June 1, 1965 R. F. COBAUGH 3,186,078

APPARATUS FOR MAKING ELECTRICAL CONNECTIONS

Filed May 21, 1963 3 Sheets-Sheet 1

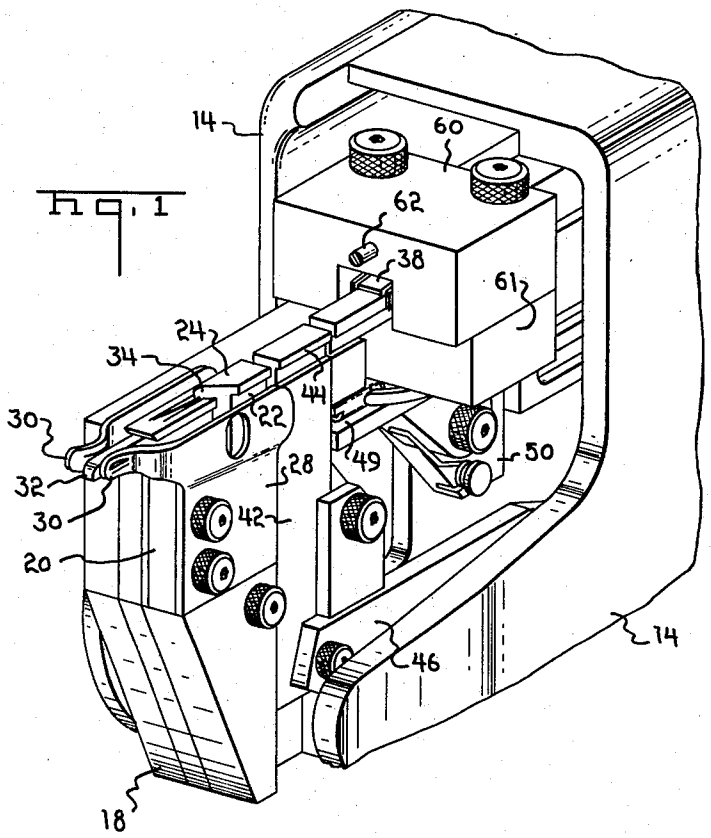

Fig. 1

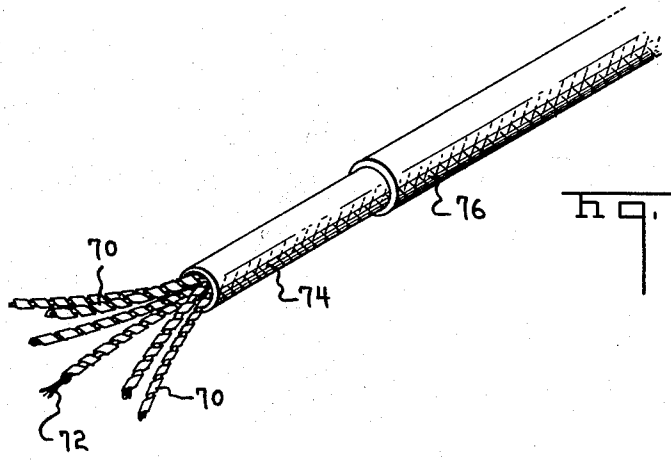

Fig. 10

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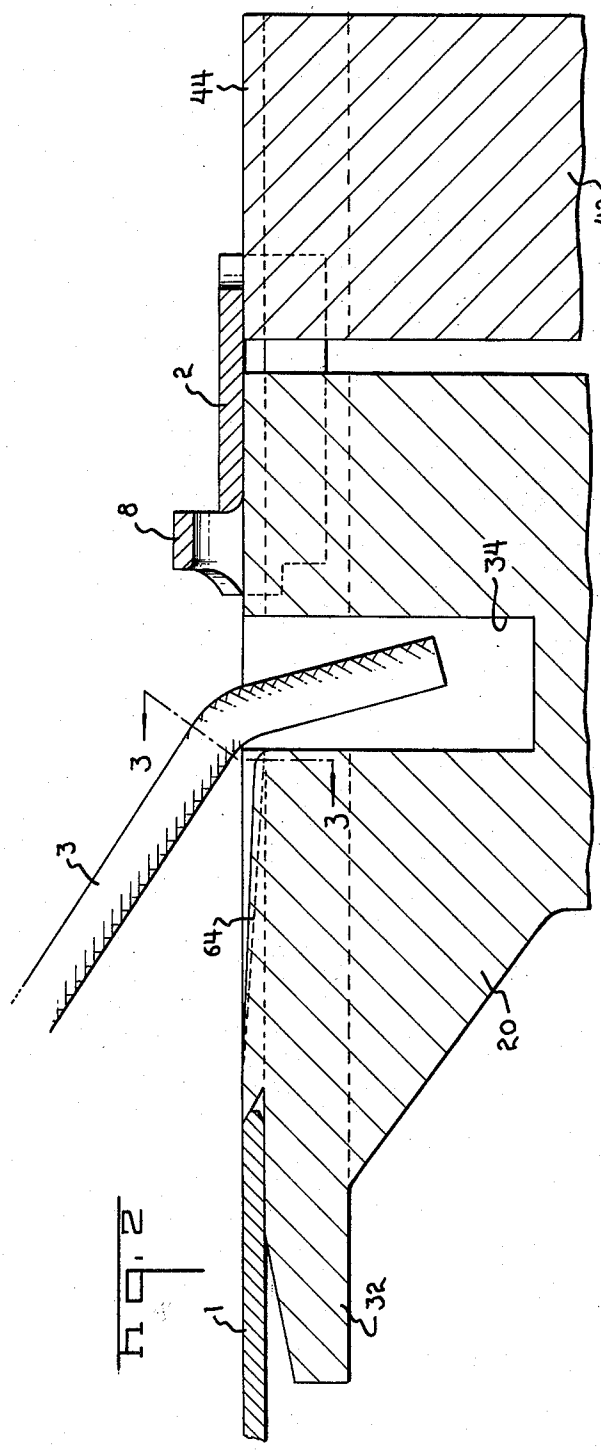

