

[54] **WIRE WRAPPING APPARATUS WITH
TERMINAL DETECTOR**

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[22] Filed: **Sept. 27, 1973**

[21] Appl. No.: **401,390**

[52] U.S. Cl. **29/203 B; 29/203 DT; 29/208 C**

[51] Int. Cl. **H05k 13/04; H01r 43/04**

[58] Field of Search **29/203 B, 203 DT, 203 TS,
29/203 D, 208 C**

[56] **References Cited**

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[57] **ABSTRACT**

An apparatus for wrapping wire on a terminal is pro-

vided with a sensing rod extending through the center of the wire attaching tool to detect the proper working relationship of the tool with respect to the terminal. The tool includes an elongated bit element and an inner wrapping sleeve, which rotate to wrap the wire, and an outer stationary sleeve to protect adjacent wrapped terminals. A pneumatic cylinder shifts the sleeves to load the stripped wire in a groove in the bit element and longitudinally extending slots are provided in the sleeves for allowing the stripped end to move into the groove. A motor is provided for rotating the tool to effect the wrapping on the terminal. On the sensing rod, a first end extends into a central bore of the bit element that receives the terminal, and the opposite or second end of the rod responsively operates a spring biased piston, in turn tripping a stationary mounted photo-cell switch. The photo-cell activates an interlock means in the control circuit to enable the proper operation of the motor, i.e., only when the terminal is properly inserted in the bore.

