

[54] **TOOL FOR SECURING CONTACTS TO FLAT MULTI-CONDUCTOR CABLE**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 224,548, Feb. 8, 1972, abandoned.

[52] U.S. Cl. **29/203 C, 29/203 D**

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

[58] Field of Search **29/203 C, 203 D, 29/203 S, 203 DT, 203 R**

[56] **References Cited**

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Attorney—William J. Keating et al.

[57] **ABSTRACT**

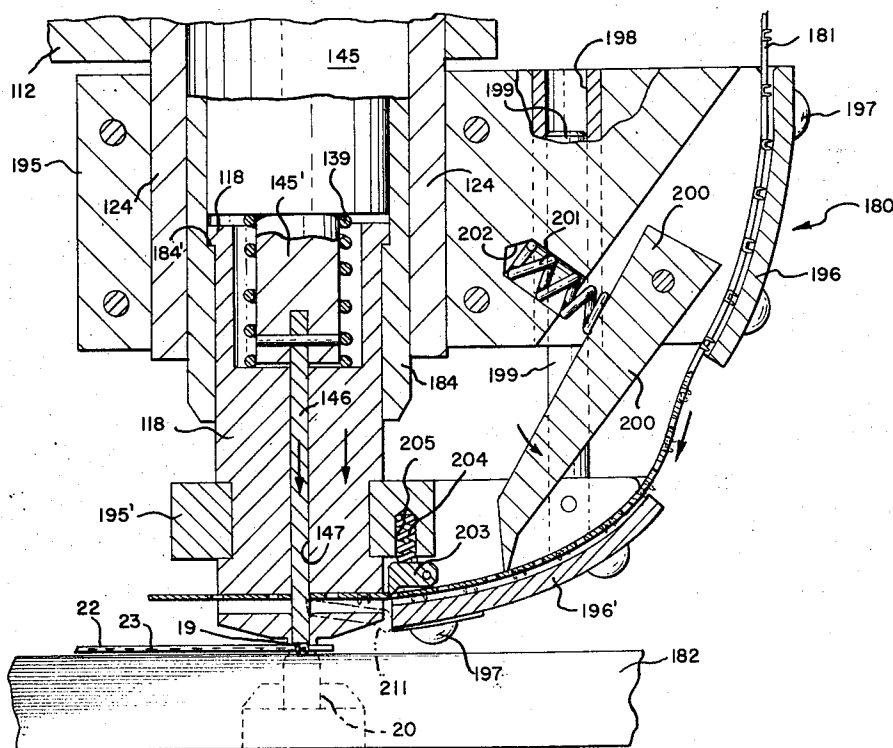
A tool for securing contacts to flat multi-conductor tape-like cable features a contact holder having a feeding path for the contact to control the width thereof during attachment to the cable, a ram recipro-

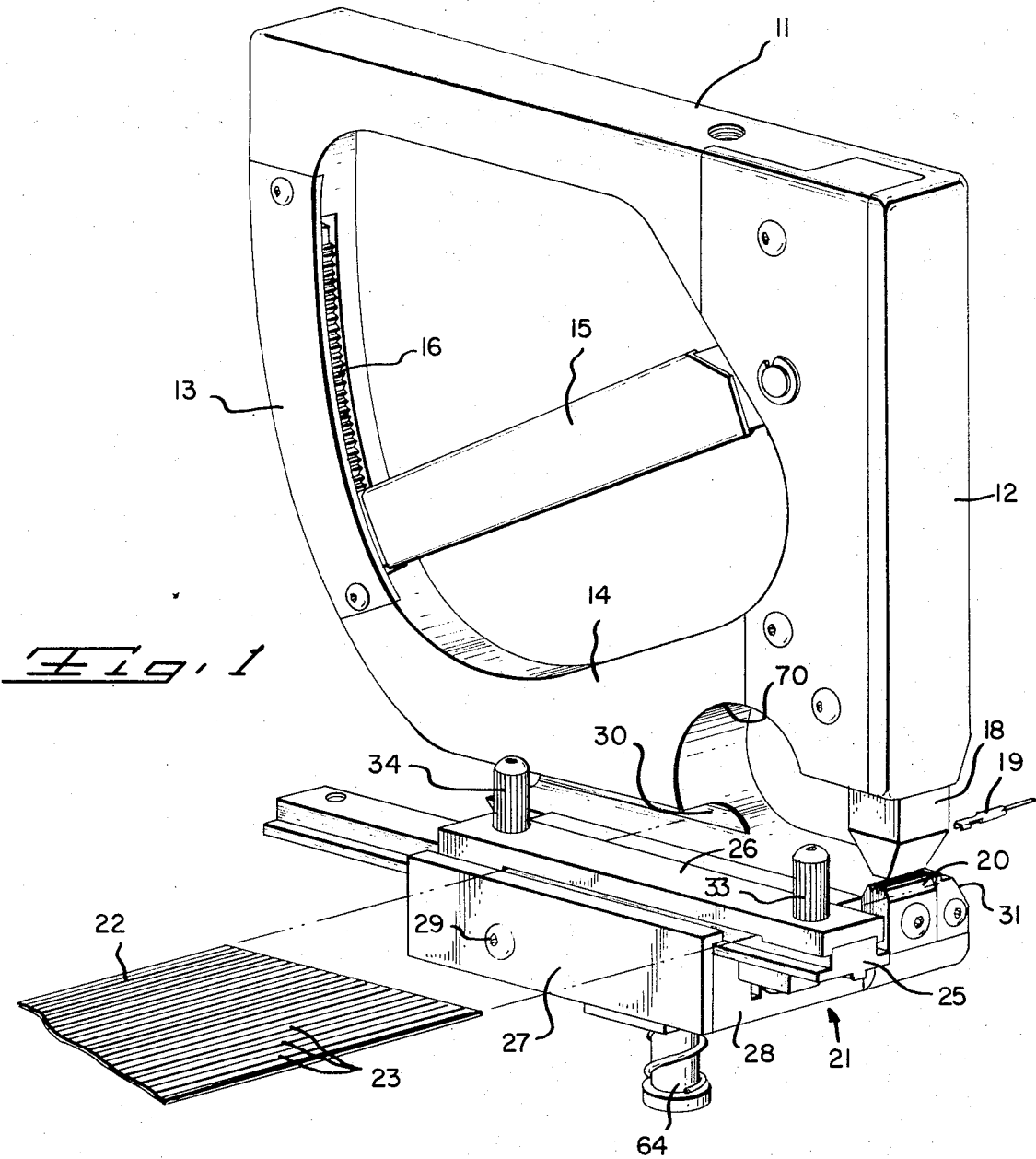
cally movable in the holder, an anvil disposed adjacent the contact holder at the end of the feeding path therein, and a ram driving mechanism being operable to assure that a given force is applied to the ram for insuring that the contact fully penetrates the cable and is properly bent back on the other side to provide engagement with the conductor strips therein. A cable feeding mechanism insures proper alignment of the cable edge with the contact holder and anvil and has a rack and pawl indexing device for shifting the cable within the tool for applying a contact to the next conductor strip.

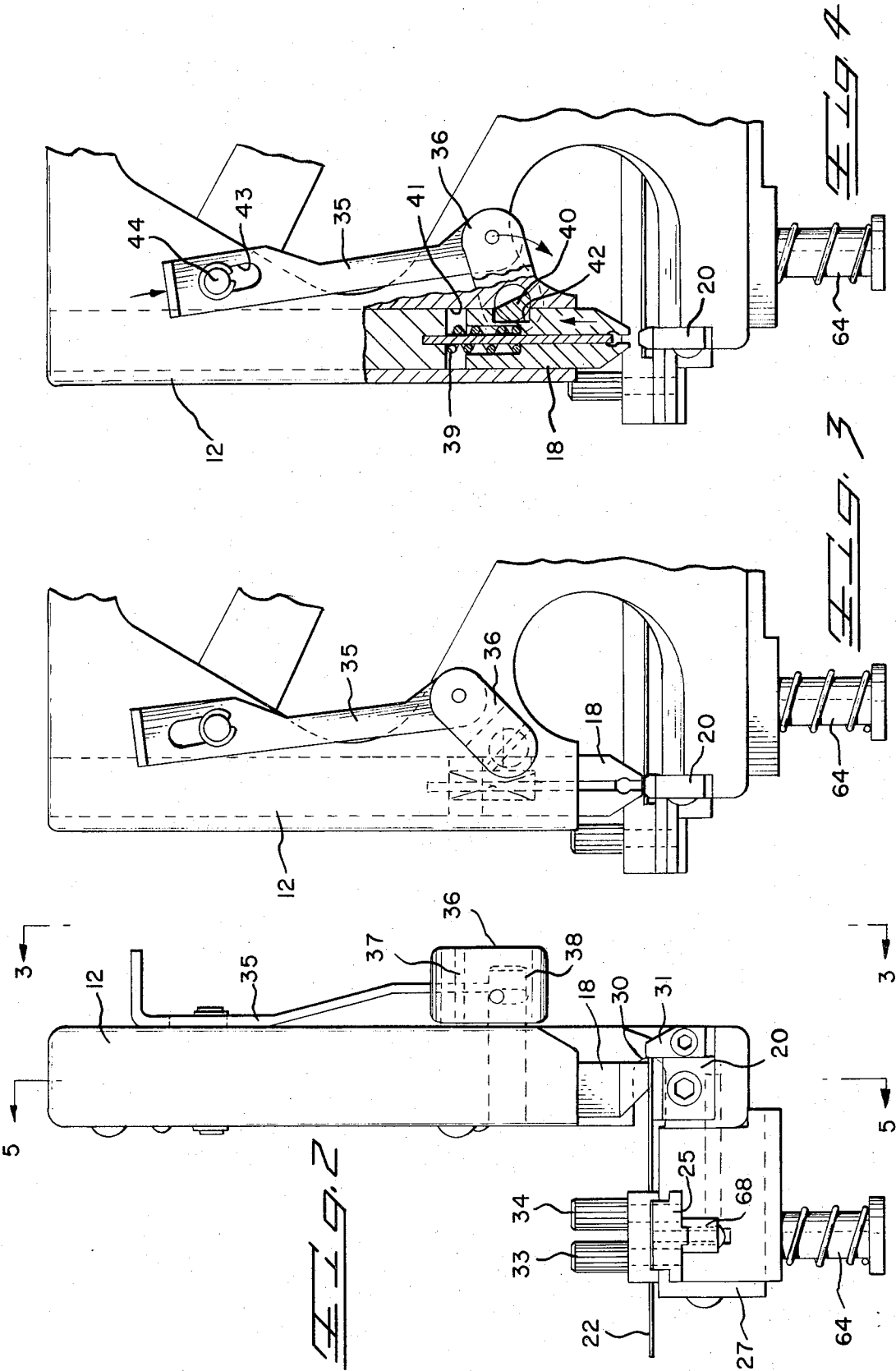
In a portable version of the tool, the contact holder is normally biased against the anvil, and a lever camming mechanism is provided which permits limited reciprocable movement of the contact holder for inserting a cable into position between the holder and the anvil and for indexing the cable, as desired. The contacts in this version are separately and manually inserted into the contact holder.

