United States Patent [19]

Caveney et al.

[11] **3,810,288**

[45] **May 14, 1974**

[54] **WIRE INSERTION AND SPLICING SYSTEM INCLUDING REACTION TOOL**

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[73] Assignee: **Panduit Corp.**, Tinley Park, Ill.

[22] Filed: **Feb. 10, 1972**

[21] Appl. No.: **225,267**

[52] **U.S. Cl.** ..... **29/203 P**

[51] **Int. Cl.** **H05k 13/04**, H01r 43/00

[58] **Field of Search** ..... 29/203 P, 203 R, 203 D, 29/203 DT, 203 H, 203 MW

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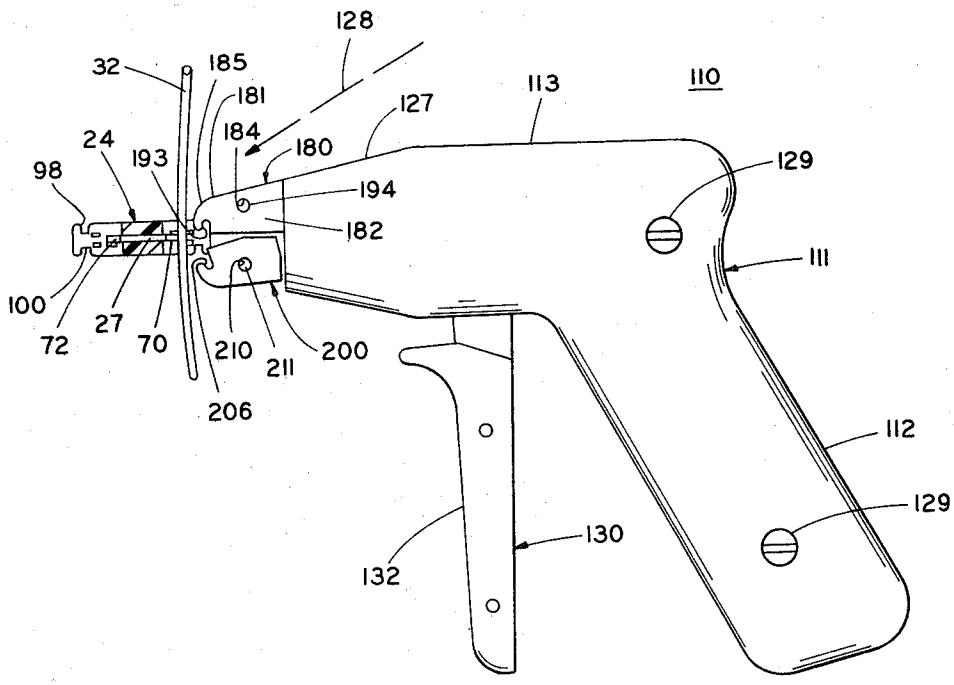
Primary Examiner—Thomas H. Eager

Attorney, Agent, or Firm—Charles R. Wentzel, Esq.

[57] **ABSTRACT**

A wire termination and splicing system is disclosed and includes a slotted connector block having reaction surfaces for cooperating with a tool and a reaction type tool including an actuator, drive mechansim, a pair of electrically isolated wire insertion members, and a pair of connector gripping members, the actuator being connected to the drive mechanism which includes a full stroke device, the wire insertion members being connected to the drive mechanism and including cutting blades and camming surfaces for cooperating to close the connector gripping members onto the reaction surfaces of the connector, and the connector gripping surfaces including locating teeth to assure proper alignment of the tool on the connector prior to wire installation. An overload mechanism may be included in the drive mechanism to prevent damage to the connector block or the tool due to misuse.