Fig. 2

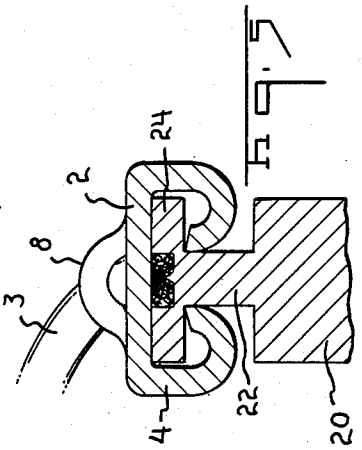

Fig. 5

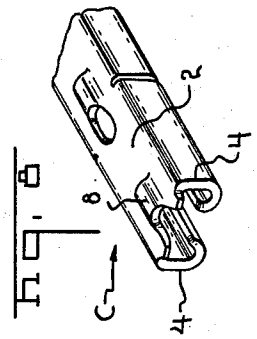

Fig. 6

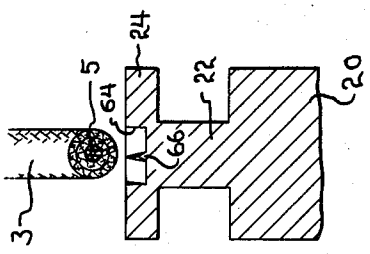

Fig. 7

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Fig. 4

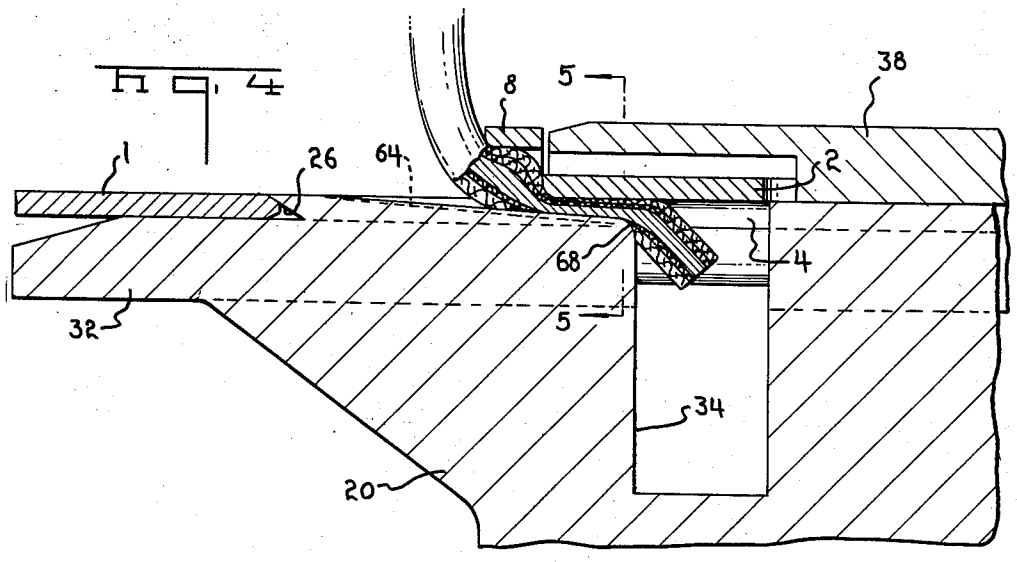
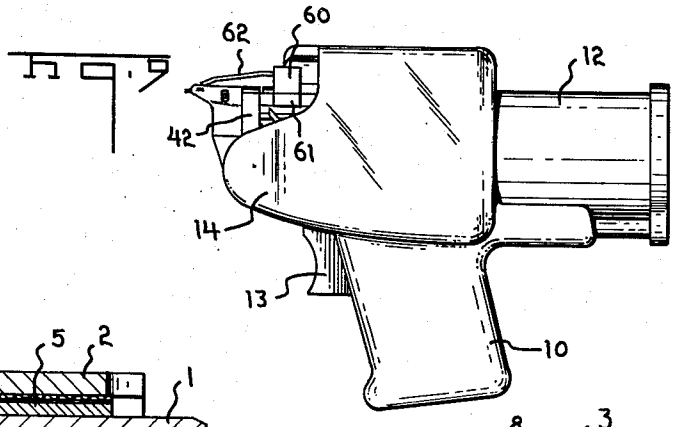


Fig. 5



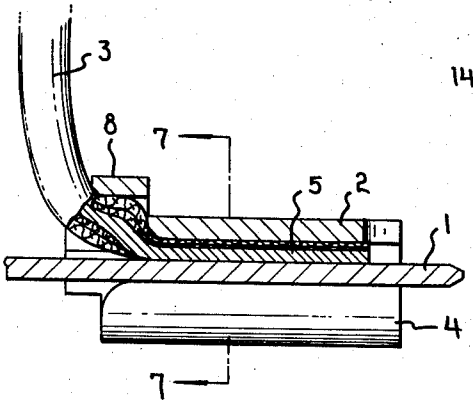


Fig. 6

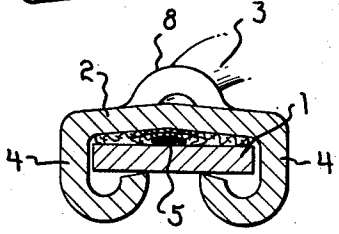


Fig. 7

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APPARATUS FOR MAKING ELECTRICAL CONNECTIONS

Robert F. Cobaugh, Hershey, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Filed May 21, 1963, Ser. No. 282,092
7 Claims. (Cl. 29—203)

This application is a continuation-in-part of my co-pending application Serial Number 171,074, filed February 5, 1962, for Electrical Connections.

This invention relates to apparatus for forming an electrical connection between a conductor and a terminal post.

In my co-pending U.S. patent application Serial Number 171,074, I disclose a method and apparatus for making electrical connections between a terminal post and an insulated wire by positioning a mandrel in alignment with the post and sliding an open-sided terminal clip over the mandrel and onto the post. The mandrel is provided with an opening extending transversely of the path of movement of the clip into which the end of the wire is inserted. In accordance with one embodiment of the invention of application Serial Number 171,074, a groove is provided on the surface of the mandrel which has a cross sectional area which is substantially equal to the cross sectional area of the conducting core of the wire so that as the clip moves past the wire, the insulation of the wire is cut by the edges on each side of the groove. Thereafter, and upon further movement of the clip towards the terminal post, the conducting core of the wire is withdrawn from the severed section of insulation so that after the clip comes to rest on the terminal post, the stripped end of the wire is held against the surface of the post by the clip. Application Serial Number 171,074 discloses several additional embodiments in which the mandrel is not used and in which the wire insulation is stripped prior to making the electrical connection. The foregoing brief description of one embodiment of the invention of Serial Number 171,074 is presented only as background information to the description of the present invention which follows.