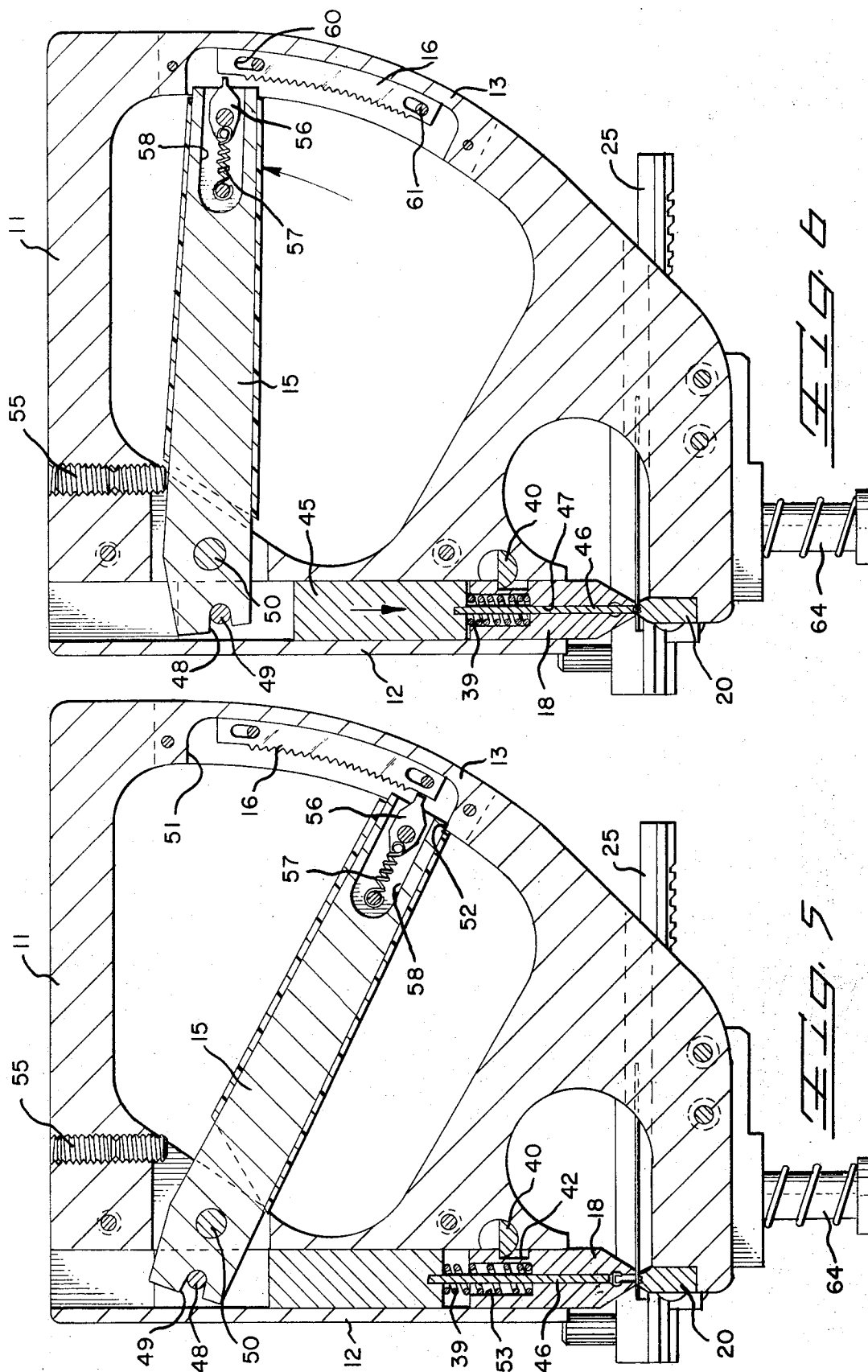
A machine version of the tool having an electrically controlled fluid-powered cylinder offers greater versatility through the provision of a rotary head carrying the contact holder and a rotary table supporting the anvil. In this version, the contacts are automatically fed from a reel and the contact holder and anvil are normally spaced apart, except during the contact-securing operation.

26 Claims, 21 Drawing Figures









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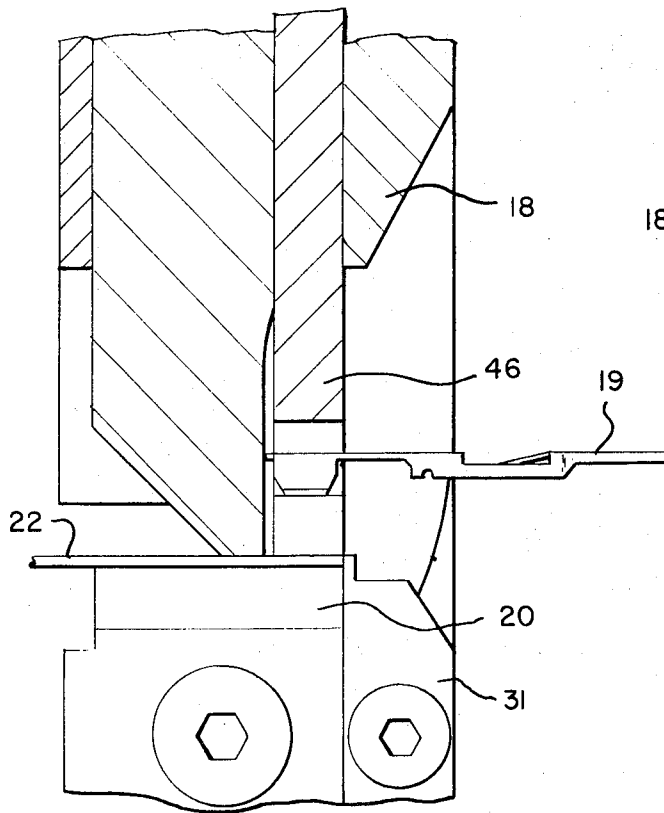