10 Claims, 27 Drawing Figures



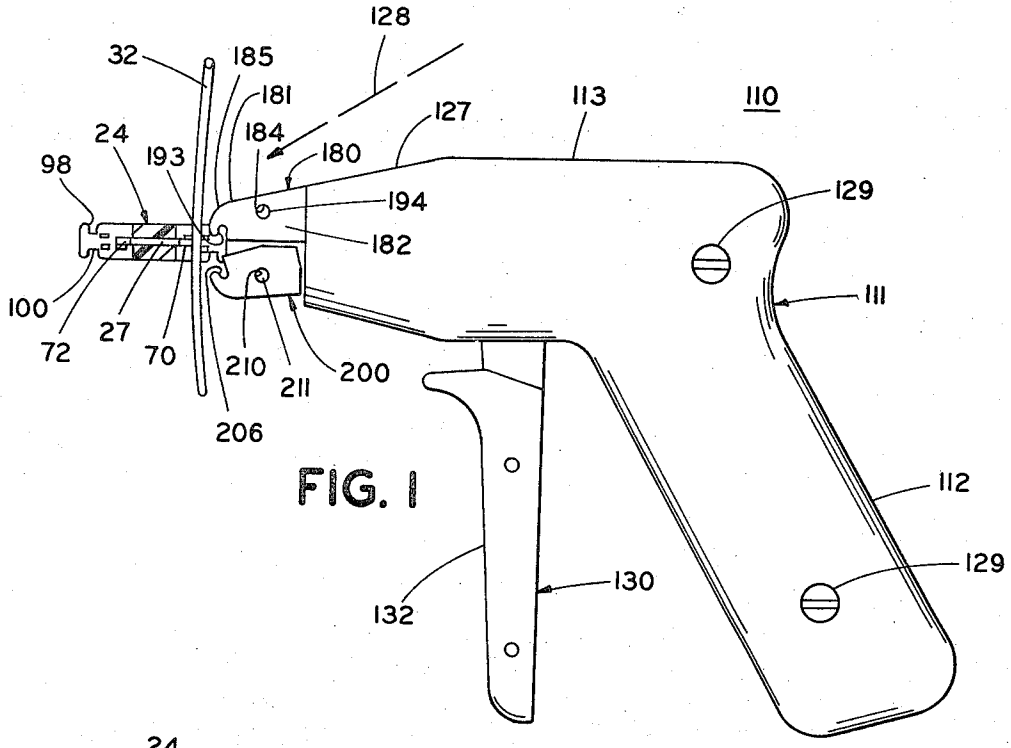


FIG. 1

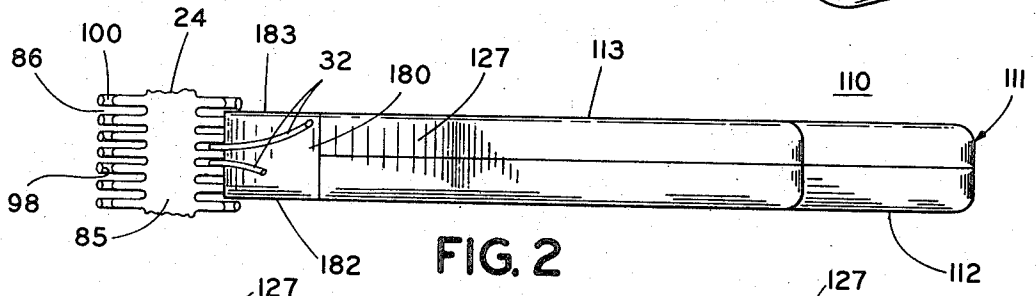


FIG. 2

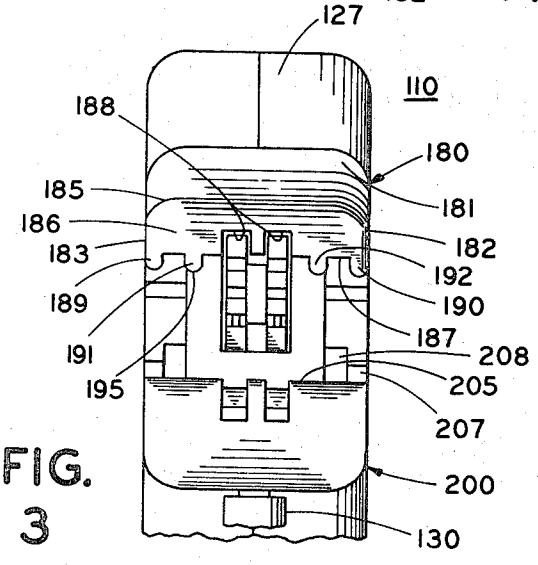


FIG. 3

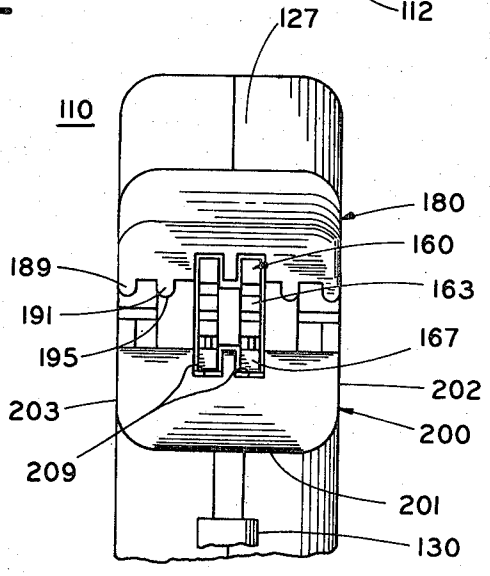


FIG. 4

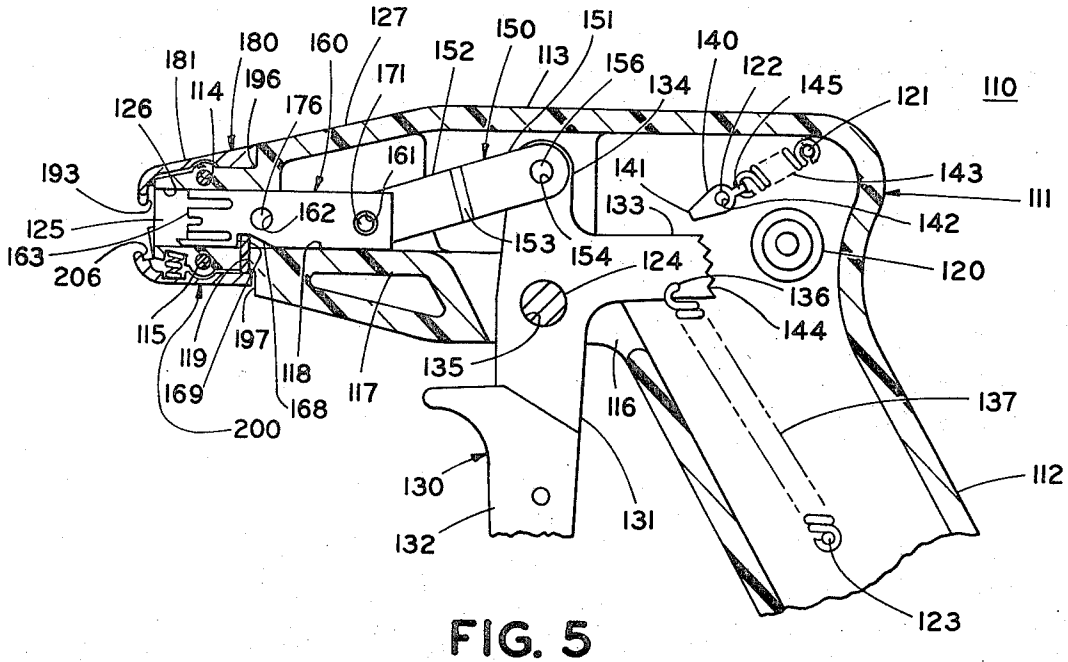

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FIG. 5

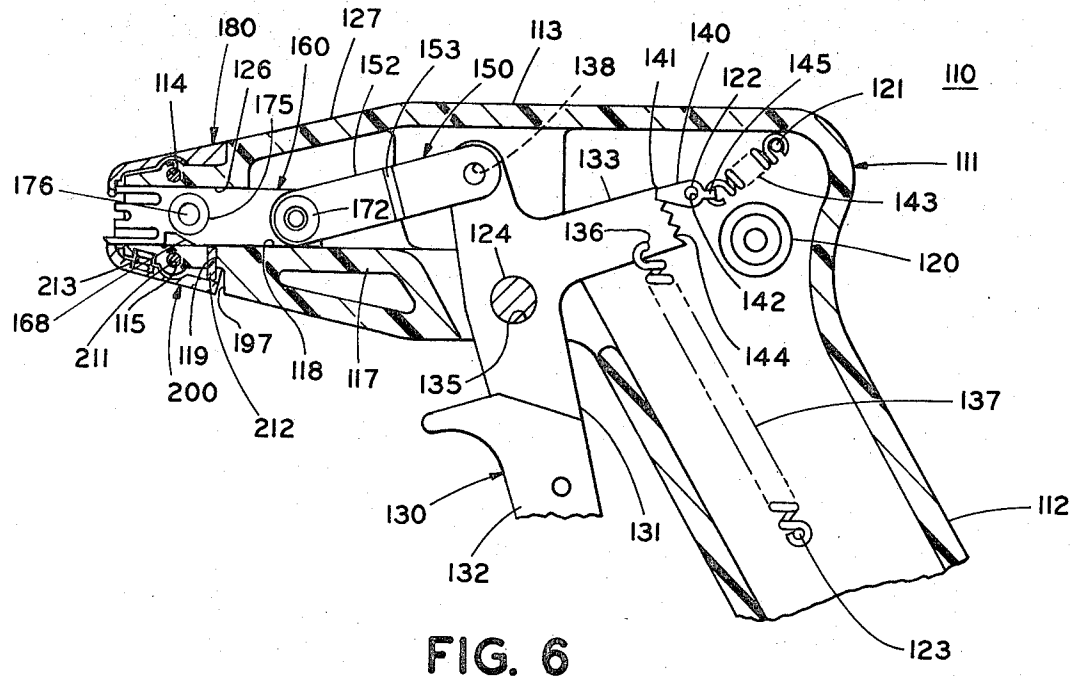

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FIG. 6

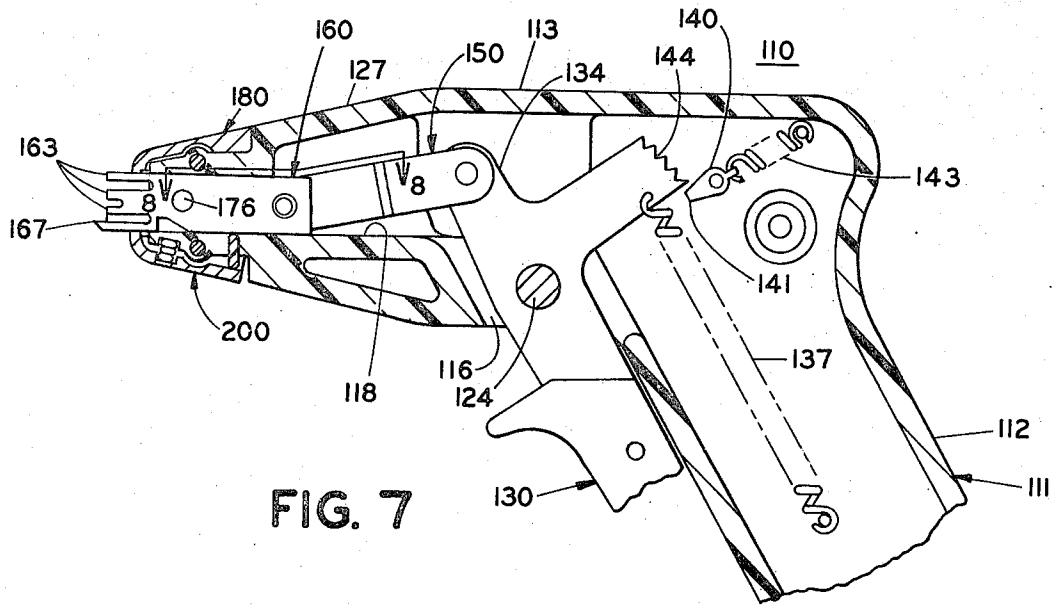


FIG. 7

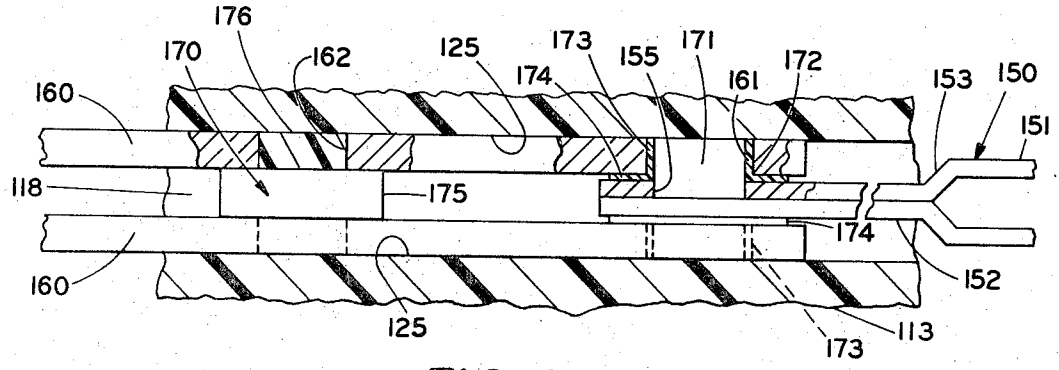


FIG. 8

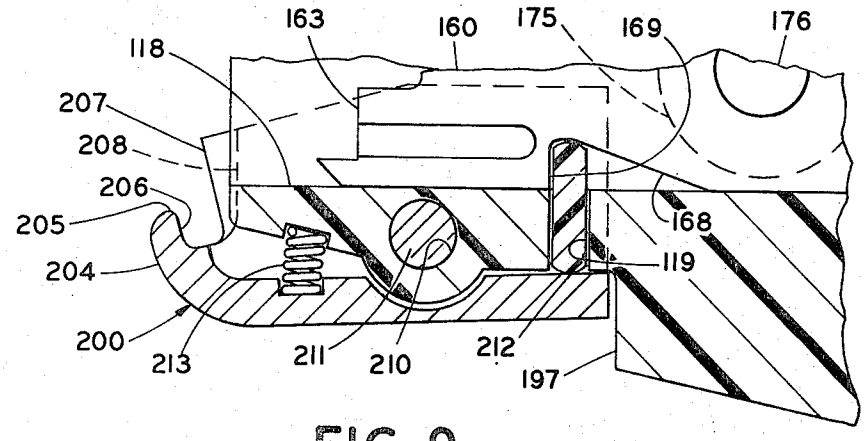


FIG. 9

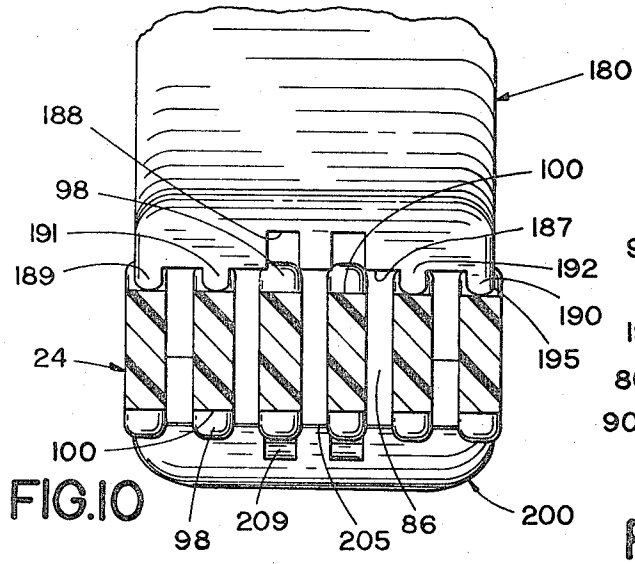


FIG.10

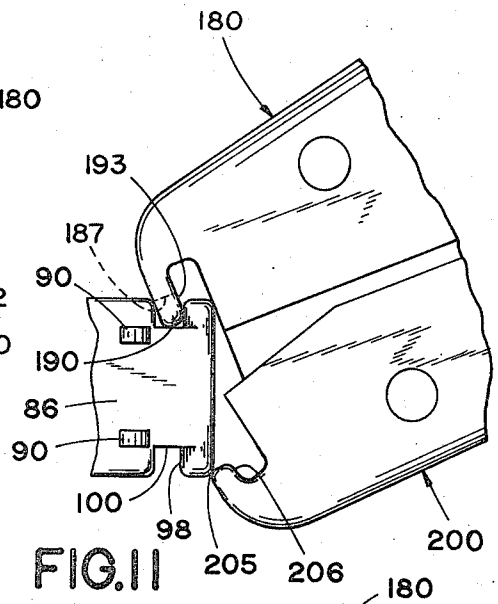


FIG.11

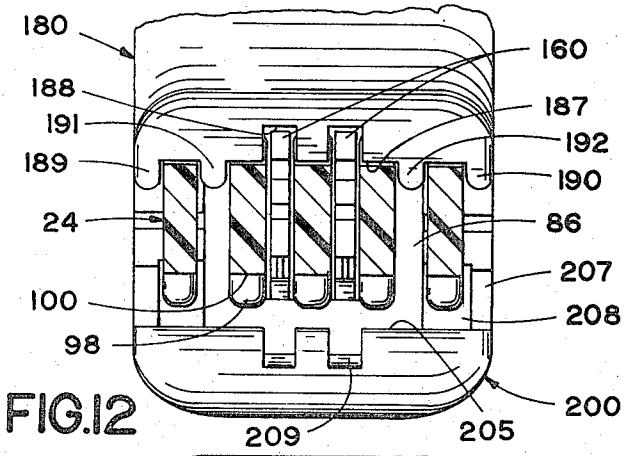


FIG.12

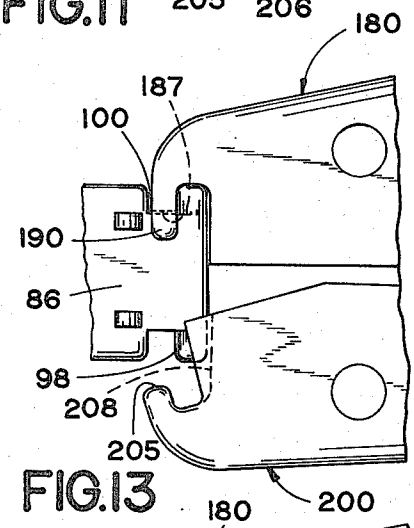


FIG.13

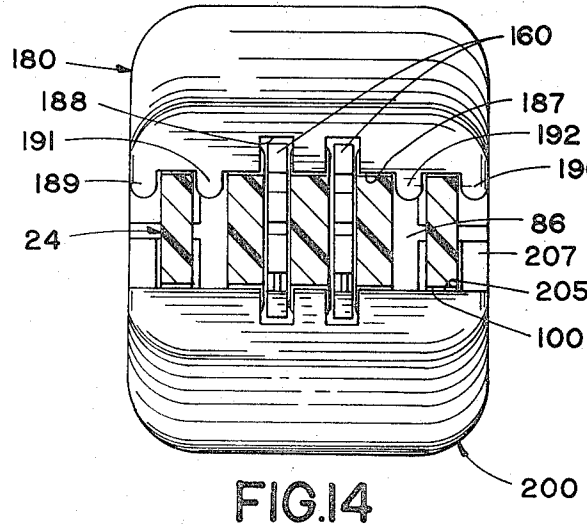


FIG.14

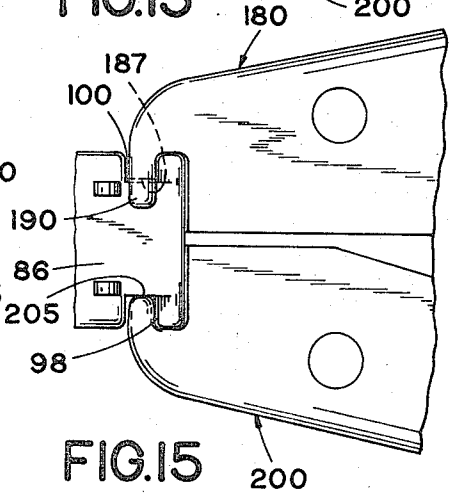


FIG.15

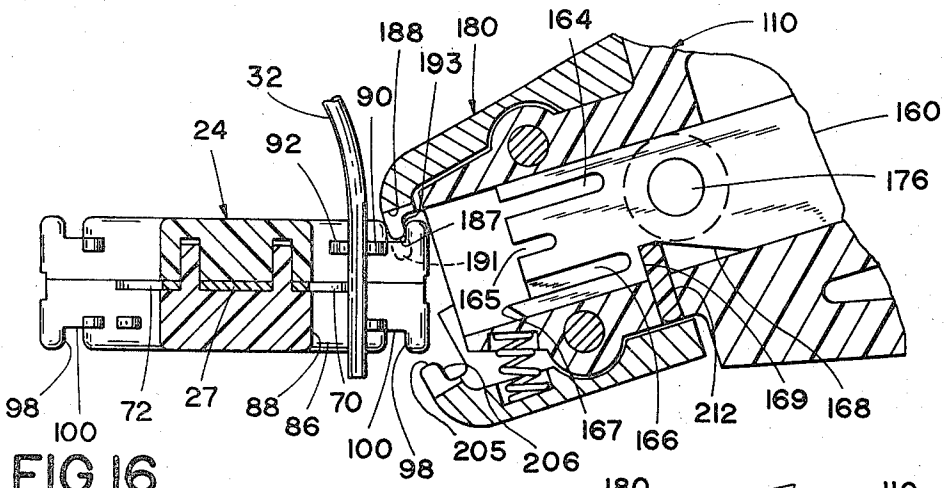


FIG.16

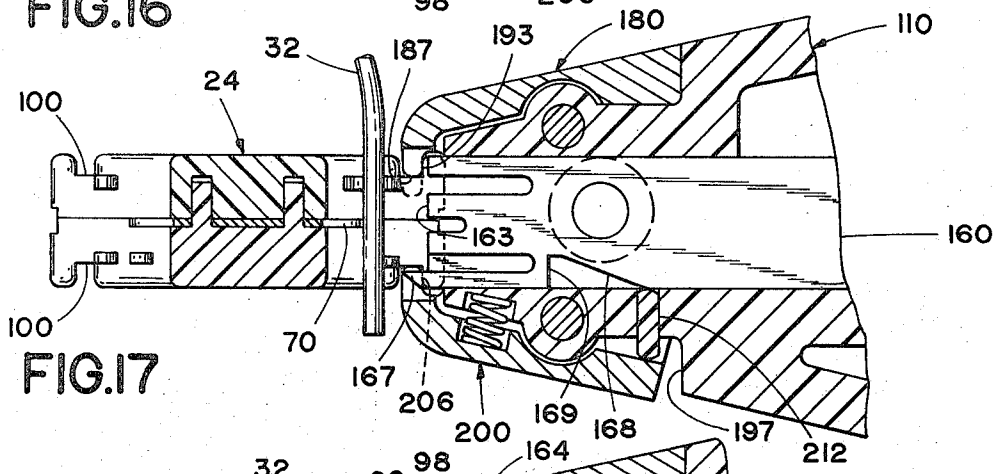


FIG.17

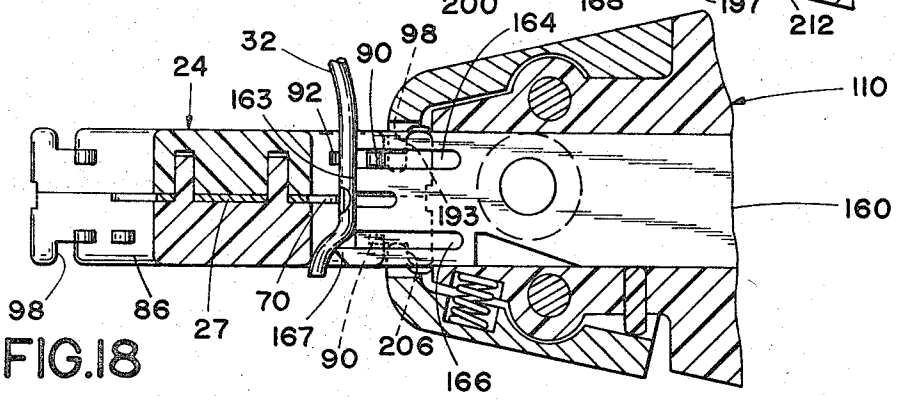


FIG.18

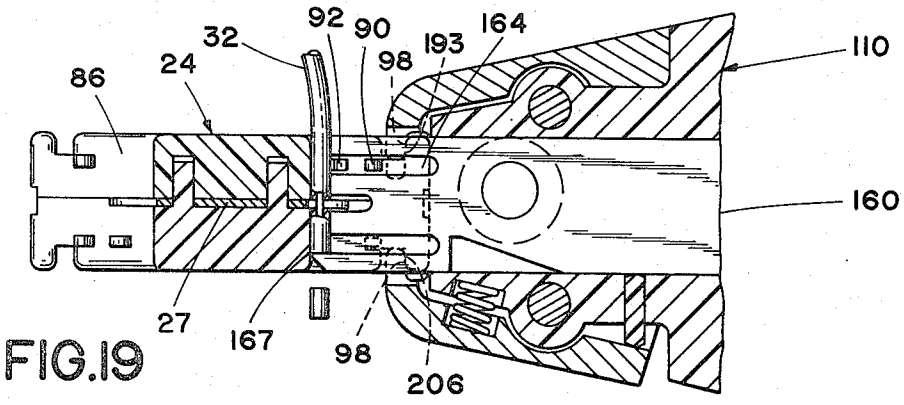


FIG.19

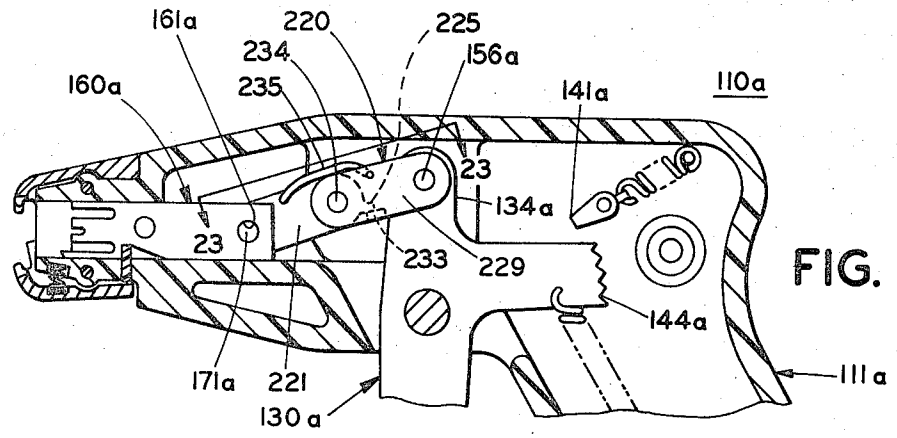


FIG. 20

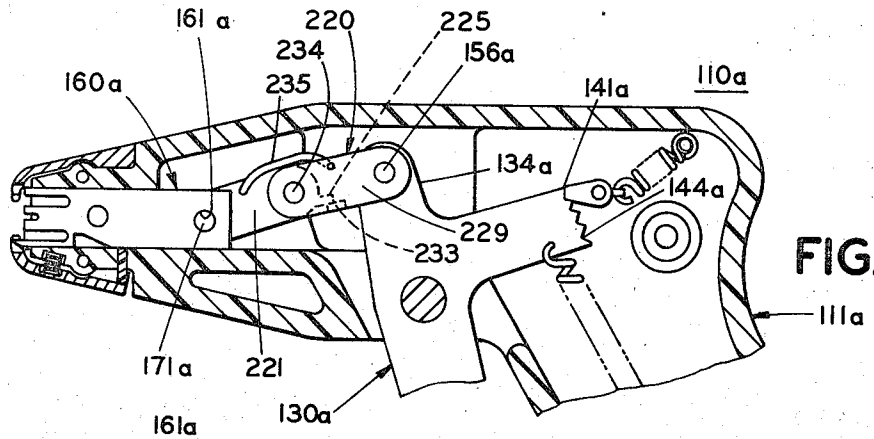


FIG. 21

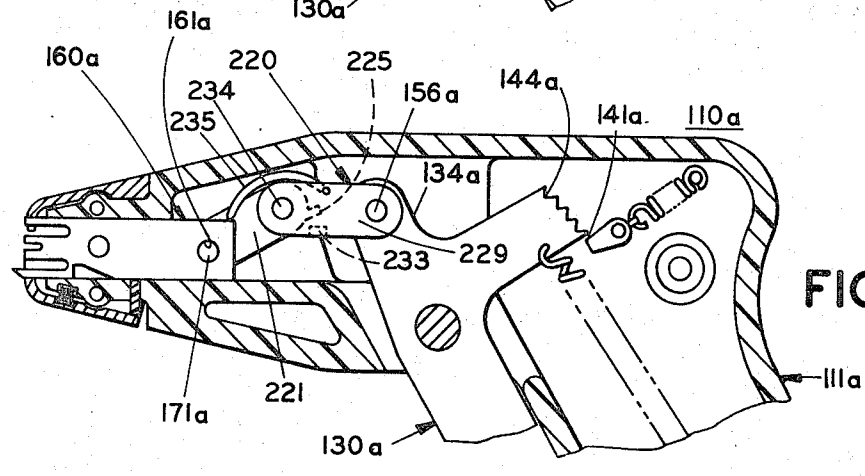


FIG. 22

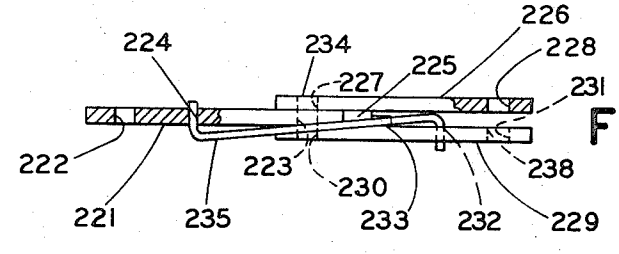


FIG. 23

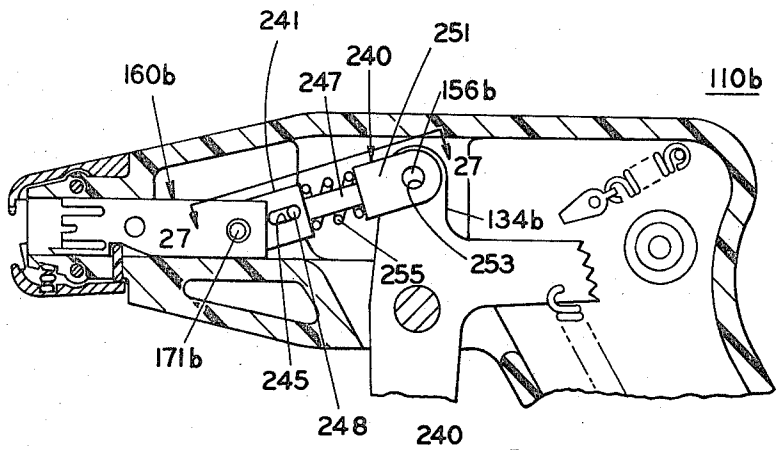


FIG. 24

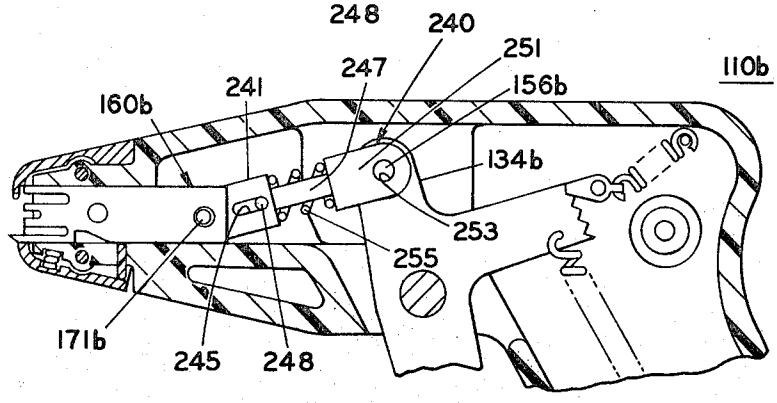


FIG. 25

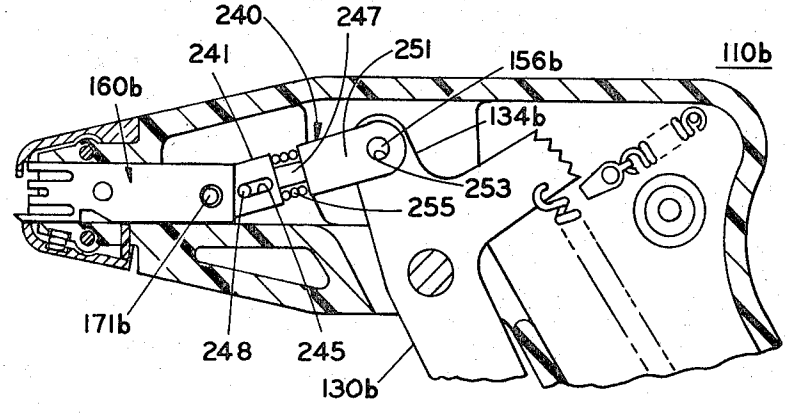


FIG. 26

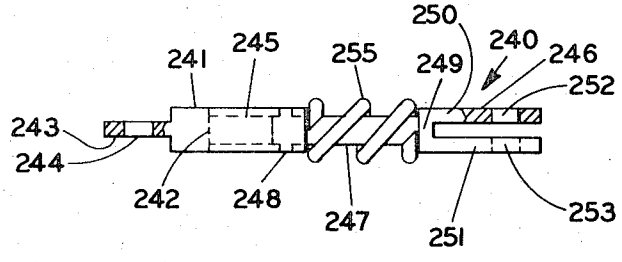


FIG. 27

WIRE INSERTION AND SPLICING SYSTEM INCLUDING REACTION TOOL

BACKGROUND OF THE INVENTION

The present invention relates to a wire termination and splicing system and to reaction tools for installing insulated wires onto a cooperating connector. More particularly, it is directed to a system including a novel connector and a novel reaction tool for installing insulated wires onto insulation stripping contacts, the connector having reaction surfaces designed to cooperate with the reaction tool.

In the field of telephone wiring systems, insulation stripping or crushing connectors are widely used for making rapid reliable contacts in junction cabinets between specific telephone installations and the incoming lines from the central telephone office. In such connectors, an insulated wire is normally positioned between a pair of insulation crushing jaws on a contact and is laterally forced between the jaws causing the deformation and removal of the insulation from the wire by the action of the jaw surfaces. This type of wire installation is usually effected by means of a punch-like hand tool having a slot for receiving the tips of the insulation crushing jaws and a pair of wire contacting surfaces disposed on either side of the slot to engage the wire on either side of the contact. The wire is forced onto the contact manually by pushing on the fixed handle of the installation tool which has no moving parts. The force of the installation is transmitted through the contact to the connector block which in the prior art is a bulky block of insulated material heavy enough to absorb the force of the wire installation.

Newer connectors of the variety referred to as insulation stripping connectors are becoming miniaturized to the extent that they can no longer be expected to withstand the force of a conventional wire installation operation as described above. In addition, there is increasing pressure by the industry for improved speed and reliability of installation of wire parts onto such connectors. An example of such an improved miniaturized connector suitable for the rapid installation of 25 pairs of insulated wires is the connector illustrated and claimed in co-pending U.S. Pat. application Ser. No. 225,089, filed of even date with the present application, entitled Wire Termination and Splicing System and assigned to the assignee of the present invention. In the connector illustrated therein, the contacts are buried in slots slightly wider than the insulated wire diameter, are precisely located within the slots and are made of very thin rendering them somewhat more fragile and susceptible to mishandling than the heavier prior art contacts. In addition, the insulative portion of the connector is normally end mounted and is unsupported in the area where the forces of wire installation are applied. A standard wire installation tool as described above, would not be suitable for the installation of wires onto such a connector since it would require proper positioning of the insertion member in the associated slot to avoid injury to the wire stripping area of the contact and would cause a bending moment on the body of the connector between the mounts which might result in damage to the connector block.