The present invention relates generally to an apparatus in accordance with the general teachings of application Serial Number 171,074 where stripping of the insulation cannot be carried out in accordance with the teachings of application Serial Number 171,074 and/or complete stripping of the insulation from the wire is not desired. The present invention is useable with most types of insulated wires and has particular utility where it is necessary to form an electrical connection between a terminal post and a wire of the type commonly known as "tinsel wire" since wire of this type is not amenable to conventional insulation stripping techniques.

It is accordingly an object of the invention to provide an improved apparatus for forming electrical connections between insulated wires and terminal posts. It is a further object of the invention to provide an apparatus for forming electrical connections which does not require stripping of the insulation from the wire. A further object of the invention is to provide an apparatus for forming an electrical connection between a terminal post and a tinsel wire. A further object is to provide an apparatus for forming electrical connections between a wire and a terminal post in which the conducting core of the wire is brought into contact with the post and the insulation of the wire surrounds and seals the connection.

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These and other objects of the invention are achieved in a preferred embodiment in which the generally channel-shaped connector clip is moved past a transversely extending wire and onto the terminal post with which the connection is to be made. During such movement of the clip, its leading end engages the wire and drags it relatively towards the terminal post. In a preferred embodiment, an insulation severing knife is provided on the path of movement of the wire and is so located that the end portion of the insulated wire moves relatively over and along the knife edge so that an axial slit is formed in the wire insulation. Thereafter, the wire is compressed by the clip against the surface of the terminal post in a manner such that the insulation is flattened and the axial slit becomes an elongated axial gap exposing the metallic core of the wire. In the finished crimped connection, the exposed conducting core of the wire is pressed against the surface of the post and the flattened and parted insulation is disposed around the core with the connector clip holding the insulation and the core against the post to establish the electrical contact.

In the drawing:

FIGURE 1 is a perspective view of the leading end portion of a tool in accordance with the invention.

FIGURE 2 is a fragmentary sectional view on an enlarged scale showing the tool mandrel positioned against a terminal post and showing the end of a wire positioned in the mandrel preparatory to movement of the clip past the wire and onto the post.

FIGURE 3 is a view taken along the lines 3—3 of FIGURE 2.

FIGURE 4 is a view similar to FIGURE 2 but showing the positions of the parts when the clip has moved partially along its path of movement towards the post and after the clip has initially engaged the wire.

FIGURE 5 is a view taken along the lines 5—5 of FIGURE 4.

FIGURE 6 is a sectional side view showing the manner in which the clip holds the wire against the terminal post in the completed electrical connection.

FIGURE 7 is a view taken along the lines 7—7 of FIGURE 6.

FIGURE 8 is a perspective view showing a section of strip of end-to-end connected clips for making electrical connections in accordance with the invention.

FIGURE 9 is a side view of the tool for carrying out the invention.

FIGURE 10 is a perspective view of a short section of tinsel wire.

Referring first to FIGURE 8, one form of terminal clip C for making connections in accordance with the invention comprises a flat web 2 having sidewalls 4 extending from its longitudinal edges. The marginal edge portions of these sidewalls are curled inwardly towards each other and towards the underside of the web 2, the distance between the curled edges of the sidewalls and the underside of the web being such that the connector is adapted to embrace a terminal post 1 and to clamp or hold the conducting core 5 of a wire 3 against the surface of the post as shown in FIGURES 6 and 7. Advantageously, the leading end of the web 4 is provided with an outwardly cupped recess 8 which functions as a strain relief and as an insulation support for the emergent

section of the wire which extends from the lower end of the web.

One form of apparatus for carrying out the invention comprises a hand tool (FIGURE 9) having a depending handle 10 and a air cylinder 12 on its upper side. The type of tool shown in FIGURE 9 contains mechanism for feeding connector clips in strip form from a reel or other suitable source, and the for transferring the leading connector of the strip to a position in front of a plunger which is driven by the piston rod of an air cylinder 12. This mechanism in this particular type of tool is fully disclosed in the co-pending application of Edwin Floyd, Jr., Serial Number 250,300, filed January 9, 1963, and need not be described in detail here. Accordingly, only the structure of the nose portion of the tool, shown in FIGURE 1, will be described in detail. The disclosed tool is provided with a pair of cover plates 14 which encase the mechanism which actuates the various transfer devices, terminal fitting devices, and the plunger which are described below.