Fig. 7

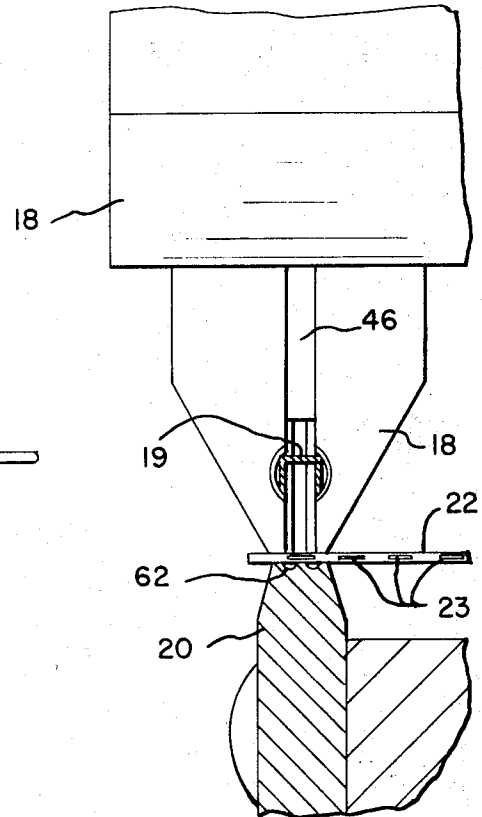
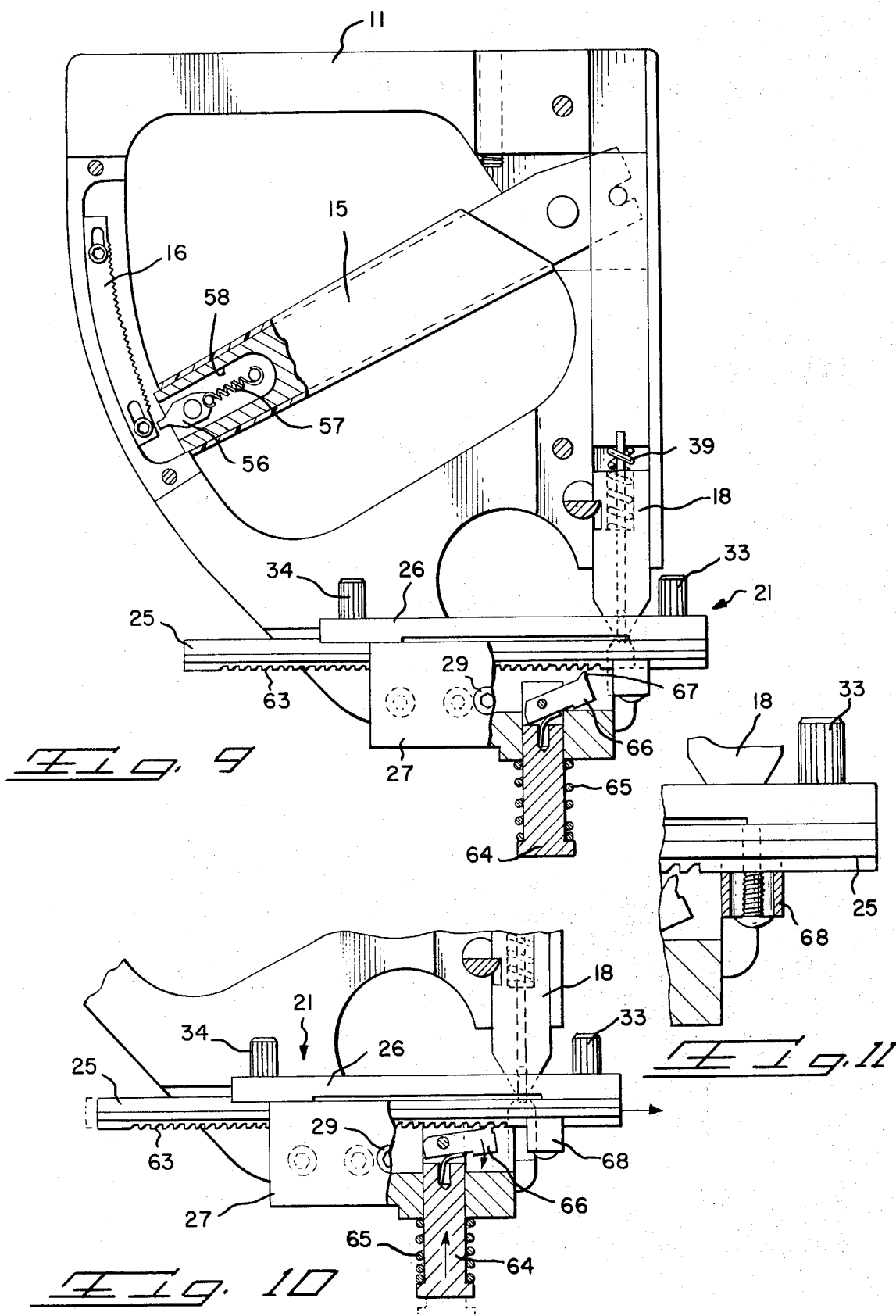
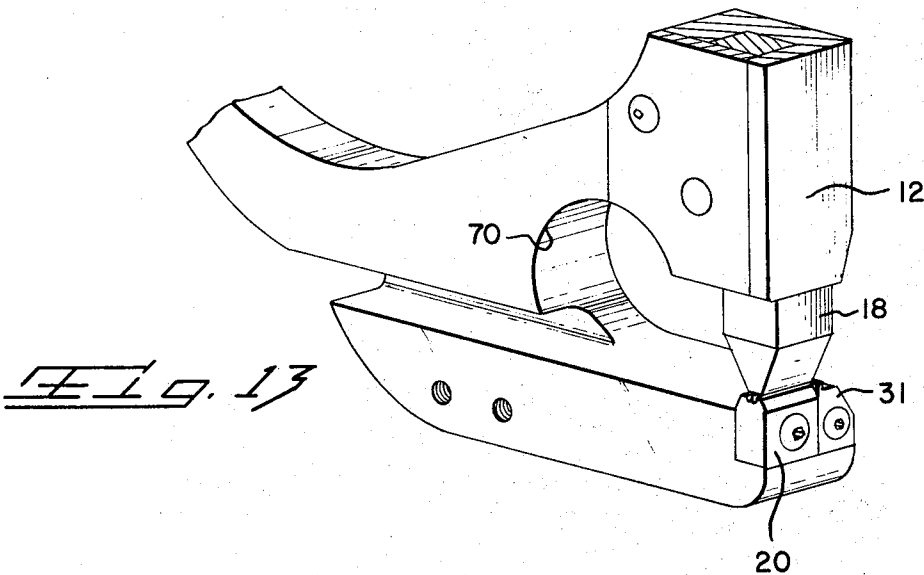
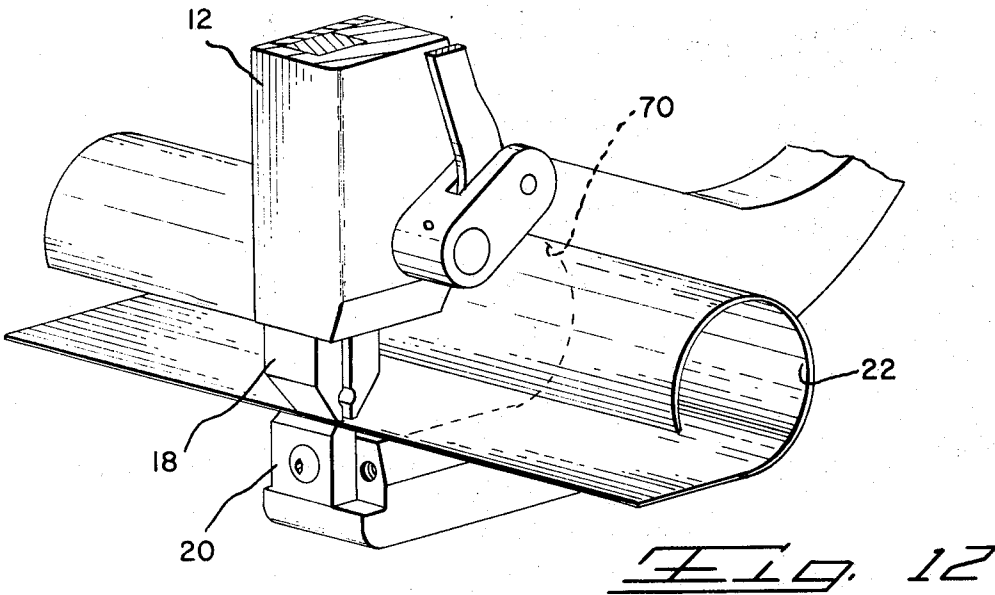
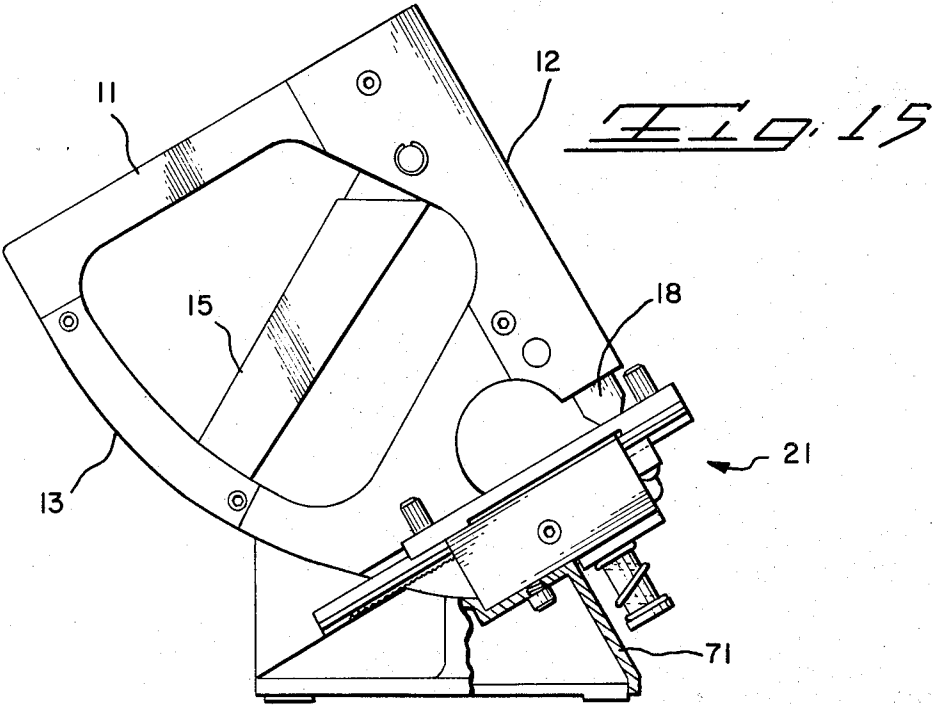
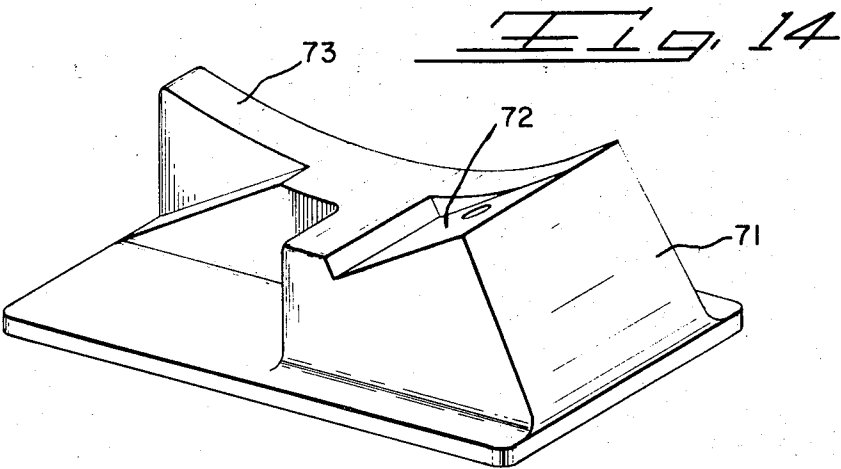