The novel reaction tool described and claimed herein provides a quick and easy means in cooperation with the compatible miniaturized connector for positively

locating one or more wire insertion members in the appropriate slots of a connector block to prevent damage to the insulative portion of the connector block or the contact by the wire insertion member. The reaction tool of the present invention further provides a balanced reaction force by gripping the contact adjacent the point of wire installation and absorbs the force of the wire installation through the walls of the slots and back through the body of the tool. This reaction type tool thus permits installation of one or more wires in a connector of the type described without causing a bending moment on the connector block and with no net force on the mounts of the connector block.

It is an object of the present invention to provide a novel wire installation tool.

It is a further object of the present invention to provide an improved tool for the insertion of wires onto contacts.

Still a further object of the present invention is to provide a self-aligning reaction tool for installing wires onto the contacts of a connector quickly and efficiently.

These and other objects of the present invention will become clear in connection with the following detailed description of the invention taken together with the drawings in which:

FIG. 1 is a side elevational view of a preferred embodiment of the tool of the present invention ready for installation of a wire onto a compatible connector;

FIG. 2 is a top view of the tool and connector shown in FIG. 1;

FIG. 3 is a front view of a tool embodying the present invention with the connector gripping members opened;

FIG. 4 is a front view of the tool shown in FIG. 3 with the connector gripping members in a closed position;

FIG. 5 is a side elevational view of the tool of FIG. 1 with the housing partially removed to show the interior of the tool in the at rest position;

FIG. 6 is a view similar to FIG. 5 illustrating an intermediate position of the tool;

FIG. 7 is a view similar to FIG. 5 but illustrating the tool at full stroke;

FIG. 8 is a fragmentary view partly in section taken along lines 8—8 of FIG. 7;

FIG. 9 is an enlarged fragmentary view of a portion of the tool shown in FIG. 5 in the at rest position;

FIG. 10 is a front view of a tool with the connector gripping members misaligned on the connector;

FIG. 11 is a side view of the misaligned tool shown in FIG. 10;

FIG. 12 is a front view of a tool with the connnector gripping members properly aligned with a connector in the at rest position;

FIG. 13 is a side view of the aligned tool shown in FIG. 12;

FIG. 14 is a front view of a tool similar to FIG. 11 but showing the connector gripping members in the closed position;

FIG. 15 is a side view of the tool shown in FIG. 14;

FIG. 16 is a fragmentary sectional view of the front portion of the tool as it is being applied to a connector;

FIG. 17 is a view similar to FIG. 16 showing the connector gripping members in a closed position;

FIG. 18 is a view similar to FIG. 17 showing an intermediate position of installation;

FIG. 19 is a view similar to FIG. 18 showing the tool in the full stroke position;

FIG. 20 is a partial sectional view of an alternative embodiment of the tool of the present invention incorporating a first form of overload mechanism with the parts in the at rest position;

FIG. 21 is a view similar to FIG. 20 showing the tool in an intermediate installation position;

FIG. 22 is a view similar to FIG. 21 illustrating the tool in the full stroke position, but with the wire insertion member held short of its full stroke position and the overload mechanism actuated to accommodate the same;

FIG. 23 is a fragmentary view of the first form of overload mechanism taken along line 23—23 of FIG. 20;

FIG. 24 is a partial sectional view of a second alternative embodiment of the tool of the present invention incorporating a second form of overload mechanism with the parts in the at rest position;

FIG. 25 is a view similar to FIG. 24 illustrating an intermediate position of the tool;

FIG. 26 is a view similar to FIG. 25 showing a full stroke position of the tool but with the wire insertion member held short of its full stroke position and the overload mechanism actuated to accommodate the same; and

FIG. 27 is a fragmentary view taken along line 27—27 of FIG. 24 illustrating the second form of overload mechanism.

DETAILED DESCRIPTION OF THE INVENTION