13 Claims, 4 Drawing Figures

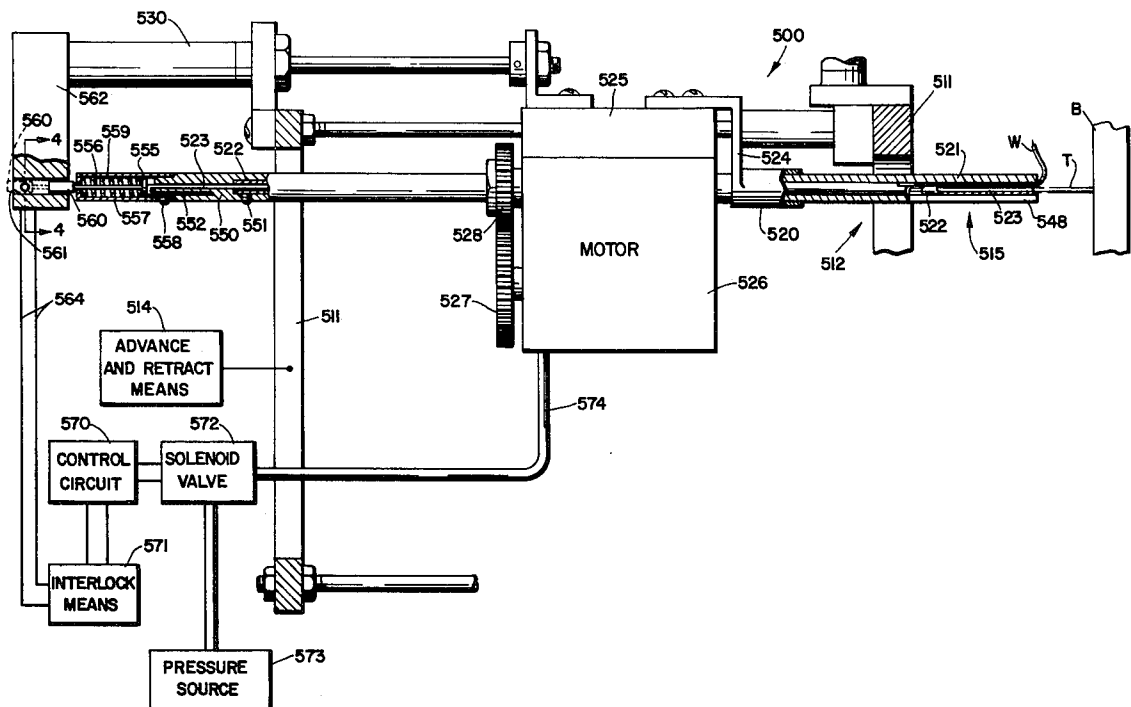


FIG. 1

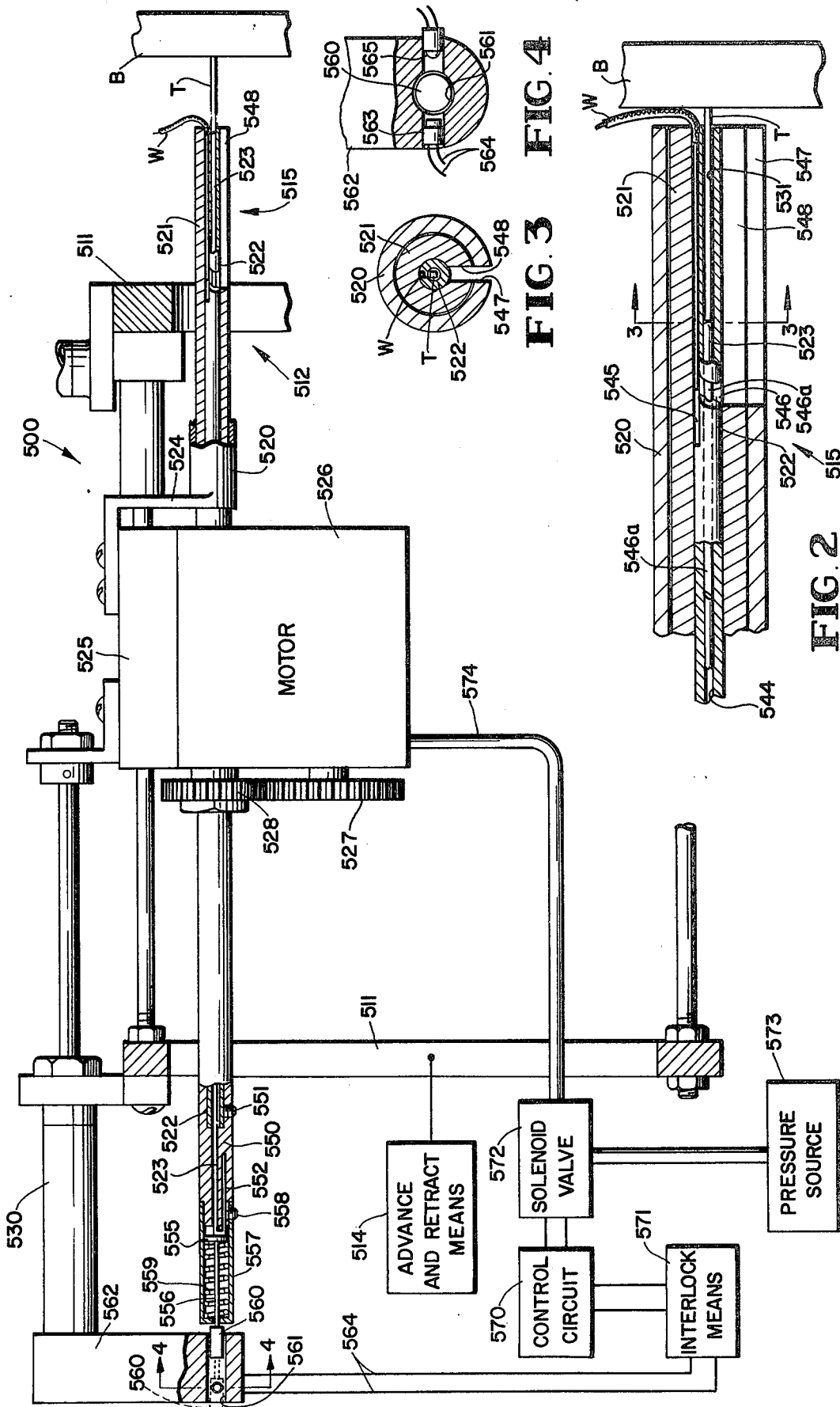
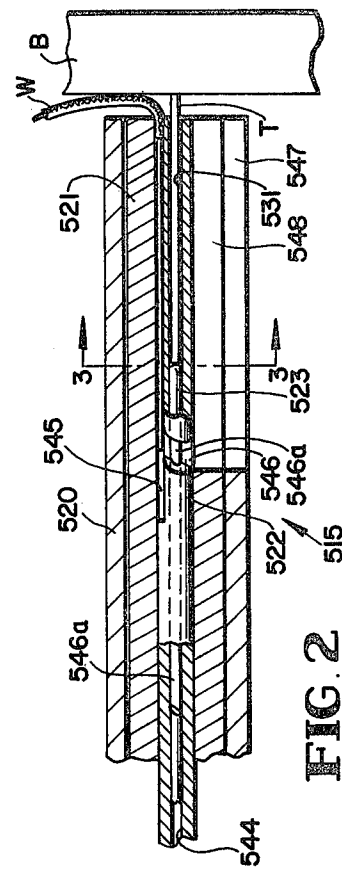


