This invention relates to apparatus for forming electrical connections between wires and terminal posts in the manner disclosed in co-pending application Serial Number 171,074, filed February 5, 1962, for Electrical Connections.

The above-identified application Serial Number 171,074 discloses and claims a hand held tool for making electrical connections between wires and terminal posts by means of one pair of terminal clips which are adapted to embrace the post and hold the wire against its surface. This type of tool comprises a mandrel which conforms to the cross section of the terminal clip and which is adapted to be placed against the end of the terminal post. A recess extends into the mandrel into which the end of the conductor is inserted. The terminal clip is pushed over the mandrel, past the recess, and onto the terminal post in a manner such that the clip engages the wire and drags its end portion over the mandrel and the terminal post so that when the clip comes to rest on the post the conductor is held against the surface of the post by the clip.

The present invention relates to improvements to the general type of hand tool shown in application Serial Number 171,074 which improvements relate to the controlling of the wire during operation of the tool. Specifically, the present invention is directed to a clamping means for temporarily and releasably clamping the end portion of the wire to the mandrel so that the operator need not manually hold the wire in the mandrel recess while he is using the tool. The present invention is further directed to the control of the orientation of the wire, while it is being connected to the terminal post. This latter aspect of the present invention, the control of the orientation of the wire, has been found to be desirable where electrical connections are being made to terminal posts mounted on a panelboard in a rearranged pattern and relatively close to each other. It has been found that under some circumstances a wire which is being connected to one terminal post will be drawn or thrown against the edge of an adjacent terminal post while the wire is being dragged over the mandrel and the terminal post to which it is being connected. Since the terminal posts frequently have relatively sharp edges, such throwing or flinging of the wire against the edge of the post has been found to cause nicking and even severing of the wire under some circumstances.

It is accordingly an object of the present invention to provide an improved apparatus for making electrical connections between a terminal post and a wire by means of a terminal clip which is adapted to embrace the post and to hold the wire thereagainst. It is a further object of the invention to provide an apparatus for forming electrical connections having improved means for releasably clamping the wire in the apparatus preparatory to the operation of making the connection. A still further object is to provide an apparatus having means for controlling the orientation of the wire with respect to the terminal post during the operation of connecting the wire to the post.

These and other objects of the invention are achieved in a preferred embodiment thereof comprising a mandrel which has a cross section conforming to the cross section of the terminal clip which clamps the wire against the post. The mandrel is provided with a recess for reception of the end of the wire and means are provided for pushing the clip over the mandrel, past the recess and onto a terminal post in a manner such that the leading end of the moving clip engages the wire and drags it across the mandrel and over the surface of the post. In order to draw or orient the wire either to the right or to the left, keepers or guides are provided on each side of the mandrel in the vicinity of the recess, these keepers comprising plates secured to the mandrel and having wire receiving notches therein. The preferred embodiment is provided with a spring biased detent mounted on a pivoted arm above the surface of the mandrel for releasably clamping the end of the wire in the recess, the arrangement being such that upon insertion of the wire into the recess, it is clamped against a withdrawing force. Release of the wire at the time of application of the clip to the post is accomplished by camming the arm in which the detent is mounted away from the mandrel so that the detent releases its grip on the wire as the clip moves past the recess.

In the drawing:

FIGURE 1 is a partial side view, with parts broken away, of a tool embodying the preferred form of the invention.

FIGURES 2 and 3 are fragmentary perspective views showing the frontal end of the tool of FIGURE 1 and illustrating the manner in which a wire is dressed to the right (FIGURE 2) and to the left (FIGURE 3) prior to making an electrical connection.

FIGURE 4 is a fragmentary sectional view of the frontal end of the tool of FIGURE 1 showing a wire clamped in the wire receiving recess of the mandrel preparatory to making an electrical connection with the terminal post.

FIGURE 5 is a side view showing a pair of terminal posts electrically connected by terminal clips and a conductor.

FIGURE 6 is a fragmentary plan view showing a section of a wiring panel having terminal posts extending therefrom which are arranged on a grid system.

FIGURE 7 is a perspective view showing a single terminal post.

FIGURE 8 is a perspective view of a short section of strip made up of end-to-end connected terminal clips.

FIGURE 9 is a view taken along the lines 9--9 of FIGURE 1.