Referring now to FIGURE 1, the disclosed form of tool comprises a frame plate 18 having a mandrel block 20 mounted on its upper lefthand end as viewed in the drawing. A T-shaped mandrel comprising a rib 22 and a head 24 is provided on the upper side of mandrel block 20. The thickness of the mandrel head 24 is such that the connector clip can be moved over this projection with a relatively snug sliding fit. The head 24 does not extend to the end of the block but terminates in an undercut surface 26 beyond which an arm 32 extends which is adapted to be positioned against the side of the terminal post 1. Plates 28 are secured to the mandrel block on each side and have inwardly bent resilient fingers 30 extending towards the sides of the arm 32 to assist the operator in holding the tool steadily against the end of the post. A recess 34 extends downwardly as viewed in the drawing through the head 24 of the projection and into the rib 22 thereof and opens into the righthand side of the head.

The terminal clips are pushed by means of a plunger 38 from a T-shaped projection 44 on the upper end of a transfer slide 42 over the T-shaped mandrel. In the disclosed embodiment this plunger has a recess in its leading end in which the terminal clip is nested during such movement. The clips are loaded onto projection 44 of transfer slide 42 when the transfer slide is in a lowered position and is in alignment with a strip of clips on a feed track generally indicated at 49. Lowering of the transfer slide 42 is accomplished by means of a lever 46 which is actuated by the piston rod of the piston cylinder as fully explained in the above-identified Floyd application. The strip of clips is fed leftwardly in FIGURE 1 to position the leading clip on the projection 44 on slide 42 by means of reciprocable block 50 having a feed finger thereon which engages the strip to push it leftwardly as viewed in the drawing.

It is advantageous to provide a spring finger 62 on the upper side of the tool to bear against the surface of the terminal post when the tool is positioned against its end and to assist in holding the tool in its proper position for application of the clip. In the disclosed embodiment this spring extends from a block 60 which straddles the path of reciprocation of the plunger and which is mounted on a block 61 secured to the frame plate.

It will be understood that the linkages between the piston-cylinder and the various mechanisms for actuating the transfer slide 42 and the terminal feed block 50 as well as the sequence in which these elements of the disclosed tool operate are explained fully in the above-mentioned co-pending application, Serial Number 250,300, and need not be described in further detail since the instant invention is directed to the projection 22, 24 on the anvil, the recess 34, and the manner in which the insulated wire is slit during usage of the tool as will now be described.

A groove 64 is provided on the upper surface of the head 24 of the T-shaped projection and slopes from a location adjacent the frontal end of the tool towards the recess 34. As it approaches the recess 34, this groove drops off abruptly as indicated at 68 and merges with the lefthand side of the recess to provide a gently curved transition surface. As shown best in FIGURE 3, a V-shaped rib 66 is provided on the floor of the recess 64 centrally between the two sides. The apex of this rib is advantageously sufficiently sharp to permit it to cut into the insulation sheath 3 of the wire when the wire is dragged through the groove as is described below.

In use, the parts will normally be in the position shown in FIGURE 1 with a terminal positioned on the projections 44 of the transfer slide 42. The tool is positioned against the terminal post 1 with the end of the post disposed against the undercut surface 26 of projection 22, 24 and with the fingers 30 bearing against the sides of the post. The operator inserts the end of an insulated wire into the recess 34 and squeezes the trigger 13 to admit compressed air into the righthand side of the cylinder and to drive the plunger 38 leftwardly in the drawing. The plunger first moves over the upper end of the transfer slide 42 and pushes the connector clip from the transfer slide and onto the projection 22, 24 of the mandrel. As the clip moves over this projection and past the recess 34, its leading end engages the wire 3 and first compresses it in the groove 64 of the head 24 of the projection. As the clip moves relatively leftwardly, the insulated wire is compressed to an increasing extent within the groove 64 due to the slope of the floor of the groove so that the wire is deformed until it effectively fills the entire cross section of the groove (FIGURE 5). As a result of this compression of the wire, the insulation on the underside of the wire is forced against the cutting edge of the rib 66 which forms an axial slit in the insulation extending to the end of the wire.