FIG. 3

FIG. 4

FIG. 2



WIRE WRAPPING APPARATUS WITH TERMINAL DETECTOR

FIELD OF THE INVENTION

The present invention relates to apparatus for attaching conductors to terminal boards, and more particularly, to apparatus for assuring proper wire wrapping of stripped ends of wires on electrical terminals.

BACKGROUND OF THE INVENTION

The making of solderless wrapped connections on electrical terminals is a standard in the electronics industry for interconnecting all types of electrical circuitry, such as in computer and in communication circuits. There have been provided in the past many ways proposed for making the wrapped connections. These may be generally classified as: (1) manual, utilizing a rotary driving tool; (2) semi-automatic, utilizing the same type of hand tool, but with automatic position pointers for the operator; and (3) automatic, utilizing mechanical means for both the location identification and the tool activation. In all three types of operations, but particularly in the third category mentioned, there has existed a problem of improper activation of the rotating tool; i.e., rotating the tool prior to the bit being properly positioned on the terminal to be wrapped. If the tool is activated prior to the terminal being inserted into the axially extending bore in the end of the bit element, the wire rotates uncontrollably and either becomes tangled in a helical coil, if the tool is not on a terminal at all, or the wire wrap may be made at an improper Z-level if the tool is on the terminal, but just not seated properly. In either situation, the wrapping operation must be interrupted, the wire replaced, and the tool reloaded before the procedure can be reinstituted, with consequent loss of valuable production time. Particularly in automatic machines, the computer controlled sequencing is also interrupted, and the possibility exists that when the machine is restarted improper connection of terminals is caused and thus a complete inoperative terminal board may be wired and must be destroyed.

Perhaps the greatest single cause of the tool not properly picking up the terminals as it moves in to perform a wire wrapping operation is bent terminals, i.e., a terminal that has been slightly bent from the normal or perpendicular relationship with respect to the board being wired. There are also occasions when improper or inadequate "zeroing" of the machine occurs, or simply when human error enters the picture in the manual type operation and the motor is prematurely activated on the hand tool.

OBJECTIVES OF THE INVENTION

Thus, it is a main object of the present invention to provide a wire attaching apparatus wherein a precedent requirement to activation of the tool is detection of the proper working relationship of the tool with respect to a reference, such as the terminal to which the wire is to be attached.

It is still another object of the present invention to provide a sensing means associated with the tool such that the tool may be reliably operated, either in a hand or automatic mode, only when the terminal receiving bore of the tool is properly engaged on the terminal.

It is still another object of the present invention to provide an improved wire wrapping apparatus with a simple sensing means including an axially extending sensor rod housed within the bit element of a wire wrapping tool.