Referring specifically to FIGS. 1 and 2, a preferred embodiment of the present invention is illustrated in the form of a reaction tool 110 positioned to insert insulated wire 32 onto a connector 24. In describing the connector, which is the subject matter of the previously mentioned co-pending application, the numbering system employed for the previous application will be maintained wherever possible with parts being given like numbers in both applications in order to facilitate an understanding of the relationship between the tool 110 and the connector 24. The connector 24, as can be seen in FIG. 2, includes a series of laterally disposed open-ended slots 86 extending from a central insulative core 85. The central core portion has embedded within it a series of contact strips 27 each of which has a pair of stripping and gripping areas 70 and 72 (FIG. 16) disposed at opposite ends of the contact strip extending into the slots 86 at their respective bases. At the outer lateral extremity of the walls forming the sides of the slots 86 and symmetrically disposed at opposite ends of the slots are a series of reaction surfaces 98 which are formed in the insulative material of the connector 24 and are each convex in the plan view to cooperate with the tool to assure positive location of the tool with respect to the preselected slots 86 prior to wire installation. Each reaction surface 98 faces toward the central core of the connector 24 which is also the direction of wire installation and they form the outer walls of a series of channels 100 each having a U-shaped profile and being adapted to cooperate with the tool 110 during wire installation. Further details of the connector 24 will be set forth in connection with the description of FIGS. 16–19.

Referring now to FIG. 5, a preferred embodiment of the reaction tool 110 of the present invention is shown in side elevational view with half of the housing removed so that the internal mechanism of the tool can be clearly observed. The reaction tool 110, in the illustrated embodiment, comprises a hollow tool body 111 in the shape of a pistol and having a central cavity. The tool body 111 includes a piston grip portion 112 and a forwardly extending body portion 113. A pivoted handle 130 is mounted within the tool body 111 and is positioned adjacent to the piston grip portion 112 for convenient gripping by the fingers of the user. The upper portion of the handle 130 within the tool body 111 includes an arm 133 and a drive leg 134. The arm 133 extends generally at right angles to the handle 130 and functions to mount a return spring and as part of a full stroke mechanism for the tool.

A full stroke mechanism including a pivotally mounted pawl 140 is positioned in the upper end of the pistol grip portion of the tool and cooperates with the arm 133 as will become apparent hereinafter. The drive leg 134 is connected to a drive mechanism including connecting rods 150 which are in turn connected to a pair of electrically isolated wire insertion members or blades 160 so that movement of the handle 130 causes the connecting rods 150 to move the insertion member forward with respect to the for-wardly extending body portion 113 of the tool body 11. A first connector gripping member 180 is rigidly mounted at the upper outer extremity of the forwardly extending body portion 113 and is adapted to cooperate with the reaction surfaces 98 on one corner of the connector 24. A second connector gripping member 200 is positioned on the lower outer extremity of the forwardly extending body portion 113 and is pivotally mounted so that its outer tip can move into and out of engagement with an oppositely disposed set of reaction surfaces 98 on the connector 24. The aforementioned parts are arranged to cooperate so that the movement of the handle 130 toward the pistol gripping portion 112 will cause the wire insertion members 160 to move toward the nose of the forwardly extending body portion 113 and simultaneously cause the second gripping member 200 to move into a gripping attitude with respect to the reaction surfaces 98 on the connector 24.

The tool body 111 which is made up of the pistol grip portion 112 and the integral forwardly extending body portion 113 is hollow and is preferably made of a suitable insulating material such as a moldable plastic. It can be seen from FIG. 2 that the width of the outer periphery of the tool is such that it can be easily held by the operator's hand and that the pistol grip portion and the handle are contoured to comfortably fit the human hand. The forwardly extending body portion 113 includes a pair of laterally disposed openings at its outer tip which act as mounting openings 114 and 115 for the first and second connector gripping members 180 and 200. At the lower wall of the forwardly extending body portion 113 adjacent the pistol grip 112, a handle receiving slot 116 is provided with a portion of the slot formed in each of the mating halves of the tool body which, in the illustrated embodiment, are essentially mirror images of each other so that the tool has a parting line as can be seen in FIG. 2 extending down its center.