Referring first to FIGURE 8, electrical connections in accordance with the above-identified Co-pending application, Serial Number 171,074 are made by means of terminal clips 90, each clip comprising a web 92 having sidewalks 94 extending from its opposite sides. The longitudinal edges of the sidewalks are curled inwardly toward each other and towards the underside of the web 92, the distance between the surface of the underside of the web and the edges of the sidewalks being such that the clip is adapted to embrace the terminal post 104 with the wire held against one side of the post by the web 92. Advantageously, an outwardly cupped insulation support and strain relief 98 is provided at the leading end of the web so that the emergent portion of the wire is held in the insulation support and extends through a notch at the end of this insulation support. The terminal posts 104 have a generally rectangular cross section and ordinarily are chamfered at their upper ends 106. These posts may be formed by cutting and swaging strip stock metal so that they have relatively sharp edges at their upper ends.

Wiring panelboards 100 (FIGURE 6) are ordinarily provided with a multiplicity of terminal posts 104 arranged on a grid system and the various electrical connections between the posts are made by conductors and clips as indicated in FIGURES 5 and 6. Only a single pair of posts are shown as being connected in FIGURE 5 although it would be understood that in practice, a
mazes of wires will interconnect the posts in accordance with a predetermined plan.

Turning now to FIGURES 1 and 2, the invention is herein disclosed as being provided on a hand tool of the general type disclosed in application Serial No. 250,300, filed January 9, 1965, by Edwin Floyd, Jr. Since the present invention is directed only to a wire dressing means and wire clamping means which appears in the upper lefthand portion of the tool of FIGURE 1, the structure of the tool and the manner of operation will be described only briefly and to the extent necessary for an understanding of the present invention.

The clip applying tool shown comprises a handle portion 2 having a pneumatic cylinder 4 mounted on its upper end, a trigger 6 being provided to admit air at the righthand end of the cylinder and operate the tool. The handle 2 is formed by the two section cover plates 8, 10 which encases the clip feeding, clip transfer and clip moving mechanisms described briefly below and in complete detail in application Serial Number 250,300.

The clip feeding, clip pushing and associated mechanisms are mounted on a frame plate generally indicated at 12 and a mandrel block 14 is fastened to this frame plate on the frontal end of the tool. A mandrel 15 extends along the upper side of block 14 and has a generally T-shaped cross section (FIGURE 9) comprising a central rib 16 and a head 18. A recess 20 extends into the mandrel intermediate its ends for reception of the end of an insulated conductor as shown in FIGURE 4. The mandrel head 18 terminates short of the frontal end of the tool in an undercut indicated at 22. The rib 16 extends beyond the end of the head forming a projecting finger 26 against which the terminal post is adapted to be positioned during operation.

Individual terminal clips are delivered to a position in alignment with the mandrel by means of a transfer slide 28 having a T-shaped projection 30 on its upper end for supporting an individual clip. Slide 28 is pivotally connected at 32 on its lower end to a lever 34 which is pivotally intermediate its ends as shown at 35. It will be apparent that upon counterclockwise rocking of this lever 34 about its pivotal axis the transfer slide 28 will be lowered from the position shown in FIGURE 1 until it is in alignment with a terminal clip feed path on the upper side of a bar 40 which is secured to frame plate 12. The terminal strip is fed over this feed path by means of a feed pawl 42 pivotally mounted on the end of a reciprocable block 44. Pawl 42 extends upwardly through a slot in the bar 40 and engages the strip so that during lefward movement of the block 44 the strip will be fed lefwardly until the leading terminal clip is fed onto the T-shaped projection 30 of the transfer slide. Upon upward movement of the transfer slide, the leading connector on projection 30 is moved past a transversely extending shear block 48 which is secured to the frontal end of the guide bar 46 also mounted on frame plate 12. As is apparent from the drawing, the transfer slide is guided along its path of reciprocation by means of guide blocks 36, 38 integral with the frame plate and on each side of the slide.

The terminal clip positioned on the upper end of the transfer slide is moved relatively lefwardly in FIGURE 1 onto the mandrel, past the recess 20, and onto a terminal post by means of a reciprocable plunger 50. During such movement of the clip, its leading end engages the wire which extends into the recess 20 and presses the insulation thereof against the edges on each side of a sloping groove 24 on the upper surface of the mandrel thereby to sever the insulation so that upon further lefward movement of the clip the conducting core of the wire is withdrawn from the end section of the insulating sheath and dragged through the groove 24, over the surface of the mandrel and onto the terminal post.

The various linkages and mechanical connections between the plunger 50, the block 44, the lever, and the piston rod in the cylinder 4 are described in complete detail in the above-identified application Serial Number 250,300.

