom wall with the wall 66, as indicated at numeral 72. In the illustrative embodiment shown in the drawings, the angular extent of the bottom wall 60 is approximately 250° from point 70 to point 72. To realize the maximum benefits of this invention, the angular dimension, i.e. the length, of the bottom wall should be as great as possible and limited only by the spacing of the walls 66 and 68 necessary to pass the wire to the counterbore 58 or by the entrance requirement of a suitable machine tool for forming the counterbore. However, substantial performance improvement over known wrapping bits can be expected even if the helix of the bottom wall extends only about 180°. The lead of the bottom wall helix is selected to conform substantially to the lead of the helix of the wire convolutions of the wrapped connection and can readily be calculated from the wire diameter and the cross sectional dimensions of the terminal.

The side wall 62 of the counterbore 58 comprises a segment of a right cylinder coaxial with the terminal bore 44. As indicated above, the side wall 62 is open between the walls 66 and 68 to afford the wire access to the counterbore 58. Due to the helical advance of the bottom wall 60 of the counterbore 58, the axial dimension of the side wall 62 progressively changes from a maximum at the low point 70 of the bottom wall to a minimum at the high point 72 of the bottom wall. However, for reasons to be explained, it is preferable that the axial dimension of the side wall 62 be selected with respect to the diameter of the wire C to provide bearing contact between the side wall and the wire about most of the periphery of the counterbore 58. The diameter of the counterbore side wall 62 is less than the sum of twice the wire diameter plus the diagonal dimension of a transverse cross section of the terminal T. Thus the side wall 62 is dimensioned with respect to the terminal and the wire to compress the wire radially against the terminal whereby the wire is deformed or notched at each sharp corner of the terminal. The degree of compression exerted by the side wall, hence the wall diameter, is selected with reference to such factors as the type of wire and terminal materials employed, the size of the electrical contact area required between the wire and the terminal, the degree of mechanical tightness needed in the connection; and, the radially applied restraining force required to prevent overwrapping of wire convolutions.

Hereinbefore the bottom wall 60 and the side wall 62 have been described as discrete right angled surfaces having direct contact with the wire C; however, the present invention essentially contemplates that the counterbore 58 have surface means capable of applying forward axial thrust and radial compression to a portion of the wire convolution being formed inside the counterbore. FIGS. 5 through 12 show that these functions of the counterbore 58 are performed not only by the bottom wall 60 and the side wall 62, but that the curved surface 64 contacts the wire in the counterbore and exerts a compressive force against the wire surface having both axial and radial components. The radii of the surface 64 and the wire should conform in order to achieve

maximum surface-to-surface sliding contact therebetween. Thus it will be understood that the interior surface of the counterbore 58 could comprise a single curved wall extending from the terminal-receiving bore 44 to the outer bit face surface 56. In this case it would be appropriate to describe the counterbore 58 as having a curved interior wall helically disposed about the axis of the terminal-receiving bore 44.

The advantages afforded by the present invention will be better understood from the following description of the operation of the tool 10. The end portion 48 of conductor C is stripped and inserted into groove 50 while an insulated portion of the conductor is bent into anchored position within a slot 52 and is manually held against the exterior surface of the bit sleeve 30. The tool 10 is then moved forwardly to insert the end of terminal T into bore 44; and, the tool motor is energized by depressing trigger 16. The bit 28 and its end face 46 will then revolve within the bit sleeve 30 and about the stationary terminal T. The stripped portion 48 of conductor C will be withdrawn from groove 50; and, successive convolutions thereof will be wrapped around terminal T until the extreme end of the conductor C is withdrawn. As thus far described, the winding operation is somewhat similar to the operation of prior art devices for applying a conductor to a terminal; however, the following detailed description of the action of the improved bit face 46 will point out certain essential features of the invention unattainable in prior art devices.