As the clip C moves relatively past the groove 64 and onto the terminal post 1, it is forced to yield resiliently as shown at FIGURE 7 and the wire is contained between the web and the opposed surface of the clip. The relatively high force exerted on the wire causes it to be flattened and the insulation is parted along the slit formed by the cutting edge of the rib 66. This flattening of the wire coupled with the force exerted on it by the clip has the effect of forcing the conducting core 5 of the wire against the surface of the terminal post so that after the clip has come to rest, an electrical connection as shown in FIGURE 7 is achieved.

Preferably, the physical properties of the clip should be such that when it is in the condtition shown in FIGURE 7 it will be capable of following the wire insulation if some of the insulation should flow from between the web and the terminal post. In other words, it is desirable that the clip should function as a spring member capable of compensating for relaxation of insulation which would otherwise involve a lowering of the contact pressure between the wire and the terminal post.

The invention can be practiced with any type of insulated wire which can be slit by the action of the cutting edge of the rib 66, for example, any of the conventional plastic insulations such as Teflon (polytetrafluoroethylene), nylon, or conventional fiber insulations. One advantage which applies to all types of insulation is that the area of physical contact between the terminal post and the wire is completely surrounded by tightly compressed insulation material which is resiliently urged by the connector clip against the wire and the surface of the terminal post. This feature of the invention provides a continuous seal surrounding the contact areas against adverse environments such as corrosive moistures or gases.

The invention has been found to be of particular utility where it is necessary to form a connection between a terminal post and a wire of the type commonly identified as tinsel wire. A wire of this type is shown in FIGURE 10 comprising a plurality of extremely small ribbon like strands 70, each of which is helically wrapped around a continuous core of fibers 72, usually natural fibers such

as cotton. The individual strands **70** are, in turn, covered by an inner insulating sheath **74** and an outer insulating sheath **76**. In FIGURE 10, these insulating sheaths are shown as being of natural fibers although tinsel type wires are also manufactured with at least one plastic insulating sheath in surrounding relationship to the strands.

This type of wire is used where a highly flexible wire is required but has proved to be particularly troublesome when electrical connections must be made. It does not respond to conventional stripping techniques for the reason that the conducting core is made up of the helical ribbons surrounding the fibers **72** so that any attempt to cut the wire may result in severing of the strands. Tinsel wires can be connected to terminal posts in accordance with the principles of the present invention with relative ease since it is only necessary to sever the outer insulating sheaths **74**, **76** by means of the cutting edge on the rib **66** while the wire is being drawn through the groove **64**. The helical strands of the tinsel wire will then be exposed and will be pressed against the surface of the terminal post as is shown in FIGURE 7.

While the described embodiment of the invention includes a cutting edge for forming the axial slit in the insulating sheath 3 of the wire, it has been found that with some types of insulation this cutting edge is not required. Particularly, where the insulating sheath comprises a plastic material having a high notch sensitivity and which tends to split after being stretched, it is possible to form the slit by merely drawing the wire over the surface of the anvil while it is held in a flattened condition by the connector clip as described in my previous application Serial Number 171,074. When the wire is flattened under these circumstances it is stretched on its underside to a degree such that the insulation parts on opposite sides, that is on the side adjacent to the web and on the side adjacent to the anvil. It will be apparent from FIGURE 5 that such parting of the insulation will be brought about for the reason that it is highly deformed on these sides but is not deformed on the diametrically opposed sides where it is not confined.

An important purpose of the groove **64** in the disclosed embodiment of the invention is to center the wire with respect to the cutting edge **66** as the wire is pulled or dragged by the clip from the recess and over the surface of the mandrel. In the disclosed embodiment, this groove has a relatively large cross sectional area adjacent to the recess as indicated in FIGURES 3 and 4. Obviously, this groove can therefore be relatively more shallow than in the embodiment shown and under some circumstances can be eliminated entirely if movement of the wire over the cutting means is achieved in another manner. For example, several spaced apart cutting edges can be provided on the mandrel which would be so located that movement of the wire over at least one of these edges would be inevitable.