An arm 52 is mounted above the upper surface of the mandrel and extends rearwardly into a notch in a block 56 to which it is pivotally connected at 54. Block 56 straddles the frame plate 12 and is, in turn, secured by means of fasteners to a block 58 which is secured to the frame plate by means of fasteners. A leaf spring 62 has one end thereof secured to the upper side of the block 56 and extends over the upper side of the pivoted arm 52 normally to bias this arm to the position shown in the drawing while permitting limited counterclockwise movement of the arm about its pivotal axis 54.

The forward end of arm 52 slopes obliquely towards the mandrel as shown at 66 and is provided with a central inwardly extending slot 64. A pair of stops or feet 65 extend downwardly from the underside of the arm 52 at its forward end and bear against the upper side of the mandrel block when the parts are in the position shown in the drawing. The obliquely extending surface 66 on the frontal end of the arm is provided with conical depressions 68 on each side of the slot 64 to define guide surface for a conductor when it is being inserted into the recess 20. As will be apparent from an inspection of FIGURES 1 and 2, the comprising of conical depressions 68 constitute a funnel for the conductor.

The conductor is clamped within the recess by means of a dog disposed in the slot 64 and pivoted on a pin 72 extending across this slot. This dog has a depending arm 70 extending downwardly towards the mandrel and has a horizontally extending arm 74 which bears against the upper surface of the arm when the detent is in its normal position. A compression spring 76 bears against the arm 70 of the dog at one end and it is received within a recess in the arm 52 at the root of the notch 64. This spring 76 normally biases the dog to the position shown in FIGURE 1 in which the arm 74 is in engagement with the upper surface of the arm 52.

A pair of plates 78 are secured to the mandrel block on each side thereof by means of fasteners 79 and extend upwardly past the mandrel. On their upper ends these plates are arcuate formed so that they curve away from, and then towards, the planes of the sides of the mandrel block. These plates have forwardly projecting finger extensions 82 which are coextensive with the finger extensions 26 of the mandrel block and are curved inwardly towards the sides of extension 26. For a forward displacement of these extensions 82 is to center the terminal post with respect to the head portion 18 of the mandrel and to grip the terminal post on each side when the tool is pressed against its end in order to maintain the tool in alignment with the mandrel.

On their upper ends, the curved portions 80 of the plates are provided with rearwardly directed notches 86 having a width sufficient to receive the wires 88. These notches function as keepers or guides to maintain the wire in its desired orientation preparatory to a clip applying operation as will presently be described.

In use, the parts will normally be in the position shown in FIGURE 1 with a single terminal clip on the projection 30 of the transfer slide 28 and the plunger 50 will be in its retracted position. The operator first inserts the wire into the slot 64 between the guide surfaces 68. As previously noted, the conical depressions 68 constitute a funnel so that if the wire is not perfectly aligned when it is inserted, its end portion will be guided along the conical surfaces towards the recess 20. As the wire end moves inwardly, that is along the line indicated in FIGURE 1, its rear is engaged to the lower end of the arm 70 of the dog causing the dog to be moved about its pivotal axis 72 against the force of the spring 76. Further insertion of the wire will result in its being guided into the recess 20 until the desired length of wire is received within the recess. The lower end of the arm 70 of the dog will
at this time be resiliently urged by the spring 76 against the wire and will clamp it against the sides of the recess as shown in FIGURE 4 so that the operator can pull on the wire without withdrawing it from the recess.

The operator then dresses the wire either rightwardly or leftwardly by leading it into the appropriate one of the guide posts 74 and will position the tool in alignment with the terminal post to which an electrical connection is to be made. Positioning of the tool against the terminal post is accomplished by merely aligning it with the post and forcing it downwardly past the post until the gripping fingers 82 are against the sides of the post and the wire is clamped against the sides of the post. The operator then depresses the trigger 6 to drive the plungers leftwardly and move the clip over the mandrel, past the recess, and onto the terminal post as described above. During leftward movement of the plungers, its leading end 54 engages the depending foot 65 and pivots the arm 52 about its pivotal axis 54 thereby causing the dog to release its grip on the wire.

When the remaining end of the wire is connected by means of a clip to the post 112, it is, of course, dressed to the left for this operation. If the wire is first connected to post 108 and then to post 114, the wire could be dressed to either the left or right, when the connection to post 114 is being made, and tensioned so that it would lie either in the plane C—C or D—D.

When the notches are utilized during the making of the second of two electrical connections with terminal posts and the wire is pulled taut when the tool is positioned against the second post, there will be very little slack in the wire of the finished connection so that the wire board will have a neat and orderly appearance.