BRIEF DESCRIPTION OF THE INVENTION

In accordance with the present invention, a wire attaching apparatus is provided with a simple, fool-proof sensing means for determining the proper relationship between the tool and the terminal to which the wire is being attached before the means for activating the tool may be operated. More specifically, the present invention relates to a wire wrapping apparatus with terminal sensor means that is incorporated directly into a wire wrapping tool and serves to mechanically detect the proper working relationship between the tool and the terminal. To assure that the main control circuit actually performs the initiation of the wrapping operation so that the sequencing integrity and proper Z-level location is maintained, an interlock means is imposed as an interface between the sensing means and said control circuit.

The rotary wrapping tool disclosed includes an elongated bit element, an inner wrapping sleeve, and an outer protector sleeve. The usual terminal receiving bore is formed in the face of the bit element, and in accordance with the invention, the sensing means advantageously includes an axially shiftable rod housed along the center axis of the bit element. The first end of the rod extends into the receiving bore to sense the end of the terminal and switch means is actuated by axial movement of the rod upon engagement.

The sensor rod, in accordance with more specific features of the present invention, extends through the bit to a second end to engage a linkage means in the form of an axially shiftable piston and spring means. An actuator cylinder for the switch means is carried by the piston rod of said piston. The switch means comprises a photo-cell that is connected to the interlock means in the control circuit, which in turn allows operation of a solenoid valve for providing air pressure to rotate the tool driving motor.

The second end of the sensor rod includes another important feature in the form of a reverse offset extension member in a guide block. This element prevents relative rotation between the rod and the guide block for assuring accurate operation, to prevent interference with the wire during loading, and to limit the axial movement of the rod under the spring bias of the spring associated with the linkage piston. The actuator cylinder carried on the rod of the piston is sufficiently long to assure tripping of the photo-cell on at least two Z-levels of wire attachment to the terminal. The wrapping tool may include the groove for housing the stripped wire in the bit element with a slot in each of the sleeves to permit loading of the wire by movement into said groove.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein I have shown and described only the preferred embodiment of the invention, simply by way of illustration of the best mode contemplated by me of carrying out my invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modification in various

obvious respects, all without departing from the invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

DESCRIPTION OF THE DRAWING

FIG. 1 is a partial side view of a wire wrapping apparatus, partially in cross-section, showing the preferred embodiment for carrying out the principles of the present invention;

FIG. 2 is an enlarged cross-sectional view of the wrapping tool and showing the relationship of the tool on the terminal in readiness for the wrapping operation;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2 with the stripped wire lying in position in the groove for wrapping; and

FIG. 4 is a partial cross-sectional view taken along line 4—4 showing the preferred photo-cell switching means.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to FIG. 1 of the drawings for a more detailed look at the preferred embodiment shown for illustrating the principles of the present invention, there is provided a wire wrapping apparatus or head, generally designated by the reference numeral 500. The wire wrapping head includes a main frame 511 shown in part in this figure. Within the main frame is provided a wire catching and loading means, partially shown and generally designated by the reference numeral 512. An advancing and retracting means for the head 500 is shown schematically at 514. The wire wrapping head also normally includes a stripping and cutting means for the wire, however, this is not shown in the present drawings since a showing is not required for a general understanding of the present invention. It should be understood that the broad inventive concepts disclosed herein, while applicable to incorporation in the automatically operable embodiment shown, said concepts are equally useful in hand tools for manual and semi-automatic operations, mentioned above.

Thus, with this in mind and proceeding to describe FIG. 1, there is shown a suitable terminal board B with a terminal or pin *t* extending normally outward from the face of said board. It is to be assumed that a wire W is to be wrapped on the terminal *t* so as to make an acceptable electrical connection, as discussed in my previous application. The wire W is shown as already stripped and loaded in a rotary wire wrapping tool 515, which is preferably of the side loading type. The tool 515 is of the concentric type, that is, it is to receive the terminal *t* along the central longitudinal axis and is to rotate about said central axis. This permits wrapping the wire W without up and down vibration of the tool and does away with any requirement for special means for accommodating such movement and generally gives superior results, also as further discussed in my previous application.