Fig. 8



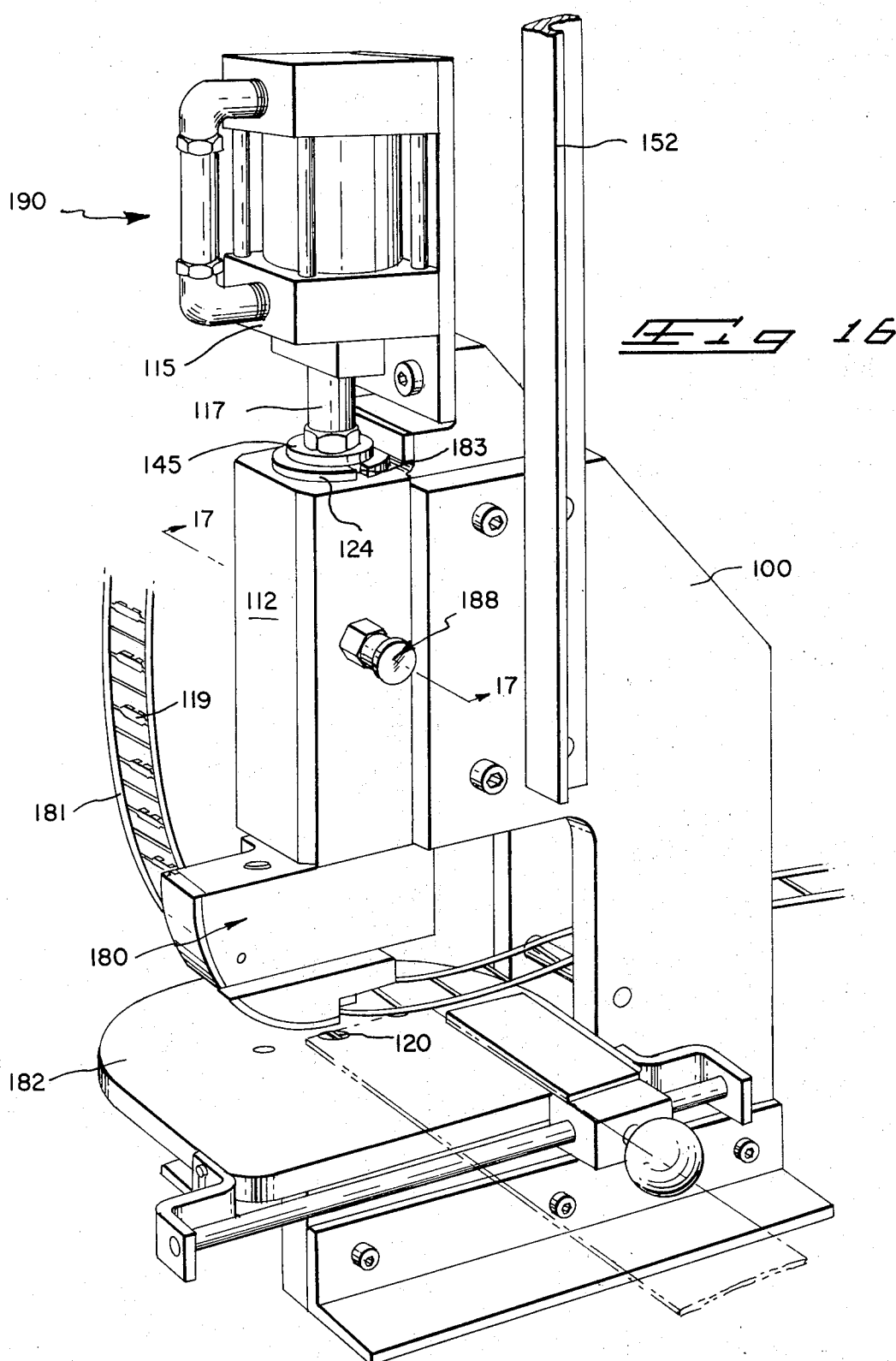




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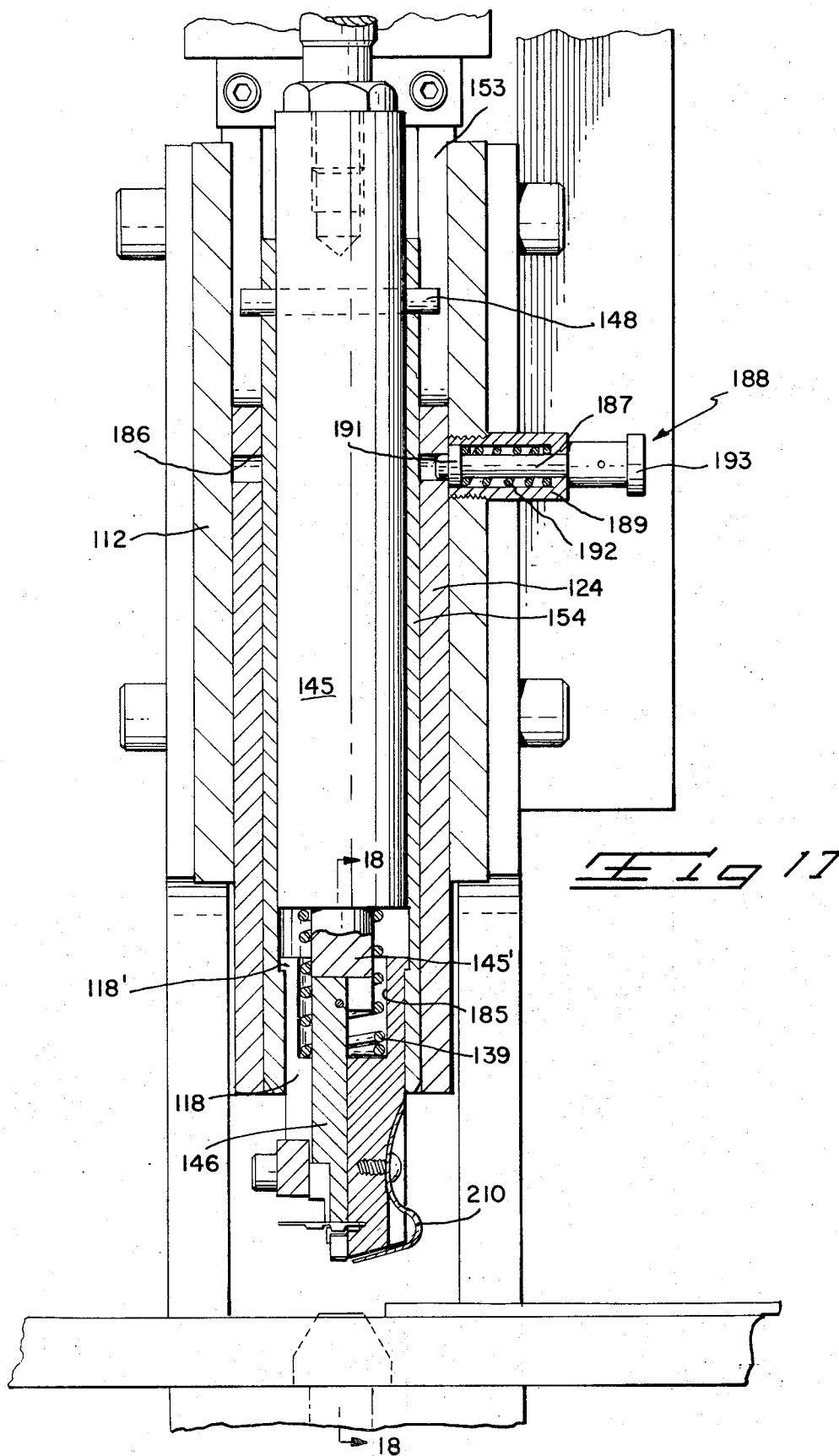