FIGS. 5 through 12 show angular positions of the bit face 46 and the counterbore 58 with respect to the wire at ninety degree increments of counterclockwise rotation of the bit 28. As viewed in FIG. 5, the wire is drawn forwardly and downwardly from the groove 50 over the inner surface 54 between the walls 66 and 68 and into the counterbore 58. As the wire is applied to the terminal it forms a natural helix having a lead determined by the size of the wire and the size and shape of the terminal; and, the lead of the helix defined by the counterbore 58 is selected to conform substantially to the helix of the wire convolutions. FIG. 12 shows that as the wire enters the rotating helical counterbore 58, it is engaged by the surfaces 60, 62 and 64 at the low point 70 of the helix whereupon the counterbore will begin to bear upon the wire and to impart forward axial thrust and radial compression to the wire. The forward axial thrust insures that the wire is urged tightly against the preceding convolution to avoid a so-called "open helix" in the finished connection. The radially compressive component of the force imparted initially by the counterbore 58 to the wire presses the wire inwardly toward the terminal. As will be understood from FIGS. 5 through 12, the low point 70 of the counterbore will sequentially engage successive portions of the wire to provide initial axial and radial compression of each wire convolution. Thereafter, the initially engaged portion of the wire will remain in sliding contact with the counterbore surface until the helical advance of the wire convolution causes the initially engaged portion to disengage from the axially retracting bit face 46 at the high point 72 of the counterbore helix. It will also be understood that, as each convolution is being formed, it is preferable that the entire surface of the counterbore be in sliding engagement with the convolution thereby continuously imparting axial and radial compression to the entire portion of the convolution which is engaged by the counterbore. As the counterbore surface rides over the wire portions overlying the sharp corners of the terminal, these overlying portions are compressed into deforming engagement with the corners to a desired degree predetermined by the dimensions of the terminal, the wire and the counterbore.

From the foregoing description of the structure and operation of the wrapping bit 28, it will be understood that the counterbore 58 is shaped and dimensioned to provide a socket in the bit face 46 which surrounds a

major portion of a wire convolution; and, upon the application of axial thrust and rotation to the bit, the interior socket surface operates on the wire convolution to apply the wire to a terminal in an improved manner. The principal distinguishing features of the socket defined by the counterbore 58 are the helical advance of its wall surface with the helix of the wire convolution and the substantial extent of the angular embrace of the socket wall about the perimeter of the wire convolution. These distinguishing features coact to provide generous bearing contact between the socket and the wire convolution whereby the unit bearing pressure of the bit face upon the wire is at a low level and rapid wearing and spalling of the bit face is avoided. The compressive embrace of the socket 58 about the wire convolution also produces a wrapped connection devoid of poor characteristics caused by lateral terminal deflection. Instead, the socket steadies the terminal and the wire convolution and converts bit thrust and rotation into well distributed compressive forces urging the wire into notching relation with the terminal corners. Moreover, the embracing relation of the socket and the wire convolution prevents radial separation of the embraced convolution from the terminal even under conditions of extremely high axial bit pressures which tend to produce overwrapping. Still another advantage produced by the bit socket is that the socket 58 embraceably contacts the wire convolution over a sufficient area of the latter to urge the bit 28 into proper coaxial alignment with the terminal. This characteristic of the bit greatly reduces the influence of an inexperienced or inattentive tool operator upon the quality of a finished connection.

While the bit 28 has been shown and described as having particular utility when employed in hand-held, motor-actuated tools, it will be appreciated that the invention is not limited to a particular type of wrapping device. Wrapping bits of this type are well suited for use in automatic multibit wiring machines as well as in manually rotated tools. Since the invention resides primarily in the novel bit face configuration, many different types of special wrapping bits may incorporate this invention without interfering with such known special features as lateral loading of the conductor into the bit, combined insulation stripping and wire wrapping operations, et cetera. Moreover, it will be understood that the above description and accompanying drawings comprehend only the general and preferred embodiment of the bit face and that various changes in the construction, proportion and arrangement of the various bit face surfaces may be made without sacrificing any of the enumerated advantages of the invention.

What is claimed is:

1. A bit for wrapping a wire about a terminal in helical convolutions comprising:

- (a) a bit end face;
- (b) a terminal-receiving bore in said end face; and,
- (c) said end face defining a wire-contacting counterbore for said terminal-receiving bore;
- (d) said counterbore having a bottom wall and a side wall joined by an arcuate surface;
- (e) said bottom wall being helically arranged with respect to the axis of said terminal-receiving bore; and
- (f) said arcuate surface having a radius generally conforming to the radius of said wire.

2. The bit according to claim 1, wherein:

said counterbore compressively embraces a major portion of the periphery of a wire convolution whereby said wire convolution is pressed radially against the terminal.

3. The bit according to claim 1, wherein:

- (a) said bit face includes axially spaced inner and outer surfaces; and,
- (b) said bottom wall rises helically from said inner surface toward said outer surface.

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4. The bit according to claim 1, wherein:
said bottom wall has a helical lead generally conform-
ing to the lead of the helical wire convolutions
wrapped by said bit about said terminal.
5. The bit according to claim 1, wherein:
the diameter of said counterbore is less than that of a
wire convolution.
6. The bit according to claim 1, wherein
the helical bottom wall extends about a major portion
of the periphery of said terminal-receiving bore.
7. The bit according to claim 1, wherein:

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the bottom wall extends through an arc of approxi-
mately 250°.

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