As perhaps best illustrated in the enlarged view of FIG. 2, said tool 515 includes a stationary outer sleeve 520, an inner sleeve 521, a bit element 522, and finally a sensor rod 523; all parts being concentric, as shown. The stationary sleeve 520 is adapted to be held against rotation by a bracket 524 mounted on an axially moveable carriage 525, which serves to load the wire end,

also as illustrated (FIGS. 1 and 2). The inner sleeve 521, the bit element 522, and the sensor rod 523 are adapted to be driven in unison by motor 526 carried on the carriage 525. The gears 527 and 528, and suitable keying means (not shown) between the gear 528 and the sleeve 521, complete the rotary driving mechanism.

As is evident to those skilled in the art, after the wire W has been loaded in the tool 515 by the forward shifting action of the carriage 525 by pneumatic cylinder 530, the advancing and retracting means 514 is activated to relatively move the entire head 500 with respect to the terminal *t*. This action brings the tool 515 first to the intermediate position shown in FIG. 1, and finally to the operational position, shown in FIG. 2. In the intermediate position, the forward face of the tool 515 just touches the tip of the terminal *t*. Assuming that the terminal *t* is not bent, and that the *x-y* locator (not shown) for the head 500 has properly performed its operation, the terminal *t* is thus positioned properly for receipt into bore 531 of bit element 522 (see FIG. 1). In the final operational position (see FIG. 2) the proper relative position for wrapping the wire W is reached; that is, the position with the terminal *t* fully enclosed in said bore 531. It will be understood that the showing of FIG. 2 assumes the wrapping operation is to take place at the first Z-level, that is adjacent the face of the board B. As will be further understood, when wrapping at other Z-levels (such as the second and third Z-levels) is required, the head 500 is simply stopped between the initial contact position of FIG. 1 and the first Z-level position of FIG. 2 by some outside operating means (not shown).

The sensor rod 523 operates switch means (to be fully described below) and thus serves the important function of assuring that the terminal *t* is properly received (at the desired Z-level) in the bore 531. The sensor rod 523 forms with other elements to be described below, a unique and highly simplified sensing means that is not only low in cost of manufacture, but highly sensitive and reliable in operation. If the terminal *t* is not within the bore 531, no longer will the tool be allowed to proceed to rotate causing tangled wires where a terminal *t* has not been engaged, or an improper wrap where the terminal has not been fully engaged. Down time of wrapping stations or machines due to this problem is eliminated thereby greatly enhancing the production capabilities of any installation.

Proceeding with describing of more details of the inventive apparatus, the first end of the sensor rod 523 is located at the working end of the tool 515 and is axially slideable in bore 544 extending rearwardly of the terminal receiving bore 531 and mating exactly therewith. Radially spaced from the bore 544, 531 is a parallel groove 545, which holds the stripped end of the wire W in position ready to be wrapped on the terminal *t* when the tool is rotated by the motor 526. Notch 546 on the bit element is for positioning the wire W just before loading, and it is to be understood that if necessary, the rod 523 may be correspondingly notched. Such a notch 546a in the rod extends sufficiently along the length so as to be always contiguous with the notch 546 regardless of the axial position of said rod 523. In other words, the notch 546a in the rod is at least the length of the notch 546, plus the length of travel of the rod 523 during the sensing operation. This feature does allow the radial dimension of the tool to be kept to a minimum to facilitate operation on a circuit board with

closely spaced terminals. The tip of the stripped end of the wire W may lie in the notch 546 as the tool is moved on the terminal without fear of interference by the rod 523 with this construction.