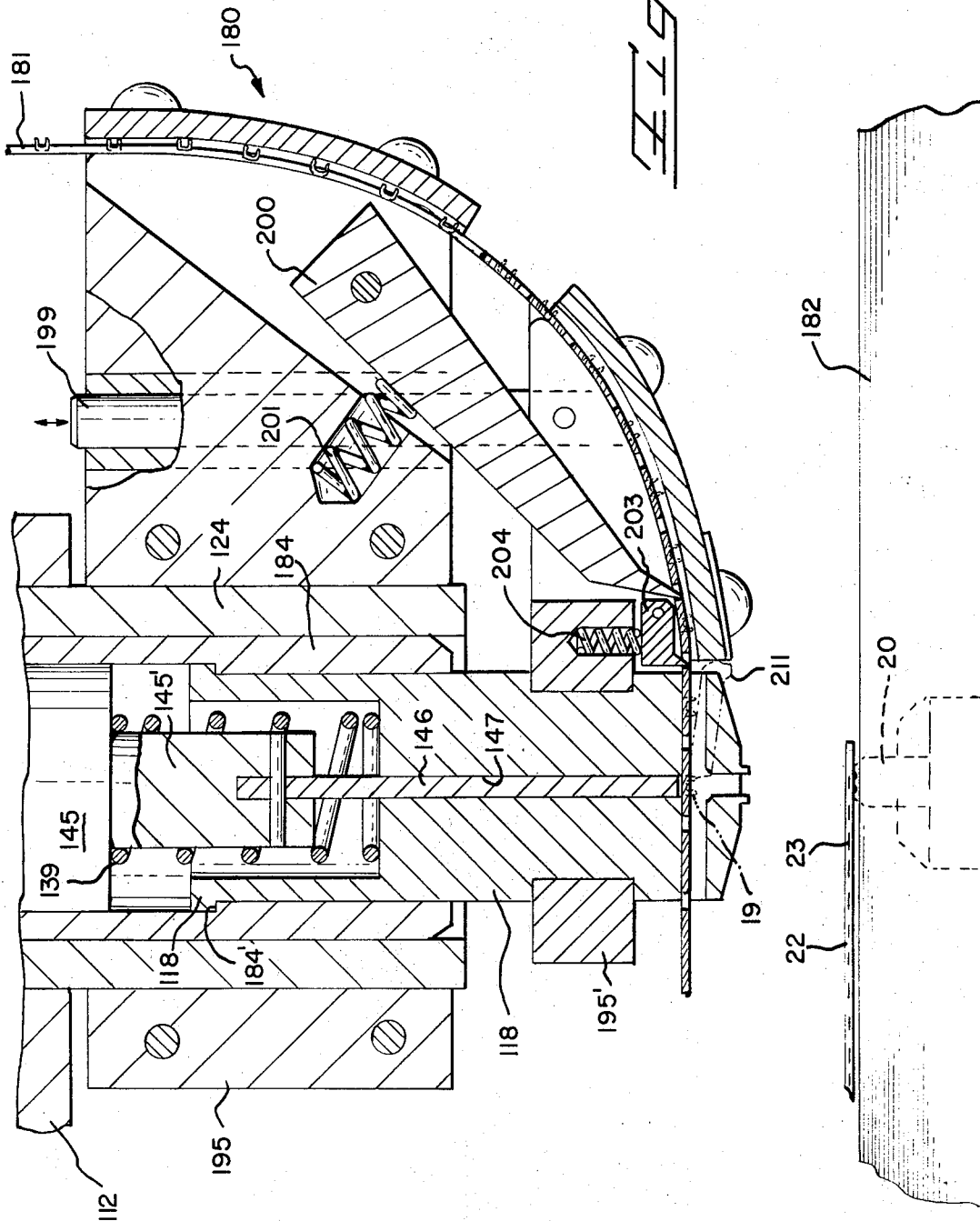
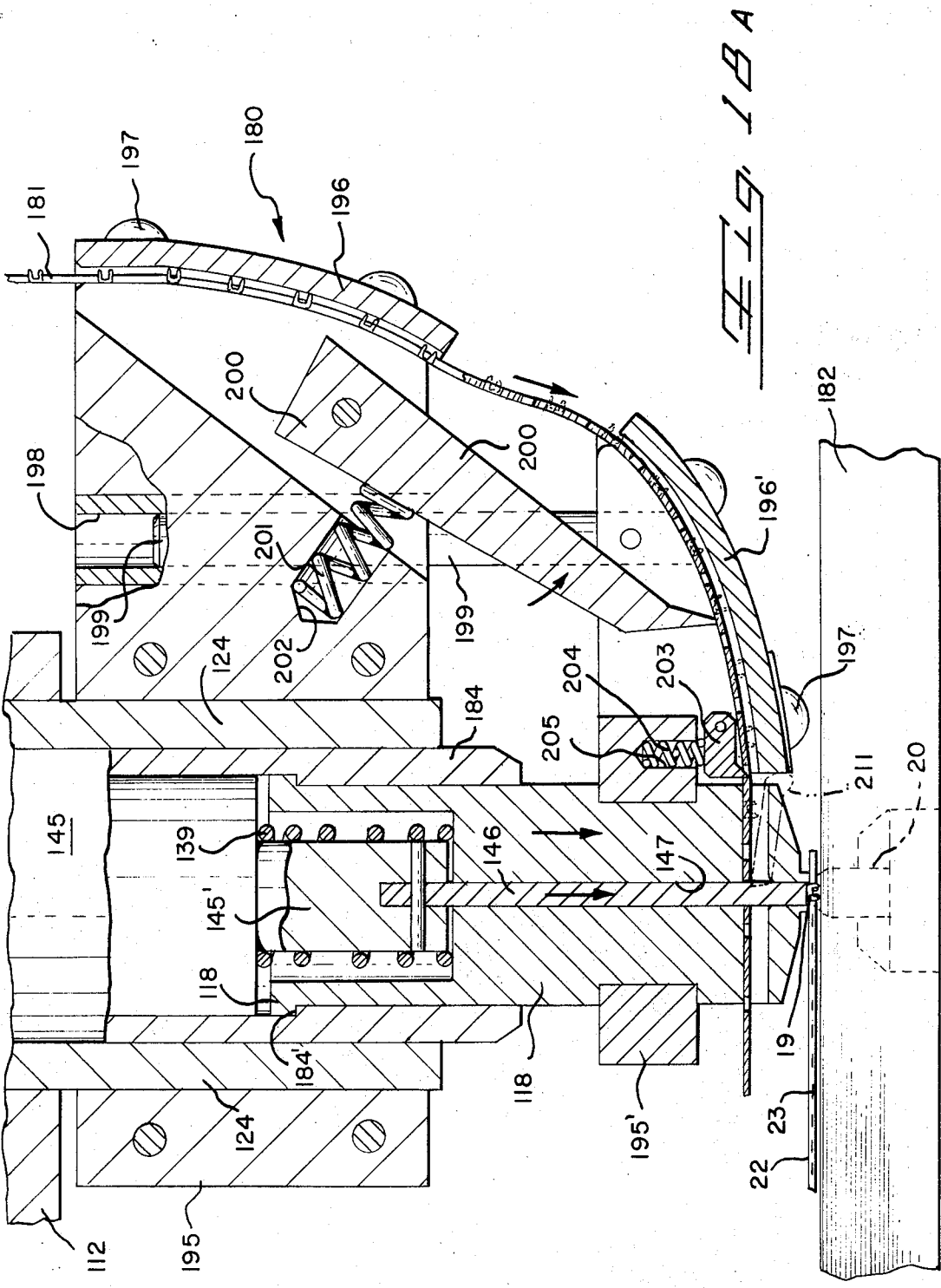
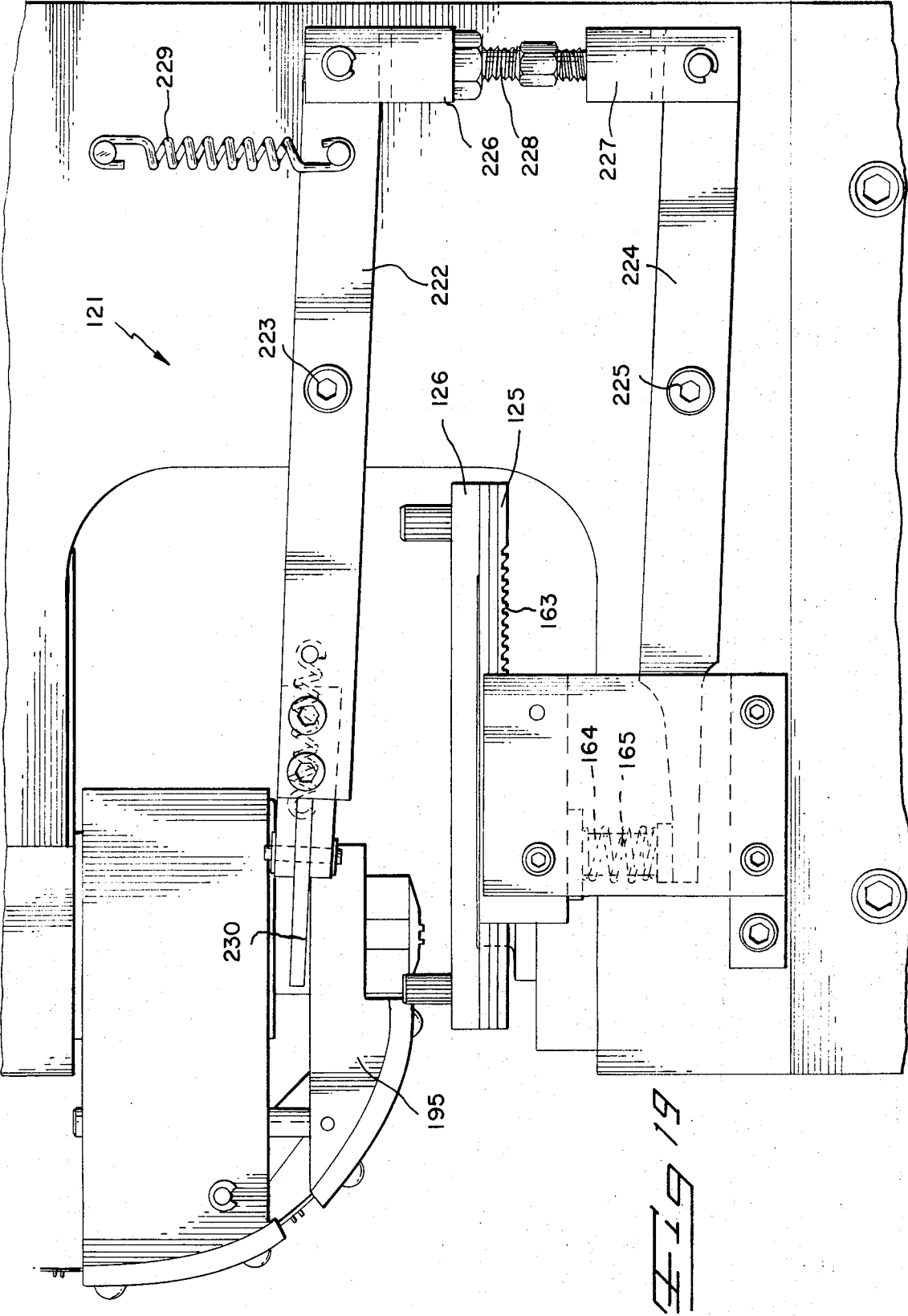