The tool body is also provided with an inner partition 117 located forward of the handle receiving slot 116 and spaced from the lower wall of the forwardly extending body portion 113 to define on its upper surface

an insertion member guide floor 118 which is planar and extends from the central area of the tool forwardly to the outer extremity or nose of the body portion 113 to provide a flat surface permitting the reciprocal movement of the wire insertion members 160 in response to the movement of the handle 130. An opening in the guide floor 118 is provided in the forward extremity of the body portion 113 in the form of a lifter slot 119 the function of which will become apparent in connection with the detailed description of the insertion members 160 and the second connector gripping member 200. In addition to the guide floor 118, a rectangular open-ended guide channel for the wire insertion members is defined by a pair of parallel side walls 125 and a top wall 126 which combine in the nose of the tool to provide a rectangular passage extending forwardly between the connector gripping members 180 and 200.

The outer top wall 127 of the tool body is tapered toward the nose to provide a clear view by the operator of the slots 86 in the connector during wire installation. As can be seen from FIG. 1, the operator's line of sight 128 permits visual observation to confirm that the tool 110 is aligned with the proper slots prior to actuation of the tool. This feature prevents the possibility of installing only one of a desired pair of wires due to misalignment.

At the upper end of the pistol gripping portion 112, the illustrated half of the tool body 111 (FIG. 5) is provided with a threaded boss 120 which receives a screw 129 (FIG. 1) extending through an opening in the opposite half of the tool body in order to assit in holding the two halves of the tool is assembly. An additional threaded boss (not shown) is provided at the lower end of the pistol gripping portion to further assist in assembling the tool. At the upper extremity of the central cavity within the pistol gripping portion, a laterally extending pin 121 is positioned extending from the side wall of the cavity in order to affix and hold the end of a spring which constitutes part of the full stroke mechanism mentioned earlier. This pin 121 may be formed integrally with the wall or may be a separate metal pin inserted into an opening in the side wall. A second pin 122 extends from the same side wall parallel to the first pin and is adapted to mount the pawl 140 of the full stroke mechanism for pivotal movement during the operation of the tool 110. A return spring pin 123 is positioned in the lower end of the pistol gripping portion 112 to act as a fixed retainer for one end of a return spring for the handle 130. A large diameter pin 124 which acts as the handle pivot is positioned to extend between the two side walls of the tool cavity in the central area of the handle receiving slot 116 and also may be formed integrally or inserted in a suitable opening.

The handle 130 is formed from a flat sheet of metal such as steel and is formed in one piece which includes a downwardly depending elongated gripping leg 131, the arm 133 which extends at essentially right angles to the gripping leg 131 adjacent the pivot and the drive leg 134 which is formed as an upward extension of the gripping leg beyond the pivot point. The gripping leg 131 is covered with a suitable handle grip 132 made of rubber or other resilient material in order to facilitate operation of the tool when held in the operator's hand. The handle 130 is mounted on the handle pivot 124 by means of a pivot opening 135 which extends through the handle 130 at the juncture of the gripping leg 131, the arm 133 and the drive leg 134.

The drive leg 134 is provided with a drive link opeing 138 at its upper extremity which in the mounted position within the tool body 111 is just below the top wall midway along the forwardly extending body portion 113. The drive link opening 138 provides the connection to the connecting rods 150 which are in turn connected to the wire insertion members 160.

The arm 133 as mentioned earlier, has two distinct functions. It serves as a mount for one end of the return spring by providing an opening 136 which receives one hooked end of a return spring 137 the other end of which is hooked over the return spring pin 123 in the pistol grip so that the action of the return spring tends to cause the handle 130 to pivot in a clockwise direction as viewed in FIG. 5 until it reaches the at rest position. The second function of the arm 133 is to act as part of the full stroke mechanism of the tool which assures movement of the handle 130 through a complete insertion stroke before it can be released. In order to perform this function, the outer end of the arm 133 is provided with a series of teeth in the form of a ratchet 144 which is disposed facing toward the pawl 140 and is adapted to be engaged thereby.

The remainder of the full stroke mechanism includes the pawl 140 which is mounted on the pin 122 by means of a pivot hole 142 to permit free rotation of the pawl in the plane of the tool handle 130 and the arm 133. The pawl 140 further includes a tapered extension which terminates in a pawl tip 141 having corners suitably shaped to engage the teeth of the ratchet 144 as it passes the tip of the pawl during rotation of the handle 130 about the handle pivot 124. In order to dispose the pawl in the desired position to act as a full stroke mechanism and to return it to a neutral position when it is not engaged by the teeth of the ratchet 144 an eye 145 is provided on the opposite end of the pawl from the tip 141. The eye 145 is engaged by the end of a short tension spring 143. The tension spring 143 is in turn hooked over the full stroke spring pin 121 at the upper rear-most corner of the cavity of the tool body 11. As can be seen from FIG. 5, the tension of the spring 143 acts to keep the pawl in a position of rotation just out of contact with the teeth of the ratchet 144 when the handle is in the at rest position. In this position the ratchet 144 is positioned beneath the tip 141 of the pawl 140.

The connecting rods 150 are in the form of a pair of metal strips each having a first end 151 connected to the drive leg 134 and a second end 152 connected to the wire insertion members 160. The first end 151 and the second end 152 of each of the connecting rods 150 are offset from each other by a central offset portion 153 (FIG. 8) in such a manner that the first ends 151 are spaced apart and parallel to each other a distance approximately equal to the thickness of the handle 130. The first ends 151 are each provided with a suitable drive pin opening 154 and these openings are positioned on either side of the drive link opening 138 on the drive leg 134 and the pivotal connection is effected by means of a drive pin 156 extending through the three openings and suitably affixed.

The second ends 152 of the two connecting rods 150 are positioned against each other due to the offset portions 153 in each of the rods and each includes a blade pin opening 155. In the assembled tool, the two blade

pin openings **155** are located so that they are aligned. Thus the two connecting rods **150** provide a balanced pushing or pulling force on both the handle and on the wire insertion members or blades **160.**

Referring again to FIG. **8,** it can be seen that each of the wire insertion blades **160** consists of a flat, generally rectangular, thin plate of metal such as steel. Each insertion blade **160** is provided with a first blade opening **161** located at the rear end of the blade remote from the wire insertion surface and with a second blade opening **162** disposed midway along its length.

The forwardmost end of the wire insertion blades **160** constitutes the wire engaging surface **163** which actually makes contact with the insulated surface of the wire during installation of the wire onto the contacts of the connector. As can best be seen in FIG. **16,** the wire engaging surface **163** is provided with a series of recesses and relieved areas extending into the wire insertion blade toward the second blade opening **162.** The first recess **164** is in the form of a deep slot extending lengthwise into the wire insertion blade **160** and, in the illustrated embodiment, positioned closely adjacent to the upper elongated edge of the wire insertion blade **160.** A second recess **165** in the form of a shallower slot is positioned midway between the long sides of the wire insertion blade **160** and extends parallel to the sides to a depth approximately one-half the depth of the first recess **164.** A third recess in the form of a relieved area **166** extending parallel to the other two recesses and to a depth approximately equal to the depth of the first recessed area **164** is provided adjacent to the bottom long edge of the wire insertion blade **160.** The relieved area **166** is not cut through the blade in the form of a slot but is rather formed as a thinned down section (FIG. **3**) by a pair of shallow grooves positioned back-to-back on opposite sides of the blade **160.** As will become more apparent in connection with the later description of the installation of a wire, the first recess **164** and the relieved area **166** are to accommodate wire retention structures, built into the walls of the connector slots, during insertion of a wire. The second recess **165** is for the purpose of accommodating the end of a buried contact at the bottom of the slot during insertion of the wire.

The wire engaging surface **163** is further provided with a cutter blade **167** disposed adjacent its lower extremity close to the bottom side edge of the wire insertion blade **160** and extending forwardly from the wire engaging surface **163** so that in all positions of the blade the cutter blade **167** forms the outermost point of the wire insertion blade **160.** It is this cutter blade **167** positioned just below the relieved area **166** which receives highest stress during installation of a wire. Thus the relieved area **166** provides added strength to the blade which would not be provided by an open slot. The underside of each wire insertion blade **160** is provided with a triangular cutout having one side perpendicular to the lower edge of the blade to form a blade stop **169** at the forward end of the blade adjacent the relieved area **166** and a second angled side comprising a sloped lifter cam surface **168** extending from the deepest point of the blade stop **169** on an angle back to the lower edge surface of the wire insertion blade **160.**

Each of the wire insertion blades **160** is positioned within the rectangular blade receiving channel formed by the guide floor **118,** side walls **125,** and top wall **126.** The blades are held in sliding engagement with the side walls **125** by means of spacers best seen in FIG. **8.** As can be seen, the first blade openings **161** in the insertion blades **160** are positioned on either side of the matched blade pin openings **155** of the connecting rods **150** and are slightly larger in diameter than these openings. Each first blade opening **161** receives an insulating bushing **172** made up of an insulating collar **173** which is inserted in the opening and an insulating circular flange **174** which is positioned between the respective wire insertion blade **160** and the adjacent second and **152** of one connecting rod **150.** The outer insulating bushing **172** is positioned in the first blade opening **161** of the opposite blade **160** and is also positioned with its circular flange **174** disposed between the blade **160** and the respective adjacent second end **152** of the other connecting rod **150.** All of the aforementioned members are linked together by means of a blade pin **171** which extends through the blade pin openings **155** of the connecting rods **150** to form a pivotal connection between the connecting rods and the wire insertion blades **160.** This structure also provides, at that point, complete electrical isolation of the right-hand wire insertion blade from the left-hand wire insertion blade although they are commonly mounted by means of the common blade pin **171.**

This electrical isolation and spacing is further maintained by means of a blade spacer **170** (FIG. **8**) made entirely of insulating material in the form of a small disc **175** having a pair of short cylindrical stubs **176** extending from opposite sides thereof and having a common axis therewith. The disc **175** contacts the facing surfaces of the blades **160** and is of a suitable width to maintain the spacing of the wire insertion blades **160** so that they are positioned against the side walls **125** of the blade channel. The stubs **176** are received in the respective second blade openings **162** of the two wire insertion blades **160.** Thus, in movement of the blades **160** the blade spacer **170** is carried by means of the stubs **176** in the openings **162** to prevent the blades from assuming a spacing less than the disc **175** while the walls **125** of the channel set the outer dimension of the blade spacing so that the blades are provided with a fixed uniform and precise spacing which coincides with the spacing of the adjacent slots **86** on the connector **24.**

The reason for maintaining the insertion blades in electrical isolation from each other and from the remainder of the metallic parts of the tool is that the wires being installed are installed in pairs and often are in the hot or current carrying condition during installation. The isolation of the blades **160** thus prevents shorting between wire pairs while permitting simultaneous pair installation.

The first connector gripping member **180** which, in the illustrated embodiment, is fixed relative to the tool body **111** is mounted on the upper and outer extremity of the forwardly extending body portion **113** which has a cutout **196** to fit the inside shape of the gripping member **180.** The connector gripping member **180** includes a transverse wall **181** extending across the top of the tool and a pair of laterally disposed parallel side walls **182** and **183** each having a mounting pin opening **184** aligned on opposite sides of the tool body nose with the upper mounting opening **114** and affixed thereto by a mounting pin **194.** The transverse wall (FIG. **5**) is not of uniform thickness and is heavier at

its rear end to fit the cutout **196** on the tool body. The side walls **182** and **183**, as can best be seen in FIG. **1**, are of a lesser height at the outer tip of the tool and increase in height toward the main body of the tool. This shape causes the transverse or top wall **181** to taper downwardly to the front of the tool thus maintaining the operator's line of sight **128** referred to earlier. The outer end of the first connector gripping member **180** is formed by a curved transition **185** which merges the transverse wall **181** into a front wall **186** best seen in FIG. **3**. The front wall **186** is also connected to the side walls **182** and **183** so that the overall shape of the connector gripping member **180** is hood-like.