The disclosed arrangement for guiding the wire into the recesses 20 by way of the conical surfaces 68 results in the wire being led centrally over the head of the mandrel and into the recess so that the axis of the wire lies above the central axis of the groove 24. Furthermore, since the dog arm 70 is centrally located with respect to the groove 24, the wire is retained in its centered position until the clip moves past the recess, and drags the wire over the mandrel. This automatic centering of the wire is advantageous since the conducting core of the wire should be disposed over the groove with the insulation extending beyond the sides of the groove in order to achieve stripping of the insulation as described in my previous application Serial Number 171,074.

An additional beneficial result achieved in the practice of the instant invention is that in the finished crimped connection the wire emerges from the insulation support 98 of the terminal clip along an accurate or curved path so that it is bent gently in the direction of the wire extends. The formation of this curve in the wire results from the bending of the wire around the plates 78 when it is positioned in the dressing notch 86.

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 following claims when viewed in their proper perspective against the prior art.

I claim:

1. Apparatus for forming an electrical connection between a wire and a terminal post by means of a terminal clip having a web and sidewalks on two opposite sides thereof, said clip being adapted to embrace said post to hold said wire against the surface thereof, said apparatus comprising: a mandrel having a cross section conforming to the cross section of said clip and having one side for supporting said web of said clip, means for moving said clip over said mandrel and onto a terminal post, a recess extending into said one side of said mandrel for reception of said wire, an arm extending parallel to and beside said one side of said mandrel and past said recess, the one end of said arm which is adjacent to said recess having an axial slot extending inwardly therefrom, the opposite end of said arm being pivotally mounted thereby to permit said one end to move away from said dog pivotally mounted in said slot in said arm and extending towards said one side of said mandrel, said dog being resiliently biased towards said one end of said arm, whereby, upon insertion of said wire through said slot, past said dog, and into said recess, said dog is resiliently deflected by said wire and clamps said wire against said mandrel thereby to retain said wire in said recess until said clip moves past said recess.

2. Apparatus for forming an electrical connection between a wire and a terminal post by means of a terminal clip having a web and sidewalks on two opposite sides thereof, said clip being adapted to embrace said post and to hold said wire against the surface thereof, said apparatus comprising: a mandrel having a cross section conforming to the cross section of said clip and having one side for supporting said web of said clip, an arm extending parallel to and beside said one side of said mandrel and past said recess, the one end of said arm which is adjacent to said recess having an axial slot extending inwardly therefrom, the opposite end of said arm being pivotally mounted thereby to permit said one end to move away from said dog pivotally mounted in said slot in said arm and extending towards said one side of said mandrel, said dog being resiliently biased towards said one end of said arm, whereby, upon insertion of said wire through said slot, past said dog, and into said recess, said dog is resiliently deflected by said wire and clamps said wire against said mandrel thereby to retain said wire in said recess until said clip moves past said recess.
ing to the cross section of said clip and having one side for supporting said web of said clip, a plunger reciprocable along a path extending parallel to said mandrel for pushing said clip over said mandrel and onto said terminal post, a recess extending into said one side of said mandrel for reception of said wire, an arm extending parallel to said one side of said mandrel, said arm being pivotally mounted at its rearward end and having a forward end extending past said recess, said forward end having an axial slot therein to permit insertion of said wire into said recess, a pivotally mounted clamping dog in said slot whereby upon insertion of said wire through said slot and into said recess, said wire is clamped in said recess, said dog being engageable by said plunger during forward movement of said plunger thereby to disengage said dog from said wire and to raise said arm when said clip engages said wire.

3. Apparatus for making an electrical connection between a terminal post and a conductor by means of a connector clip, said clip having an open seam extending axially along one side thereof and being telescopically movable onto said post, said apparatus comprising, a mandrel conforming to the internal cross-section of said clip, clip pushing means for pushing said clip over, and beyond one end of, said mandrel, an opening extending into said mandrel for reception of said conductor, funnel means in alignment with said opening for guiding said conductor into said opening, said funnel means having an open side on the one side thereof which is directed downstream, relative to the direction of movement of said clip over said mandrel, and conductor keeper means on each side of said mandrel and adjacent to said one end of said mandrel whereby, the end portion of a conductor which is to be connected to a post can be inserted through said funnel and into said opening, and an adjacent portion of said conductor can be positioned in one of said keeper means, and whereby upon movement of said clip over said mandrel and onto said post, said conductor will be dragged by said clip onto said post, and said conductor will extend from said clip laterally to the side of said one keeper means in which said conductor was positioned.

4. Apparatus as set for in claim 3 wherein said keeper means comprises a pair of plates, one of said plates being disposed on each side of said mandrel, said plate having notch means therein for reception of said conductor.

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