Fig. 18







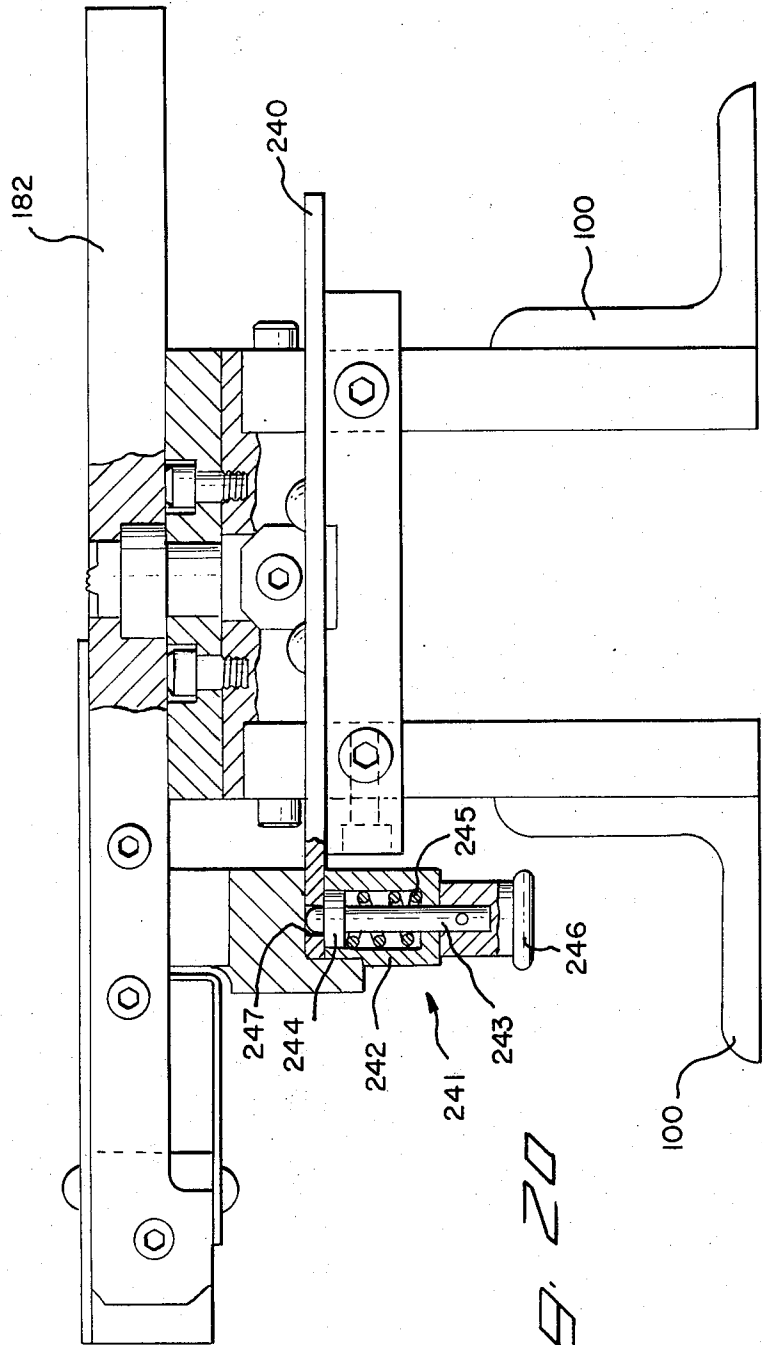


FIG. 20

TOOL FOR SECURING CONTACTS TO FLAT MULTI-CONDUCTOR CABLE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 224,548, filed Feb. 8, 1972, abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The invention

The present invention relates generally to flat multi-conductor cables and more particularly to a tool for securing contacts to the individual conductors adjacent the end edges of such flat multi-conductor tape-like cables.

The flat multi-conductor cable to which the tool of the present invention is applicable is characterized by upper and lower layers of insulation, as, for example, a transparent polyester, which may be "Mylar" manufactured by DuPont, between which are sandwiched thin parallel printed copper conductors. This tape-like cable is generally available from various commercial sources in different widths, depending upon the number of conductor strips therein, these strips usually being on the order of 0.050 inches wide and being spaced 0.10 inches on center, while the tape is about 0.008 inches thick and is very flexible, light in weight, and easily handled in complex wiring operations.

The contacts usually are miniature elongate, flexible, conductive metal pieces which may have one end formed as either a male pin or a female receptacle, while the other end has parallel edges adapted to penetrate the tape-like cable, as in a stapling operation, being bendable back on the other side of the cable and into the conductor strip of the cable to provide a conductive path.

2. Description Of The Prior Art

In the past, contacts have been secured to the individual conductors of such cables by expensive automatic machinery through which the flat cable is generally fed, while lying flat in a given plane, along a line of travel in the same plane being transverse to the orientation of the conductors therein. The machinery secures the contacts to the conductors by clamping the same thereto much like in a stapling operation so that the tiny parallel linear edges of the contacts are pushed through the tape-like cable from one side thereof immediately alongside each of the conductors adjacent a forward edge of cable and then are bent back into the conductive strip from the other side of the cable until they engage tiny ridges on the inside surface of the contact being disposed across the conductive strip against the side of the cable from which the linear edges were pushed. With the parallel linear edges of the contact being secured through the tape cable and bent back through the conductive strip to engage the ridges of the contact being passed from the opposite side of the cable into the conductor strip, not only is a positive electrical connection obtained between the conductor strip and the contact, but the contact is firmly fixed to the cable.

While this method of securing contacts to flat multi-conductor cable is generally satisfactory from a manufacturer's point of view, or in those situations where large quantities of the cable are being utilized, it does not solve the problems of the shop-worker or labora-

tory technician whose needs of such flat multi-conductor tape-like cable as not only more limited, but may be specialized, as, for example, in requiring particular arrangement of contacts on the cable, as on some of the strips and not on other adjacent strips. Further, while repairs of such cable, where a contact has been broken or must be replaced for other reasons, are often required, no manually operable bench tool having portable characteristics presently exists which also provides satisfactory performance.

Among the problems to be dealt with in attempting to provide a portable tool for securing contacts to such flat multi-conductor cable are those created by the characteristics of the contacts themselves, as well as those of the tape-like cables. For example, the contacts, in addition to being very small in physical dimensions, are made of very lightweight and flexible material, such that it is difficult to push the parallel edges thereof through the thin, but very strong, tape without bending the contacts or causing them to break. Another very critical and related factor is securing contacts to the conductor strips is the height-to-width ratio of the contact portion penetrating the cable, or that portion having the parallel linear edges which are bent back into the conductor strips to contact transverse ridges formed internally thereof. Thus, the parallel linear edges may be deformed, as by bulging, by the force being applied for causing them to penetrate the cable, whereby the width of the contact is increased during penetration, and this results in an insufficient projection of the contact edges on the other side of the cable so that an adequate engagement of the edges with the conductor strips is precluded from being made when an attempt is made to bend these projecting edges back into the conductor strips from the other side of the cable.

Also being very important is the securing of the contacts to the cable so that they are properly oriented and correctly aligned with the conductor strips, since otherwise normal use of the cable may be precluded.

In the case of powered machinery for securing contacts of the character described to flat multi-conductor cable, the problem exists that random crimping is not permitted so that the machinery presently available lacks versatility in that it is not readily adaptable for work with cable having distinct patterns or arrangements of conductors thereon or for applying contacts in such varying patterns. Further, such machinery generally cannot accommodate cables of different widths.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved tool for securing contacts to flat multi-conductor cable.

Another object of the invention is to provide a portable tool for securing contacts to flat multi-conductor cable.

Still another object of the present invention is the provision of a portable bench tool for securing contacts to flat multi-conductor cable having adequate force multiplication means for easily permitting an operator to apply sufficient pressure to force the contact through the cable while holding the tool in one hand.

Yet another object of the present invention is to provide a portable tool for securing contacts to flat multi-conductor cable in proper orientation and correct alignment with the conductor strips thereof.

Still yet another object of the present invention is to provide a portable tool for securing contacts to flat multi-conductor cable which assures proper height-to-width ratio of the contacts upon assembly with the cable so that the contacts suitably engage the conductor strips of the cable.

A further object of this invention is the provision of a portable tool for securing contacts to flat multi-conductor cable which permits the selective application of such contacts to particular conductor strips of the cable.

Still a further object of this invention is to provide a portable bench tool for securing contacts to flat multi-conductor cable which accommodates various sizes of cable.

Yet a further object of the present invention is to provide a hand-held tool for securing contacts to flat multi-conductor cable which is simple in construction and economical to produce, yet is reliable in firmly fixing a contact to the cable in good electrical engagement with a conductor strip thereof.

As even further object of the invention is to provide an improved machine for securing contacts to flat multi-conductor cable having great versatility in selectively applying such contacts to particular conductor strips of the cable.