The front wall **186** is, when the tool is held in its normal vertical position as illustrated in FIG. **1**, vertically disposed and terminates in a linear channel engaging edge **187** (FIG. **3**) which is adapted to be placed in the bottoms of the channels **100** described earlier with respect to the connector **24**. Consequently, the thickness of the wall **186** is also slightly less than the width of the channels **100** so that the first connector gripping member can be easily inserted into the channels. The central area of the front wall **186** is provided with a pair of rectangular notches **188** best seen in FIGS. **3** and **4** spaced on either side of the vertical center line of the tool a distance equal to half the distance from center-to-center on the slots **86** of the connector. These notches **188** are precisely located and are suitably dimensioned to permit the wire insertion blades **160** to pass through the front wall **186** and into the slots of the connector **24** during insertion of a wire. The size of the notches **188** is selected to avoid any metal-to-metal contact between the wire insertion blades **160** and the notches to preserve the electrically isolated condition of the two blades **160**.

The channel engaging edge **187** of the front wall **186** is further provided with four alignment teeth. The first alignment teeth are a pair of outside teeth **189** and **190** extending downwardly from the channel engaging edge **187** as extensions of the front wall **186** and each having a width slightly less than the undistorted width of the slots **86** of the connector **24**. A pair of inside alignment teeth **191** and **192** are positioned on each side of the pair of notches **188** intermediate the notches and the outside teeth **189** and **190**. Each of these teeth is also formed as an extension of the wall **186** and extends in its plane downwardly in a manner similar to that described with respect to the outside teeth. The inside teeth **191** and **192** are also of appropriate width to be snugly but easily received in the slots **86** of the connector.

Each inner and outer alignment tooth is provided with a radiused tip **195** which cooperates with the convex bearing surface **98** described earlier to provide a self-aligning feature for the tool of the present invention. Each radiused tip **195** has an axis perpendicular to the front wall **186** of the connector gripping member **180**. The four alignment teeth, as can best be visualized from FIGS. **2** and **14**, span six slots and are designed to be received in two slots on each side of the pair of slots into which the wires are to be installed. As will become apparent hereinafter, if these alignment teeth are not received into the appropriate slots **86**, the tool **110** will not properly seat on the connector **24**. Thus there is no danger of installing the wires with the tool misaligned. The back side of the front wall **186** adjacent the channel engaging edge **187** is flat and uninterrupted and constitutes an elongated bearing surface **193** facing toward the tool and adapted to engage five bearing surfaces **98** simultaneously with one of the bearing surfaces being positioned between the notches **188** and the remainder of the bearing surfaces positioned between the aligment teeth (FIG. **14**) to provide a symmetrical reaction force during installation of the wire and to prevent side-to-side twisting of the tool with respect to the connector during wire insertion.

The second connector gripping member **200** is similar in shape to the first connector gripping member **180** and includes a transverse wall **201** extending under the nose of the tool, a pair of vertically disposed side walls **202** and **203** each having a mounting pin opening **210** aligned with the lower mounting opening **115** in the nose of the tool. Pivotal mounting of the second connector gripping member **200** is effected by means of a suitable mounting pin **211** extending through the opening **115** and through the mounting pin openings **210** in the side walls. The underside of the tool nose has a cutout **197** similar to the cutout **196** on the top wall. The transverse wall **201** is of uniform thickness and does not mate with the cutout **197** thus providing clearance for pivoting of the member **200**. As in the case of the first connector gripping member **180**, the second connector gripping member **200** is provided with a front wall **204** which is connected to the transverse wall **201** across its front end. The front wall **201** terminates in a linear upwardly disposed channel engaging edge **205**. The general shape of the second connector gripping member **200** as was the case with the first connector gripping member **180** is that of a hooded nose having transverse, side and front walls connected along their respective edges.

The channel engaging edge **205** can best be seen in FIGS. **3** and **4** and is interrupted by a pair of rectangular notches **209** which are similarly spaced from the center line similarly dimensioned to the notches **188** in the first connector gripping member. The notches **209** are also for the purpose of permitting passage of the lower portions of the wire insertion blades **160** through the nose of the tool and into the respective slots of the connector without causing electrical contact between the insertion blades **160** to be established. The front wall **204** is also of a thickness somewhat less than the width of the channels **100** in the connector so that the second connector gripping member **200** can be easily received into the row of channels **100** immediately opposite the row which receives the first connector gripping member **180**. The inner surface of the front wall **204** constitutes a flat bearing surface **206** disposed toward the tool body and adapted to engage five bearing surfaces **98** on the connector in symmetrical fashion in the same manner as was described with respect to the bearing surface **193** of the first connector gripping member (FIG. **14**). The side walls **202** and **203** of the second connector gripping member **200** are for the most part quite thick walled and act as spacers to prevent lateral shifting of the member relative to the tool body **111** during pivotal movement of the member **200** on the pin **211**. In the area adjacent the front wall **204**, however, each side wall **202** and **203** is provided with a relieved area **208**, best seen in FIGS. **4** and **9**, to provide a pair of guiding or stabilizing surfaces **207** disposed directly below and having the same width as the outside alignment teeth **189** and **190** of the first connector gripping member **180**. These stabilizing surfaces

297 also assist in the alignment of the tool on the connector as will become apparent hereinafter.

In order to effect the desired movement between the connector gripping members 180 and 200 for positioning and removing the tool 110 from the connector 24 a cam means in the form of a lifter 212 is positioned in the lifter slot 119 in the lower wall of the nose of the tool and is mounted for sliding vertical movement in the slot 119 between an at rest position (FIG. 9) in which it extends above the insertion member guide floor 118 and abuts the blade stops 169 of the two wire insertion blades 160 and the installation position in which it extends from the slot 119 below the lower wall of the tool nose into the cutout 197 in engagement with the inner side of the transverse wall 201 of the second connector gripping member 200. Because the lifter 212 engages the underside of both insertion blades 160 it is made of electrically insulative material to maintain electrical isolation of the blades 160. The contact with the member 200 is made at a point on the opposite side of the mounting pin 211 from the front wall 204, thus causing the connector gripping member 200 to pivot in a clockwise direction as viewed in FIG. 6 so that the channel engaging edge 205 closes on the channels 100 beneath the connector 24 to lock the second connector gripping member 200 in the installation position for the duration of the cycle. This movement of the lifter 212 is accomplished by means of the sloped lifter cam surface 168 engaging the top of the lifter 212 at the initiation of the installation cycle and quickly forcing the lifter 212 into its lowermost position thus rendering the first and second connector gripping members 180 and 200 in a closed position with respect to each other. The return of the second connector gripping member 200 to the open position at the end of the cycle is caused by a compression spring 213 positioned in a suitable recess in the nose of the tool 110 and contacting the transverse wall 201 of the second connector gripping member 200 on the side of the pin 211 opposite the location of the lifter 212. Thus, when the wire insertion blades 160 are retracted, the action of the compression spring 213 causes the second connector gripping member 200 to pivot counterclockwise as viewed in FIG. 9 pushing the lifter 212 upwardly in the lifter slot 119 and maintaining engagement of the top end of the lifter 212 with the sloped lifter cam surface 168 until the blade 160 has returned to a fully retracted position in which the blade stop 169 engages the side of the lifter 212 completing the cycle.

It should be understood that although the lower connector gripping member 200 is illustrated as being movable, it is within the scope of the present invention to have either the first connector gripping member 180 pivotable or to have both connector gripping members pivotable. It is also within the scope of the present invention to have alignment teeth on either or both connector gripping members.

A better understanding of the tool 110 of the present invention will be facilitated by an explanation of the operation of the tool 110 during the installation of a wire. In making this explanation, reference will be made to two sequences of drawings. The first sequence, illustrating the internal operation of the tool 110 is FIGS. 5–7 and the second, illustrating the relationship of the tool nose to the connector 24, is FIGS. 16–19. Referring first to FIG. 5, the tool 110 is shown in the at rest position with the blades 160 fully retracted and the pawl 140 of the full stroke mechanism disengaged from the handle 130. In FIG. 6, the handle 130 has been rotated counterclockwise on the handle pivot 124 through approximately one-half of a full stroke. In this intermediate position, the pin connections of the drive leg 134 to the connecting rods 150 and to the wire insertion blades 160 have caused the wire insertion blades 160 to move outwardly with respect to the extremity of the nose of the forwardly extending body portion 113. This same movement of the wire insertion blades 160 has already caused the sloped lifter cam surface 168 to act downwardly on the lifter 212 causing it to move vertically in the lifter slot 119 to pivot the second connector gripping member 200 into a closed position for gripping the reaction surfaces of a connector 24. At the same time, the compression spring 213 has been compressed on the opposite side of the mounting pin 211 so that the second connector gripping member 200 is urged back toward an open position at any time that pressure is relieved from the upper end of the lifter 212. In FIG. 6, one insertion blade 160 has been removed to show the insulative bushing 172 and spacer disc 175.

Also in this intermediate position, the full stroke mechanism has come into play and the pawl tip 141 has been displaced in a clockwise direction from its at rest position by engagement with the teeth of the ratchet 144. In this position the spring 143 attached to the pawl 140 urges the pawl 140 back toward the at rest position maintaining it in engagement with the teeth of the ratchet 144. The spacing of the ratchet 144 from the pivot of the pawl 140 is small enough that the tip 141 of the pawl 140 cannot possibly pass over center while in engagement with the ratchet 144. Thus the lines of force between the teeth of the ratchet 144 and the tip of the pawl 141 extend over the top of the center line of the handle pivot 124. Thus, even when the handle 130 is released by the operator in this position and the action of the return spring 137 urges the return of the handle to the at rest position, the engagement of the pawl tip 141 with the ratchet teeth 144 prevents the clockwise motion of the handle 130 from occurring.

Referring now to FIG. 7, the tool 110 is shown in its full stroke position. In this position, the wire insertion blades 160 are extended substantially beyond the tip of the tool nose and beyond the first and second connector gripping members 180 and 200 corresponding to the position wherein the wire is fully installed. The significant difference in the internal condition of the tool 110 in this view from that of the prior view is the return of the pawl 140 to its at rest position due to the continued action of the spring 143 and due to the clearance of the pawl tip 141 beyond the lower end of the ratchet 144, thus permitting free pivotal movement of the pawl 140. In this position, if the operator lets the handle 130 free, the action of the return spring 137 causes clockwise movement of the handle toward the at rest position. During the intermediate position which is not shown, the ratchet 144 engages the tip 141 of the pawl 140 and displaces it in the opposite rotational direction from its at rest position thus assuring completion of the return of the handle 130 to the at rest position which again places parts of the tool 110 in the positions shown in FIG. 5.

As a consequence of this return movement, the compression spring 213 acts to cause the second connector gripping member 200 to pivot in a counterclockwise

manner as the lifter 212 is permitted to return to its at rest position by the sloped lifter cam surface 168. The at rest or retracted position of the entire mechanism is established by the bearing action of the blade stop 169 against the side of the lifter 212 which balances the remaining force of the return spring 137. It should be obvious to those skilled in the art, however, that many other types of stops could be employed at various locations throughout the tool body to further guarantee the at rest position desired.