Slots 547, 548 on the outer and inner sleeves 520, 521 respectively, are aligned at the bottom of the tool by the indexing means (not shown herein, but described in my prior application) to allow the wire to move through the notch 546 and into the groove 545. The slot 548 moves from alignment with the slot 547 as the rotation for wrapping occurs, but is of course realigned when the next indexing operation occurs on the next wrapping cycle. The stationary sleeve 520 prevents the edges of the slot 548 from hitting and cutting insulation of wires on adjacently wrapped terminals during rotation of the tool 515 thereby obviating a serious problem of the past. The stationary sleeve 520 thus serves as protection for the adjacent wires. In addition, the sleeve 520 serves as a stabilizing guide for the rotating parts of the tool, and as a protective casing for the parts.

With the first end of the axially shiftable sensor rod 523 located and functionally associated with the adjacent parts of the tool 515 and the operation of the tool itself fully explained above, reference can now be made to the opposite end of said tool, shown at the left hand side of FIG. 1. Thus, the second or opposite end of the rod 523 emerges from the bore 544 at the end of the bit element 522. Encompassing said second end of the sensor rod 523 is a guide block 550 fixed against relative rotation and axial movement with respect to the bit element 522 by a suitable set screw 551. A reverse offset extension member 552 is provided at the very end of the sensor rod 523 and this member is engaged in an offset bore (not numbered) in the face of the block 550. This arrangement prevents relative rotational movement of the rod with respect to said guide block 550 and, in turn, with respect to the bit element 522. This function is particularly important in the instance where the rod 523 must be notched along its length in order to mate with the loading notch 546 (see FIG. 2).

The linkage means between the switch to be controlled and the described second end of the sensor rod 523 takes the form of a slideable piston 555 with piston rod 556 housed and guided in guide cap 557, mounted on a shoulder of the guide block 550 and fixed by set screw 558. A spring 559 is positioned inside the cap 557 so as to urge the piston 555, and in turn the rod 523, forwardly or toward the first end. In operation, it will be understood that when the terminal t is properly engaged and the sensor rod 523 has been shifted axially rearwardly, the spring 559 is compressed. Pressure is thus constantly exerted to move the rod 523 back to the original position (FIG. 1) so that when the tool has been backed off the terminal t (subsequent to the wrapping operation), the switch means is automatically deactivated. No further resetting is required for the next tool sensing operation and subsequent wrapping operations may proceed.

To actually perform the switching operation, an actuator cylinder 560 is positioned on the tip of the piston rod 556, which cylinder is adapted to move freely in a passage 561 formed in a stationary housing block 562. As best shown in FIG. 4, the switch means that is operated by the cylinder 560 is a photo-cell switch 563. The photo-cell is positioned to look across the passage 561 where interception of a light beam from light source

565 occurs when the cylinder 560 is shifted to the dotted line position (shown in FIG. 1). This represents movement of the tool 515 by the advancing and retracting means 514 full on the terminal t (shown in FIG. 2); the photo-cell 563 thereby being tripped and an electrical signal being transferred over leads 564 to control circuit 570. It should be noted that the actuator cylinder 560 initially trips the photo-cell 563 prior to being positioned at the dotted line position of FIG. 1, and as will be realized, this feature permits the sensing means to also operate when the second and/or third Z-levels are to be wrapped. The only change in the mode of operation is that the light beam is intercepted in the final position by the middle and opposite end of the cylinder 560, respectively.

Preferably, the control circuit 570 through interconnecting means that includes an interlock means 571 and the leads 564 are connected to the photo-cell switch 563. This assures that the exact point of interruption of the light beam is not critical since the control circuit 570, not the photo-cell switch 563, actually initiates the actuation of solenoid 572 by the proper built-in sequencing and timing. The interlock means 571 serves to disable the control circuit 570 from operating said solenoid 572 when the terminal t is not properly positioned in the bore 531. The solenoid 572 is operable to control the supply of pressurized air from pressure source 573 through transfer conduit 574 to the motor 526.