Still an even further object of the present invention is the provision of a machine for securing contacts to flat multi-conductor cable which is powered and is also selectively controllable for applying contacts to selected conductor strips and of accepting cable for varying widths.

The foregoing and other objects are attained according to this invention through the provision of a portable tool adapted to be held in one hand of an operator by a closed-loop hand grip designed for increasing the force multiplication factor, having a contact holder featuring a feeding path for the contact to control the width thereof during attachment to the cable, a ram reciprocally movable in the contact holder, an anvil disposed adjacent the contact holder at the end of the feed path therein, and a ram driving trigger mechanism being operable to assure that a given force is applied to the ram for insuring that the contact fully penetrates the cable and is properly bent back on the other side thereof provide proper engagement with the conductor strip. A cable feeding mechanism insures proper alignment of the cable edge with the contact holder and anvil and has a rack and pawl for indexing device triggered by a manually operable switch for shifting the cable within the tool so that a contact may be secured to the next succeeding conductor strip of the cable. A lever-camming mechanism permits limited reciprocal movement of the contact holder relative to the anvil for inserting a cable into position between the contact holder and the anvil and for indexing the cable, as desired, by the cable feeding mechanism.

A machine offering the same general advantages as the portable tool version of this invention is characterized by a contact holder being carried by a rotary head portion, an anvil supporting the flat multi-conductor cable being mounted on a rotary table, and a feed mechanism for automatically feeding a carrier strip of contacts. In this version, the contact holder provides a guide for the carrier strip being fed therethrough and is normally positioned in spaced relation from the anvil between crimping operations whereby the cable may

be freely moved as desired without interference thereby.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, wherein like reference numerals designate like or corresponding parts throughout the several views, and in which:

FIG. 1 is a perspective view of one embodiment of the present invention being characterized by a portable tool for securing contacts to a flat multi-conductor cable and illustrating the positioning of a cable of this character therein;

FIG. 2 is a front elevational view of the tool shown in FIG. 1;

FIG. 3 is a side view taken along the line 3—3 of FIG. 2 and illustrating the lever mechanism for moving the contact holder in its normal, or idle, position;

FIG. 4 is a view of the tool similar to that of FIG. 3, illustrating the lever mechanism for raising the contact holder from the anvil in its actuated state;

FIG. 5 is a cross-section view taken along the line 5—5 of FIG. 2 and illustrating in further detail the camming portion of the lever mechanism for lifting the contact holder, as well as showing the ram driving trigger mechanism in its normal inoperative state;

FIG. 6 is a view similar to FIG. 5 illustrating the ram driving trigger mechanism at the completion of its ram driving cycle;

FIG. 7 is an enlarged front cross-sectional view taken through the contact holder and illustrating the positioning of a contact therein which is to be secured to a flat multi-conductor cable;

FIG. 8 is a side view, partly in cross-section, showing the contact disposed in the contact holder and the flat multi-conductor cable being positioned between the contact holder and the anvil;

FIG. 9 is a side view, partly in cross-section, illustrating the cable feeding mechanism in its normal state;

FIG. 10 is a view similar to that of FIG. 9, illustrating the cable feeding mechanism being operated for advancing a cable-supporting rack;

FIG. 11 is an enlarged view, partly in cross-section, showing an adjustable stop for the cable-supporting rack shown in FIGS. 9 and 10;

FIG. 12 illustrates the manner in which the tool of the present invention can be used to accommodate a flat multi-conductor cable of greater width than may normally be received in the cable feeding mechanism;

FIG. 13 is a view of the tool from the opposite side than shown in FIG. 12, further illustrating the normal backstop and aligning guide of the device;

FIG. 14 is a perspective view of one embodiment of a base for supporting the portable tool of the present invention shown in FIG. 1;

FIG. 15 is a side view, partly broken away, illustrating the portable tool embodiment of the present invention being secured to the support shown in FIG. 14;

FIG. 16 is a perspective view of another embodiment of the present invention being characterized by a machine for securing contacts to a flat multi-conductor cable and illustrating generally a carrier strip of contacts being fed between a rotary tool portion which

carries the contact holder and rotary table which supports the anvil and the cable;

FIG. 17 is a view, partly in cross-section, taken along the lines 17—17 in FIG. 16 showing the rotary head portion of the machine which carries the contact holder and driving mechanism therefor;

FIG. 18 is a cross-section view taken along the lines 18—18 in FIG. 17 showing the contact holder and ram driving mechanism in its inoperative position and illustrating the carrier strip feed mechanism being operative to move a new contact into position;

FIG. 18A is a cross-section view similar to FIG. 18 showing the contact holder and ram driving mechanism in its operative state while securing a contact to the cable and illustrating the carrier strip feed mechanism in its operative state;

FIG. 19 is an end view of the machine showing the multi-conductor cable feeding mechanism;

FIG. 20 is a view, partly in cross-section, from below the table of the machine shown in FIG. 16 illustrating the mechanism for controlling the rotation of the table.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now to the drawings, and more particularly to FIG. 1 thereof, a portable tool version of the present invention is shown having an upper horizontal hand rest 11, a forward upright housing portion 12, a rear curved or arcuate arm 13, and a lower horizontal base portion 14, all being generally arranged in the same plane in a substantially square-shaped configuration open at its center. A ram driving trigger 15 is disposed in the open portion of the same plane, being pivotally connected at one end to the forward upright housing 12 near the upper region thereof, so that it may be swung in an arc with a portion of its other end engaging a rack 16 formed on the interior surface of the rear curved arm 13 when manipulated by wrapping the fingers of the hand of an operator thereabout with the palm of the hand resting on the upper horizontal rest 11 and then squeezing or moving the fingers toward the palm.

Disposed in the upright housing portion 12 is a contact holder 18 having means on one side thereof for receiving a contact 19, shown as a male contact pin, as will be described hereinafter, and in which, in turn, is disposed a vertically reciprocable ram, not shown in this Figure, which is operable by the ram drive trigger 15. Below the contact holder 18 is an anvil 20 secured on the front side of the base portion 14. Suitably secured to the one side of the base portion 14 is an indexing mechanism generally designated by the reference numeral 21 for indexing or moving a flat multi-conductor cable 22 within the tool from the rear end to the front end thereof for placing a different conductive strip 23 thereon between the contact holder 18 and the anvil 20 for securing a contact 19 thereto. The indexing mechanism 21 includes a lower index plate 25, an upper clamp plate 26 for clamping the flat multi-conductor cable 22 against the index plate so that the cable may be moved therewith, and a side drag plate 27 suitably secured to an indexing mechanism support 28, in turn affixed to the lower base portion 14, and abutting in sliding relation the lower index plate 25 with an adjustable force through the tightening bolt 29, whereby the ease of sliding of the lower index plate 25 in the indexing mechanism support 28 may be readily controlled.

The lower base portion 14 of the tool is cut away as shown at 30, thereby providing an elongate backguide for the forward edge of the flat cable 22 which is to have the contacts 19 secured thereto. At the forward end of the lower base portion 14 of the tool, an additional cable stop or guide 31 may also be utilized, if desired, by being secured to the lower base portion 14 adjacent the anvil 20.

Turning now to FIG. 2, the tool is shown having a flat multi-conductor cable 22 inserted between the lower index plate 25 and the clamp plate 26, being clamped therebetween by the forward and rear knurled clamping screws 33 and 34, respectively, with the forward edge of the cable 22 abutting against the rear guides or stops 30 and 31. Shown on the right, as viewed in FIG. 2, is a lever 35 pivotally connected to a link 36 through a pivot pin 37 disposed adjacent one end therein. The link 36 is pivotally connected about its other end to the forward housing portion 12 through a cylindrical member 38 fixedly secured thereto.

The purpose of the lever 35 is to permit raising the contact holder 18 from the anvil 20 so that a flat cable 22 may be placed therebetween. The contact holder 18 is normally biased by a spring 39 into engagement with the anvil 20, as shown in FIGS. 3 and 4, wherein it also is shown that cylindrical member 38 on the portion thereof disposed inside the upright forward housing portion 12 is cut away through an angle of 180° thereby forming a semi-circular cam 40. Thus, the contact holder 18, which is movable vertically in a recess 41 formed in the forward housing 12, has a notch 42 in one side thereof in such a manner that when the contact holder is in its lowermost position abutting the anvil 20, the flat diammetrical wall of the semi-circular cam 40 engages the upper edge of the notch 42, and when the lever 35 is depressed downwardly, thus turning the link 36 and the cam 40 therewith, the edge portion of the cam engaging the notch 42 moves vertically upward as it is turned through an approximate 60° angle so that the contact holder 18 is urged upwardly against the biasing force of the spring 39, as best shown in FIG. 4. The lever 35 has a slot 43 adjacent its upper end through which a pin 44 secured to the upright forward housing 12 is received, whereby the degree of movement of the lever 35 downwardly and consequently the rotation of the cam 40 is controlled.

Obviously, upon release of the lever 35, the contact holder 18 automatically returns to its lowermost position where it engages the anvil 20 through the biasing force of the spring 39.

In FIGS. 5 and 6, the operation of the ram drive trigger mechanism is disclosed. Disposed in the upright forward housing portion 12, in the cavity 41 above the contact holder 18, is a plunger 45 having a ram 46 substantially rectangular cross-section secured to its lower end and disposed in a rectangular slot 47 formed in the contact holder 18. The plunger 45 is normally maintained in an upper-most position, shown in FIG. 5, by the spring 39 which is positioned in the cavity 41 being compressed between the plunger 45 and the contact holder 18.