It will be understood that the insulation slitting feature of the present invention can be provided on alternative types of apparatus for carrying out my invention as set forth in application Serial Number 171,074. This copending application discloses an alternative type of pneumatically actuated hand tool and a fully automatic apparatus intended for usage with a coordinately movable frame for automatically wiring panel boards. The instant invention can be incorporated into either of these devices.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the the following claims when viewed in their proper perspective against the prior art.

I claim:

1. Apparatus for making an electrical connection between a terminal post and a wire by means of a terminal clip which is adapted to embrace said post and to hold said wire against the surface of said post, said apparatus comprising: a mandrel for internally supporting said clip, means for pushing said clip along said mandrel and from said mandrel onto a terminal post, a recess extending into said mandrel for reception of a wire end, a groove extending along said mandrel from said recess, and parting means in said groove for axially parting the insulation of said wire whereby, upon movement of said clip past said recess, said wire is dragged from said recess and along said groove, and the insulation of said wire is axially parted by said parting means, said wire being thereafter dragged over said mandrel and onto said post whereby the insulation of said wire is compressed against said post and the conducting core of said wire is exposed and pressed against the surface of said post.

2. Apparatus for making an electrical connection between an insulated wire and a terminal post by means of a terminal clip, said clip having a web portion and having sidewalls on two opposite sides thereof, said clip being adapted to be telescopically moved onto said post and to embrace said post with said web disposed against said post, said apparatus comprising: a mandrel for guiding said clip along a predetermined path towards, and onto, said post, a recess in said mandrel for reception of an insulated wire, means for moving said clip over said mandrel and onto said post, a groove in said mandrel extending from said recess along said predetermined path, and means in said groove for axially parting said insulation when said insulation is pulled through said groove whereby, upon positioning said wire in said recess and locating said mandrel in alignment with said post, and upon moving said clip over said mandrel, said wire is dragged by said clip through said groove thereby to form an axial part in the insulation of said wire, and upon subsequent movement of said clip onto said post, said wire is compressed against said post and flattened and the conducting core of said wire emerges through said part and is brought into contact with said post.

3. Apparatus for making an electrical connection between an insulated wire and a terminal post by means of a terminal clip, said clip having a web portion and having sidewalls on two opposite sides thereof, said sidewalls having inwardly directed marginal edge portions and being adapted to embrace said post, said apparatus comprising: a T-shaped mandrel defining a guide path for said clip, said mandrel being adapted to be positioned against, and in alignment with, said post, a recess extending into said mandrel for reception of a wire whereby, upon movement of said clip past said recess, said wire is dragged from said recess and along said path, a groove in said mandrel extending downstream, relative to the direction of clip movement, from said recess, and parting means in said groove for parting the insulation of said wire as said wire moves relatively through said groove whereby, the conducting core of said wire is exposed and upon movement of said clip from said mandrel and onto said post, the insulation of said wire is compressed and flattened between said web and one side of said post and said conducting core is clamped against said post to establish electrical contact therewith.

4. A device as set forth in claim 3 wherein said parting means comprises cutting means in said groove.

5. A device as set forth in claim 3 wherein said parting means comprises a cutting edge, said edge extending from the floor of said groove.

6. Apparatus for making an electrical connection between an insulated conductor and a terminal post by means of a terminal clip which is axially movable onto said post, said apparatus comprising, a mandrel conforming to said clip, means for moving said clip along a predetermined path extending over said mandrel, and parting means disposed on said path whereby, upon positioning said conductor with its axis extending transversely of said path and upstream, relative to the direction of movement

of said clip, from said mandrel, and upon moving said clip along said path, said clip drags said conductor over said parting means, over said mandrel, and onto said post thereby to expose the conducting core of said conductor, said exposed core being held against said post after said clip comes to rest to establish said electrical connection.

7. Apparatus for making an electrical connection between an insulated conductor and a terminal post by means of a terminal clip, said clip having an axially extending open seam on one side thereof, said apparatus comprising, a mandrel conforming to the internal cross-section of said clip, parting means on said mandrel, and means for moving said terminal clip over said mandrel and onto said post whereby, upon positioning said conductor with its axis extending transversely of the longitudinal axis of said mandrel and moving said clip against said conductor, over said mandrel, and onto said post, said clip drags said conductor over said parting means and onto said post thereby to axially part the insulation of said conductor and to expose the conducting core thereof, said exposed core being held against said post after said clip comes to rest on said post to establish said electrical connection.

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