Referring now to FIGS. 16–19, the nose of the tool 110 is illustrated in a sequence of installation steps in conjunction with the compatible cooperating conductor 24 described in some detail earlier and in greater detail in the aforementioned copending patent application. In FIG. 16, a wire 32 is positioned adjacent the wire gripping area 70 of the contact strip 27 in one of the slots 86 of the connector 24. The walls of the slots are provided at their upper and lower ends with a pair of channels 100 as described earlier and a pair of convex reaction surfaces 98 also as described earlier. In this view, the wire 32 is held adjacent the stripping and gripping area 70 by means of wire restraining means in the form of protrusions 90 extending from the walls (one wall being shown in FIG. 16) of the slot 86 and spaced above and below the contact strip 27, the distances corresponding to the spacing of the first recess 164 and the relieved area 166 of the wire insertion blades 160 on either side of the second recess 165 which accommodates the stripping and gripping area 70 during insertion. Each slot also includes wire retaining means in the form of projections 92 spaced on one side of the contact strip 27 in the slot 86 the same distance toward the end of the slot as are the protrusions 90. The projections 92 act to hold the installed wire at the bottom of the slot 86. The nose of the tool 110 is positioned at an angle to the connector 24 with the channel engaging edge 187 of the first connector gripping member placed in the upper channel 100 in the slot wall. In order for this positioning to be effected the alignment teeth (shown in phantom) of the first connector gripping member 180 must be properly aligned with respect to the slots 86 so that they extend into the slots 86 as illustrated. Otherwise, the channel engaging edge 187 cannot seat in the bottom of the channel 100 in the manner illustrated. It should also be noted with respect to FIG. 16, that the second connector gripping member 200 and the wire insertion blades 160 are in the at rest position, thus permitting adequate clearance for the lower channel engaging edge 205 to clear the lower end of the slot wall in order to assume the appropriate position for installation of the wire.

In FIG. 17, the wire insertion members 160 have moved slightly to the left and the sloped lifter cam surfaces 168 have driven the lifter 212 downwardly causing the second connector gripping member 200 to pivot to the closed position engaging the lower channels 100 directly beneath the upper channels 100 and directly beneath the channel engaging edge 187 of the first connector gripping member 180. In this position, the wire engaging surfaces 163 and the cutter blades 167 of the wire insertion blades 160 have not engaged the wire, consequently no force is applied between the respective bearing surfaces 193 and 206 of the connector gripping members and the reaction surfaces 98 of the connector 24 and the channel engaging edges 187 and 205 merely rest in the bottom of the respective channels 100.

In FIG. 18, the positions of the parts of the tool 110 have changed in two respects. The wire insertion members 160 have now extended beyond the nose of the tool 110 so that the wire engaging surfaces 163 are in engagement with the wires 32 as are the tips of the cutter blades 167. In this intermediate position, each wire is just beginning to be forced onto the stripping and gripping area 70 and over the wire retaining projections 92 by the force of the wire insertion blades 160. It can also be seen that the first recess 164 and the relieved area 166 have already begun to pass the wire restraining protrusions 90 which due to the positive positioning of the tool and the respective recesses are left intact during the passage of the blade for use in installation of other wires at a later time. Also in this intermediate position, the forces have built up between the bearing surfaces 98 on the connector 24 and the bearing surfaces 193 and 206 on the respective first and second connector gripping members.

In FIG. 19, the wire 32 is fully installed and the wire insertion members 160 are at their extreme position of extension beyond the nose of the tool 110. The first recess 164 has accommodated the wire retaining projection 92 in addition to the upper wire restraining protrusion 90, and the second recess has accommodated the tip of the stripping and gripping area 70 without causing destruction thereof. The cutter blade 167 has pressed the lower end of the wire 32 against the bottom wall of the slot 86 and has passed through the wire at this point severing the free end.

FIG. 19 illustrates in detail the full stroke and consequently highest force position of the tool. It can be seen even in this position, that the force of installation is absorbed by balanced reaction surfaces 98 on the connector 24 and surfaces 193 and 206 on the tool 110 providing parallel lines of forces disposed at equal distances on opposite sides of the contact strip 27.

Upon release of the handle 130, parts of the tool 110 are automatically returned to the at rest position and are ready for another cycle. It should be understood with respect to all of the foregoing explanation that in the preferred embodiment of the tool 110, a pair of wires 32 in adjacent slots 86 are being simultaneously installed by the action of two identical and parallel acting wire insertion members 160 and that the reaction surfaces and the channels 100 are in fact, rows of discrete channels and reactions surfaces extending along the connector 24 as illustrated in FIG. 2 to provide a balanced reaction force in the side-to-side direction as well as the vertical direction mentioned just above.

FIGS. 10–15 are a sequence of front and side views illustrating the self-aligning features of the tool 110 and the connector 24. In FIGS. 10 and 11, the tool 110 is positioned so that the alignment teeth 189, 190, 191 and 192 are located directly on the convex bearing surfaces 98 rather than being positioned in the slots 86 which would properly align the notches 188 and 209 and consequently the wire insertion members 160 with the desired slots for wire insertion. This misalignment can be readily seen from FIG. 10 which is taken looking into the jaws of the tool 110 and at the convex reaction surfaces 98. It should be noted from this view, that the radiused tips 195 of the alignment teeth form essntially a point contact with their respective convex bearing surfaces 98, and with the bottom of the associated

channel **100.** In this position of misalignment, as can be seen from FIG. **11,** the alignment teeth which normally would go down into the slots **86** and extend below the bottom of the channels **100** cannot proceed further than the bottom of the channels **100** in the misaligned position. Thus, the tool will not seat properly and the channel engaging edge **187** of the first connector gripping member **100** cannot reach the bottom wall of the channel **100.** In this misaligned position, there is no danger of the connector gripping member **180** and **200** being closed allowing the wire insertion members **160** to be positioned against the outer extremities of the walls of the slots **86** since as can be clearly seen from FIG. **11,** wherein the connector gripping members **180** and **200** are in the open position, there is not sufficient room for the lower channel engaging edge **205** which is continuous, except for the notches **209,** to clear the second ends of the slot walls reaching a position below the lower channels **100.** Thus, in the misaligned position there is no possibility of the tool **110** being inserted to a point where the handle **130** can be moved closing the connector gripping members **180** and **200** and moving the wire insertion members **160** forward.

In addition to this preventative feature in the event of misalignment, it can be seen that the point-to-point contact between the radiused tip **195** of each alignment tooth and the convex surface of the associated reaction surfaces **98** will upon application of any pressure cause the tool **110** to tend to align in the proper slots **86** by having the alignment teeth slide off the convex reaction surfaces **98** thus permitting the alignment teeth **189–192** to fall into the appropriate slots **86** and assume the aligned position of the tool **110** with respect to the connector **24** as shown in FIG. **12.** It should be pointed out that the alignment of the tool **110** with respect to the connector **24** requires virtually no effort on the part of the operator beyond an initial attempt to align the tool **110** with the respective slots **86** into which the two wires **32** are to be positioned. The tool **110** will then align itself in the position shown in FIGS. **12** and **13** moving either to the left or to the right depending on the side to which it is misaligned. In FIGS. **12** and **13** it can be seen that the alignment teeth **189–192** are positioned respectively in the slots **86** and extend below the bottoms of the channels **100** in engagement with the sides of the slot walls thus positively positioning the tool **110** longitudinally of the connector **24** and assuring the positive alignment of the notches **188** with a pair of slots so that the wire insertion blades **160** will not interfere with the walls of the slots **86** and will properly insert the desired pair of wires **32.** It can also be seen from FIG. **13** that in the aligned position with the alignment teeth **189–192** extending respectively down into the slots **86** below the base of the channels **100,** the channel engaging edge **187** rests on the bottom of the channels **100** and permits the lower channel engaging edge **205** to clear the lower extremity of the slot walls and position itself directly below the lower channel **100** in position to grip the connector **24.** In this position, the relieved area **208** is positioned directly outside the extremity of the wall of the slot **86** and the stabilizing surface **207,** which was described earlier, is partially inserted into the slot **86** offering an additional alignment feature prior to the closing of the second connector gripping member **200.** In achieving the position of FIGS. **12** and **13** the alignment teeth **189–192,** the edge **187** and the surface **207** have all acted as camming and guiding surfaces to promote alignment. In FIGS. **14** and **15,** the handle **130** of the tool **110** has been moved sufficiently to cause the lower connector gripping member **200** to assume the closed position in which the channel engaging edge **205** rests on the floor of the lower channels **100** and the bearing surface **206** lies against the bearing surfaces **98** on the underside of the connector **24.** In this position of the connector gripping members **180** and **200** with respect to the connector **24,** the tool **110** is ready for a full cycle insertion of a wire **32** or a pair of wires **32** onto the connector **24.**

Referring now to FIGS. **20–27,** two alternate embodiments of the tool of the present invention are illustrated. Each embodiment differs from the tool **110** described with respect to the other figures only in the provision of an overload mechanism to prevent damage to the connector **24** or the tool **110** from an improper usage such as the insertion of a second wire **32** into the same slot **86** where another wire **32** is already positioned. In describing the alternate embodiments, the same numerals will be employed as in the earlier description for identical parts with the subscripts a and b to designate which alternate embodiment is being referred to. In the embodiment of FIGS. **20–23,** the tool **110***a* includes an overload mechanism in the form of a collapsible linkage **220** extending between the drive leg **134***a* and the first blade openings **161**a of the wire insertion members **160***a*. The collapsible linkage **220** is made up of three flat links best illustrated in FIG. **23.** The first link **221** is provided with a pair of openings **222** and **223** adjacent its opposite ends and with a small spring receiving opening **224** at about its midpoint for anchoring one end of a flexure spring **235.** The first link also includes a tab **225** disposed at the end of the link remote from the wire insertion members adjacent the opening **223** and extending outwardly from the end of the link to cooperate with a stop on the third link. The opening **222** is connected to the first blade openings **161***a* of the two wire insertion members **160***a* by means of a blade pin **171**a to provide a pivotal connection similar to that shown in FIG. **8.**

The second link **226** is also a flat strip of metal containing two openings **227** and **228** at its opposite ends. The opening **227** is positioned adjacent the opening **223** of the first link. The third link **229** is a strip of metal similar to the second link and having a pair of opening **230** and **231** spaced apart along the link a distance equal to the spacing of the openings **227** and **228.** The third link is also provided with a spring receiving opening **232** similar to the opening **224** in the first link and a stop **233** formed by bending a tab along one edge of the link at a right angle to the plane of the third link. The second and third links are connected to the first link at the opening **223** by means of a pin **234** inserted through the openings **227** and **230** of the second and third links respectively. The second and third links are connected to the drive leg **134***a* by means of a pin **156***a* extending through the openings **228** and **231.** In this assembled condition, the tab **225** engages the top of the stop **233** as can best be seen in FIG. **20** to prevent the pivotal connection between the respective links made by the pin **234** from being able to rotate through a full circle. The tab **225** and the stop **233** are positioned so that when they prevent further movement of the links with respect to each other, the center line extending through the center of the openings **222** and **223** of the

first link, as extended would pass above the center of the pin **156***a* where the second and third links are connected to the drive leg **134***a*. Thus, the assembly is never permitted to extend to a full 180° angle or dead center along the center lines of the respective openings of the collapsible linkage.

The flexure spring **235** is positioned over the top of the linkage and extends from the spring receiving openings **224** to the spring receiving opening **232**. In the illustrated embodiment the spring is a straight flexure spring having no coils and extends over the joint formed between the respective links by the pin **234**. The spring **235** is at all times slighty flexed when its ends are in openings **224** and **232**; thus it has a tendency to force the linkages toward a straight line position and causes the tab **225** to maintain engagement with the stop **233** under normal operating conditions of the tool.

In FIG. **20**, the tool is shown in the at rest position which is also the position in which the flexure spring is the controlling force and the tab **225** and the stop **233** are in contact. In FIG. **21**, the tool **110***a* is shown in intermediate position wherein the blade and the wire insertion members **160***a* are beginning to emerge from the nose of the tool. In this position the collapsible linkage **220** is still in the relatively straight position and the spring **235** is in control of the linkage. If the tool **110***a* is properly aligned and no unusual obstructions are encountered the spring **235** is strong enough that the linkage will maintain this position throughout the installation cycle. If, however, the tool **110***a* should be misaligned or there should be some obstruction in the slot **86**, the overload mechanism comes into play as illustrated in FIG. **22** in which the outer end of the wire insertion members **160***a* remains in approximately the same position as in the previous FIG. **21** and the force of the obstruction against the wire insertion member has overcome the straightening effect of the spring **235** causing the linkage **220** to buckle or collapse. This feature is particularly useful in connection with the full stroke mechanism since it permits the handle **130***a* of the tool to proceed through a full cycle disengaging the pawl tip **141***a* from the ratchet **144***a* and permitting the handle **130***a* to be returned to the at rest position without damaging either the tool **110***a* or the connector **24**. In the absence of the overload mechanism the full stroke mechanism would prevent completion of the handle cycle without the wire insertion members **160***a* themselves going through a full cycle at the same time.