Briefly summarizing the operation, when a terminal t is detected by the sensor rod 523, the cylinder 560 blocks the light path and trips the photo-cell switch 563. The interlock means 571 enables the control circuit 570, and in turn, the solenoid 572 is properly actuated in sequence by said control circuit to open the valve for air pressure to drive the motor 526 and thereby rotate the tool 515. The important factor is that only under the condition of the photo-cell 563 being tripped can the motor 526 be actuated in accordance with the present invention, and therefore false or improper wrapping operations are avoided.

It is to be understood that the apparatus of the preferred embodiment described hereinabove may be modified or changed in certain respects without departing from the basic broad principles of the present invention. For example, different wrapping tools with different structural parts and/or operating surfaces and different types of sensing means and switch means may be used if desired. Accordingly, it is to be understood that the invention is capable of use in such various other combinations and environments and is capable of changes or modifications within the scope of the inventive concept as expressed in the following claims.

What is claimed is:

1. In a wire attaching apparatus for connecting a wire end to a terminal including a wire attaching tool adapted to relatively move with respect to said terminal into working relationship, and means to activate said tool to provide the connection, the improvement comprising sensing means associated with said tool to detect the proper working relationship of said tool with respect to said terminal and means interconnecting said sensing means to said activating means to assure operation only when said tool is properly positioned.

2. In the wire attaching apparatus of claim 1 wherein said interconnecting means includes interlock means responsive to said sensing means for enabling operation

of said activating means only when the proper relationship between said tool and said terminal is provided.

3. In the wire attaching apparatus of claim 1 wherein said tool is a rotary wrapping tool including an elongated bit element and wrapping sleeve, and said sensing means includes an axially shiftable rod housed in said bit element, a bore in one end of said bit element to receive said terminal, a first end of said rod extending into said bore, and switch means actuated by axial movement of said rod upon engagement of said first end with said terminal.

4. The apparatus of claim 3 wherein said rod includes a second end extending from the end of said bit element opposite said one end, said switch means being operative in response to movement of said second end.

5. The apparatus of claim 4 wherein is further included linkage means between said second end and said switch means, spring means to bias said linkage means and said rod in the direction of said first end.

6. The apparatus of claim 5 wherein is further included a reverse offset extension member on said rod adjacent said second end, a guide block mounted on said bit element, and an offset bore in said block receiving said extension member to prevent relative rotational movement of said rod with respect to said guide block and to limit axial movement of said rod toward said first end.

7. The apparatus of claim 5 wherein said linkage means includes a piston member abutting said second end, a guide cap slideably enclosing said piston attached to said guide block and an actuator cylinder on the piston to operate said switch means.

8. The apparatus of claim 7 wherein said switch means includes a photo-cell, means for generating a light beam directed toward said photo-cell, said actuator cylinder serving to break said light beam.

9. The apparatus of claim 8 wherein said actuator cylinder is sufficiently long to assure tripping of said photo-cell on at least two levels of wire attachment to said terminal.

10. A wire wrapping apparatus for connecting a wire with a stripped end to a terminal comprising a rotary wire wrapping tool, including an elongated bit element and inner wrapping sleeve on the same, a bore in the end of said bit element for receiving the terminal, means to relatively move said tool and said terminal into working relationship with said terminal inserted in said bore, a stationary outer sleeve, a longitudinally extending groove in said tool and slot in at least said inner sleeve for receiving the stripped end, motor means for rotating at least said inner sleeve to wrap the wire on said terminal, control means for activating said motor means, and sensing means associated with said tool to detect the proper insertion of said terminal in said bore and to responsively operate said control means, whereby operation of said motor means and rotation of said inner sleeve is permitted only when wrapping on said terminal may take place.

11. The apparatus of claim 10 wherein said control means includes interlock means responsive to said sensing means for enabling operation of said motor means only when said terminal is properly inserted in said bore.

12. The apparatus of claim 10 wherein said sensing means includes an axially shiftable rod in said bit element, said bit element including a side loading notch and corresponding elongated notch means in said rod.

13. The apparatus of claim 12 wherein said notch means is sufficiently long to obviate interference with said wire during the loading and wrapping operations.

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