In the second embodiment illustrated in FIGS. **24–27**, a tool **110***b* having a second collapsible linkage **240** working on a different principal is illustrated. In the illustrated embodiment the overload mechanism is again substituted for the connecting rods **150** of the original embodiment and extends between the drive leg **134***b* and the wire insertion members **160***b*. This embodiment of the overload mechanism includes a telescoping assembly and a compression spring. The portion of the assembly connected to the wire insertion members **160***b* is a hollow tubular sleeve **241** having a circular central recess **242** extending through part of its length and open at one end. The closed end is provided with a tab **243** extending from the closed end of the tubular sleeve and having an opening **244** connected to the wire insertion members by means of a pin **171***b* to form a pivotal connection. The walls of the tubular sleeve are provided with a pair of slots **245** disposed on opposite sides of the sleeve **241** and extending part of the way from the bottom of the tubular recess to its open end.

The second member **246** is in the form of a circular rod **247** of a suitable diameter to be slidably received within the tubular recess of the sleeve **241**. It includes at its outer end a pin **248** extending laterally therethrough and into the slots **245** to provide an upper and lower stop for the telescoping action of the rod **247** within the tubular recess **242**. At the opposite end of the rod **247** a yoke is provided in the form of a U-shaped piece of metal rigidly affixed to the end of the rod **247**. The base **249** of the U is wider than the diameter of the rod **247** and parallel side walls **250** and **251** are spaced apart a sufficient distance to receive the upper end of the drive leg **134***b*. The outer end of the legs **250** and **251** are provided with openings **252** and **253** which receive a pin **156***b* to form the pivotal connection with the drive leg **134***b*.

A compression type coil spring **255** is positioned closely surrounding the rod **247** and is compressed between the base **249** of the yoke and the upper rim of the walls of the tubular recess **242**. Due to the compression forces of the spring the linkage is, in its normal position, held in its fully extended position with the pin **248** against the stop formed by the outer end of the slots **245**. The sequence in FIGS. **24, 25** and **26** is similar to that shown and explained with respect to FIGS. **20–22** and illustrates the tool in the at rest position with the overload mechanism fully extended in FIG. **24**, in the intermediate position with the overload fully extended in FIG. **25**, and in the overloaded position with the overload mechanism fully telescoped in FIG. **26**.

As was the case with the earlier described overload mechanism, the strength of the spring is such that under normal circumstances a full installation cycle would be completed without any telescoping action of the overload mechanism. In the event, however, that the wire insertion members **160***b* should strike an obstruction preventing their further movement, the telescoping of the overload mechanism overcoming the force of the spring **255** permits the handle **130***b* to proceed through a full cycle permitting the tool **110***b* to be released without damage to the connector **24**.

In an illustrative embodiment of the cooperating portions of the wire termination and splicing system of the present invention, the center-to-center spacing of the slots **86** of the connector **24** is 0.120 inches, and the width of the slots **86** themselves is 0.05 inches, the lateral dimension of each channel **100** is 0.05 inches and the outer edge or bearing surface **98** of the channel **100** is spaced 0.05 inches from the adjacent outer edge of the connector **24**. The outermost edge of the wire restraining protrusion **90** is located 0.10 inches from the center line of the contact strip **27**, is spaced from the opposed protrusions **90** a distance of 0.025 inches and has a width measured in the same direction as the width of the recessed area in the insertion blades **160** of 0.025 inches. The projections **92** are also spaced from the center line of the contact strip **27** to their outermost edge a distance of 0.10 inches and are of the same width 0.025 inches as the wire restraining protrusions. The first connector gripping member **180** includes a center-to-center spacing of the notches **188** and of the alignment teeth **189–192** of 0.120 inches. Each of the alignment teeth has a width of 0.046 inches

and the front wall **186** at the channel engaging edge **187** has a thickness of 0.045 inches. The width of the notches **188** is 0.060 inches. The second connector gripping member **200** also is provided with the notches **209** having a center-to-center spacing of 0.120 inches and each having a width 0.060 inches. The front wall in the channel engaging edge **205** has a thickness of 0.045 inches.

The wire insertion member **160** has a thickness of 0.045 inches the recess **164** has a width of 0.040 inches and a depth of 0.250 inches. The recess **165** has a width of 0.030 inches and the relieved area **166** has a width of 0.040 inches and a depth of 0.250 inches. The wall thickness of the relieved area **166** is 0.020 inches. The spacing from the center line of the recess **165** to the outer edge of the recesses **164** and **166** is 0.110 inches.

It will be evident to those skilled in the art that the relationship of the reaction surfaces on the connector and on the tool to the contacts is not limited to the exact geometry shown. In the preferred embodiment of the present invention, the reaction surfaces **98** have been illustrated as being symmetrically disposed with respect to the particular pair of contacts **27** onto which a wire or pair of wires is to be installed. It is within the scope of the present invention for the geometry of the connector and the tool to vary so long as certain conditions are met. Two or more reaction surfaces are required to be simultaneously engaged by compatible reaction members on a compatible tool. The balanced reaction forces need not be equal on each reaction surface engaged by the tool. It is sufficient for the purposes of the present invention that the resultant of all reaction forces be essentially equal, opposite and colinear with the resultant of all insertion forces. It is inherent in such a structure that for a connector having similar contacts and similar wires these resultant forces will be located substantially within an area defined by the particular reaction surfaces engaged by the tool and transverse to the direction or path of wire insertion. In such a case, there will be no rotational influence or twisting force on the connector as a whole nor on the tool outside of the area bounded by the reaction surfaces even if the reaction surfaces are disposed at different distances from the stripping and gripping area or are displaced laterally of each other on the connector block. In other words, if the connector block were suspended in mid air within the gripping members of the reaction tool, a wire could be inserted by operation of the tool with no other force being exerted on the connector.

It is understood that the present invention is not restricted to the specific embodiments set forth above in the specification and is limited only by the scope of the claims.

What is claimed is:

1. A reaction tool for installing insulated wires on a connector having a slotted block with wire stripping and gripping contacts in the slots and reaction surfaces adjacent to the slots, said reaction tool comprising a tool body, a connector gripping member mounted on said tool body and including bearing surfaces contacting the reaction surfaces on the connector block, a wire insertion member mounted on said body for movement between a retracted position and a wire installed position with respect to a contact in an associated slot, an alignment tooth on said connector gripping member engageable in one of the slots in the connector block to align said wire insertion member with an associated slot, and drive mechanism for moving said wire insertion member from the retracted position to the wire installed position to force an associated insulated wire onto a contact, thus to cause the contact to strip the insulation from the wire and to grip the wire to make good electrical and mechanical connection therewith.

2. The reaction tool set forth in claim **1**, wherein two alignment teeth are provided on said connector gripping member engageable respectively in the slots disposed on both sides of the slot with which said wire insertion member is to be aligned.

3. The reaction tool set forth in claim **1**, wherein a plurality of teeth is provided on said connector gripping member and engageable in slots disposed on both sides of and adjacent to the slot with which said wire insertion member is to be aligned.

4. The reaction tool set forth in claim **1**, for use with a slotted block in which the reaction surfaces adjacent to the slots are the walls of a channel on the surface of the block, wherein said connector gripping member is provided with a channel engaging projection extending into the associated channel for engagement with the reaction surfaces, and said alignment tooth is on said channel engaging projection and extends therefrom and into the associated slot.

5. A reaction tool for installing insulated wires on a connector having a slotted block with wire stripping and gripping contacts in the slots and spaced first and second reaction surfaces on the opposite ends of the slots, said reaction tool comprising a tool body, first and second connector gripping members mounted on said tool body for movement between a disengaged position and an engaged position with respect to the first and second reaction surfaces, a wire insertion member mounted on said tool body for movement between a retracted position and a wire installed position with respect to a contact in an associated slot, camming and guiding surfaces on said connector gripping members cooperating with the first and second reaction surfaces on the connector block to align said wire insertion member with an associated slot, and a drive mechanism for moving said connector gripping members from the disengaged position to the engaged position and for moving said wire insertion member from the retracted position to the wire installed position, said drive mechanism rapidly moving said connector gripping members to the engaged position gripping said connector to position said wire insertion member in alignment with a slot and thereafter moving said wire insertion member to the wire installed position to force an associated insulated wire onto a contact, thus to cause the contact to strip the insulation from the wire and to grip the wire to make good electrical and mechanical connection therewith.

6. A reaction tool for installing insulated wires on a connector having a slotted block with wire stripping and gripping contacts in the slots and reaction surfaces adjacent to the slots, said reaction tool comprising a tool body having a pistol grip portion and a forwardly extending body portion, a connector gripping member mounted on said tool body and including guide surfaces contacting the reaction surfaces on the connector block, a wire insertion member mounted on said forwardly extending body portion for movement between

a retracted position and a wire installed position disposed forwardly with respect to said connector gripping member, an alignment tooth on said connector gripping member engageable in one of the slots in the connector block to align said wire insertion member with an associated slot, drive mechanism for moving said wire insertion member from the retracted position to the wire installed position to force an associated insulated wire onto a contact, and a handle pivotally mounted on said tool body adjacent to said pistol grip portion for engagement by the hand of a user and connected to said drive mechanism for manual actuation thereof.

7. A reaction tool for installing insulated wires on a connector having a slotted block with wire stripping and gripping contacts in the slots and spaced first and second reaction surfaces on the opposite ends of the slots, said reaction tool comprising a tool body having a pistol grip portion and a forwardly extending body portion, first and second connector gripping members mounted on the outer end of said forwardly extending body portion for movement between a disengaged position and an engaged position with respect to the first and second reaction surfaces, a wire insertion member mounted on the said forwardly extending body portion for movement between a retracted position and a wire installed position disposed forwardly with respect to said connector gripping members, camming and guiding surfaces on said connector gripping members cooperating with the first and second reaction surfaces on the connector block to align said wire insertion member with an associated slot, drive mechanism for moving said connector gripping members from the disengaged position to the engaged position and for moving said wire insertion member from the retracted position to the wire installed position, and a handle pivotally mounted on said tool body adjacent to said pistol grip portion for engagement by the hand of a user and connected to said drive mechanism for manual actuation thereof, said drive mechanism rapidly moving said connector gripping members to the engaged position gripping said connector to position said wire insertion member in alignment with a slot and thereafter moving said wire insertion member to the wire installed position to force an associated insulated wire onto a contact, thus to cause the contact to strip the insulation from the wire and to grip the wire to make good electrical and mechanical connection therewith.

8. A reaction tool for installing insulating wires on a connector having a slotted block with wire stripping and gripping contacts in the slots and spaced first and second reaction surfaces on the opposite ends of the slots, said reaction tool comprising a tool body, first and second connector gripping members mounted on said tool body for movement between a disengaged position and an engaged position with respect to the first and second reaction surfaces, a wire insertion member mounted on said tool body for movement between a retracted position and a wire installed position with respect to a contact in an associated slot, a cutting blade mounted on said tool body for movement between a retracted position and a cutting position with respect to a wire in the bottom of an associated slot, camming and guiding surfaces on said connector gripping members cooperating with the first and second reaction surfaces on the connector block to align said wire insertion member and said cutting blade with an associated slot, and a drive mechanism for moving said connector gripping members from the disengaged position to the engaged position and for moving said wire insertion member from the retracted position to the wire installed position and for moving said cutting blade from the retracted position to the cutting position, said drive mechanism rapidly moving said connector gripping members to the engaged position gripping said connector to position said wire insertion member in alignment with a slot and thereafter moving said wire insertion member to the wire installed position to force an associated insulated wire onto a contact and moving said cutting blade to the cutting position to trim the insulated wire adjacent to the contact.

9. The reaction tool set forth in claim 8, wherein said camming and guiding surfaces have openings therein for receiving therethrough said wire insertion member and said cutting blade.

10. The reaction tool set forth in claim 8, wherein said wire insertion member and said cutting blade are integral with each other.

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