A pin 48 on the upper edge of the plunger 45 is engaged in a slot 49 on the end of the ram trigger 15 which is pivoted about a pin 50, and it is the engagement of the pin 48 with the slot 49 that limits the upward movement of the plunger 45 under the biasing force of the spring 39, such upward movement of the

plunger 45 being operative to rotate the ram trigger 15 in a clockwise direction, as seen in FIGS. 5 and 6, until the free end of the ram trigger 15 abuts the lower edge of an arcuate groove 51 formed on the inside surface of the arcuate arm 13, as indicated at 52. Hand manipulation of the ram trigger 15 moving the same in a counter-clockwise direction, or towards the upper horizontal hand palm rest 11, forces the plunger 45 and the ram 46 secured thereto to move vertically downwardly, respectively, in the cavity 41 of the forward housing portion 12 and the slot 47 in the contact holder 18, causing the coil spring to be compressed within an upper recess 53 in the contact holder. Movement of the ram trigger 15 upwardly in a ram-actuating operation is limited by a set screw 55 in the upper horizontal hand rest 11 and projecting downwardly therefrom. Adjustment of the screw 55 is preferably made at the factory in accordance with precise measurements being made of the control after it has been secured to a cable.

Another feature of the ram drive trigger mechanism of this tool is its built-in ability to avoid in a contact inadequately penetrate or be sufficiently secured to a cable by virtue of an operator inadvertently releasing the ram trigger 15 before moving it through its normal complete arcuate path. This is accomplished by a pivotable bar or pawl 56 disposed on the inside of the ram trigger 15 and engaging the rack 16 disposed in the groove 51 in the arcuate arm 13. A spring 57 connected to the pawl 56 on the side of the pivot point thereof remote from the pawl end engaging the rack 16 constantly urges the pawl toward an aligned orientation with a slot 58 in which it is disposed in the ram trigger 15. Thus, during movement of the ram trigger 15 in an upward or counter-clockwise direction, the pawl 56 engages the teeth of the rack 16 in such a manner that upon release of the ram trigger 15, it will be locked in place against movement in a clockwise direction, such as is being urged by the coil spring 39, in known manner, while once having completed its upward movement to a point where the pawl 56 is beyond the teeth of the rack 16, the ram trigger 15 then is free to move in a downward or clockwise direction under the influence of the coil spring 39 since the pawl 56 now clicks freely over the rack teeth. Similarly, however, while the ram trigger is being returned to its normal idle position, it also is locked against any attempt to move it in a counter-clockwise direction. It is noted that adjustment of the rack 16 also is possible at the factory, the rack being provided with slots 60 at either end which receive tightening bolts 61 for securing the rack to the arcuate arm 13.

FIGS. 7 and 8 are enlarged views illustrating how a contact pin 19 is placed in the contact holder 18. Thus, with the ram 46 raised, the contact holder 18 from the side of the tool opposite that on which the indexing mechanism 21 is disposed presents an opening aligned with the anvil and the ram which at its lower part is just large enough to accommodate the ram, but at its upper part is generally circular in cross-section having a diameter which is larger than the width of the ram opening. The anvil 20 has two elongate grooves in its top surface for receiving the parallel linear edges of the contact pin 19 after they have been forced through the cable 22 and to direct these edges back into the cable 22, much like in a stapling operation.

Accordingly, after the contact holder has initially been raised through operation of the lever 35 and a flat

multi-conductor cable 22 has been placed therebeneath with one of the conductor strips 33 aligned with the elongate grooves of the anvil 20, the contact holder is seated on the cable 22 and the end of the contact pin 19 having the penetrating linear edges is inserted into the circular part of the opening in the contact holder 18. The ram trigger 15 is then operated, quickly locking the contact pin by moving the same downwardly into the smaller rectangular part of the opening in the contact holder 18. Continued movement of the ram trigger 15 forces the contact pin edges into the cable 22, bulging thereof being prevented by the confining walls of the contact holder on the sides and the complete contact of the ram 46 with the upper surface of the contact pin, and after complete penetration, the edges of the contact pin 19 are bent upwardly and into the conductor strip 23 by virtue of the grooves 62 in the anvil 20.

The indexing mechanism 21 for moving the flat multi-conductor cable 22 from the rear to the front of the tool in a manner to position succeeding conductor strips 23 between the contact holder 18 and the anvil 20 is shown in FIGS. 9 and 10. As already described, a cable 22 is positioned between the lower index plate 25 and the upper clamping plate 26 with the parallel conductor strips 23 being transverse to the plane of the paper, as viewed in FIGS. 9 and 10. Once the first conductor strip 23 is positioned directly between the anvil and the ram opening 47 in the contact holder 18, the indexing mechanism 21 may then be employed.

On the lower surface of the index plate 25, a rack 63 is provided. Secured to the underside of the indexing mechanism support 28 is a vertically movable plunger 64 being biased by a compressed spring 65 in a downward direction. On the upper edge of the plunger 64, a pivotable bar or pawl 66 is mounted, having a finger or tab 67 for engaging the teeth of the rack 63. As shown, in the normal lower position of the plunger 64, the pawl 66 does not engage the rack 63, but when the plunger 64 is manually lifted, pawl 66 engages the rack 63 of the index plate 25 causing the index plate to be moved to the right a predetermined distance, according to the spacing of the teeth of the rack 63, being designed to be equal to the distance between the conductor strips 23 of the cable 22. Thus, once a cable 22 is properly positioned, the indexing mechanism 21 may be utilized for moving the conductor strips 23 thereof selectively into position between the contact holder and the anvil for receiving contact pins.

The drag plate 27 is designed to provide an adjustable force against the index plate 25 by manipulating the tightening bolt 29 so that the indexing plate may be readily slidable between the drag plate and the indexing mechanism support 28, yet not so freely slidable that it will fall out during use of the tool. Also, an adjustable stop 68 is secured to the underside of the index plate 25, as shown in FIG. 11 for the purpose of permitting initial adjustment of the index plate so that the tab 67 of pawl 66 correctly engages the first of the teeth of the rack 63.

Briefly, then, the portable tool as described may be used as follows. First, the clamp plate 26 is removed or raised so that a flat multi-conductor tape-like cable 22 may be inserted between the clamp plate and the index plate 25. The cable 22 is moved inward toward the tool housing until its forward edge abuts the rear guide 30 and the front guide 31, it being necessary to depress the

lever 35 to permit moving the cable 22 beneath the contact holder 18 to contact the front guide or stop 31. Alignment of the first or selected conductor strip 23 of the cable 22 between the anvil 20 and the ram opening 47 in the contact holder is visually performed at this time, and then the clamp plate 26 may be tightened to secure the cable 22 in its adjusted position. A contact pin 19 is then positioned in the contact holder 18, as previously described, and the ram trigger 15 is raised or moved toward the upper horizontal hand rest 11 by gripping the tool with the palm of the hand against the upper hand rest 11 and the fingers encircling the ram trigger. The configuration of the tool is especially important during this step, since it is through this design, specially the closed loop arrangement of the upper hand rest 11, the forward housing portion 12, the lower base portion 14 and the arcuate arm 13, that the large force multiplication factor necessary to provide adequate power for causing the contact pin to penetrate the cable is structurally achieved. Thus, in raising the ram trigger 15, the plunger 45 is moved downward through the pin and slot arrangement 48, 49 therebetween, thereby moving the ram 46 connected to the plunger down through the opening 47 in the contact holder 18. Once the contact pin 19 has been properly secured to the conductor strip 23, the cable 22 may be indexed forward to position its next conductor strip between the contact holder 18 and the anvil 20 by simultaneously depressing the lever 35 to elevate the contact holder 18 and pushing the plunger 64 upward against the biasing force of the spring 65 to cause the tab 67 of pawl 66 to engage the rack 63, whereupon through the coordinated upward motion thereof and pivotal arrangement, the pawl is operative to move the rack 63 and consequently the index plate 25 integral therewith and carrying the cable 22 forward through a precise distance that will center the succeeding conductor strip between the contact holder and the anvil.

In the event that a cable 22 having an extra large number of conductor strips 23 therein is being used, such that the flat cable is too wide to fit between the clamping screws 33 and 34 when being clamped between the clamp plate 26 and the index plate 25, this tool may be readily modified to handle the situation by removing the clamp plate 26 whereupon the extra wide cable 22 may be rolled, as indicated in FIG. 12, in a circular cut-out area 70 defined by the lower part of the upright forward housing portion 12 and the forward end of the base portion 14. In this case, the forward guide or stop 31 is still useful and, if desired, a short clamp plate, not shown, having only one clamping screw, such as clamping screw 33, may be utilized to clamp the beginning edge of the cable 22 or that nearest the forward end of the tool. Obviously, the tool would operate in precisely the same manner as previously described, regardless of the width of the conductor cable.

A preferred support 71 for the portable tool is shown in FIGS. 14 and 15. This support would provide a flat base upon which the tool might rest upon a workbench or the like when not in use and additionally would offer certain benefits during use. Thus, a substantially flat surface 72 is provided for supporting the lower base portion 14 and the indexing mechanism support 28, while a curved or arcuate surface 73 is provided for supporting the arcuate arm 13. As shown in FIG. 15, the flat surface 72 is so limited in size to accommodate

the tool that the plunger 64 of the indexing mechanism 21 projects beyond the support in an angled and open manner to permit ready accessibility for hand manipulation during use of the tool.

It is to be understood that although the portable tool embodying this invention has been described as generally being disposed in a horizontal position with parts thereof being oriented accordingly, it is possible that in use the tool might occupy some other position so that its orientation would be other than as described and illustrated.

While the invention has now been described as a portable tool for securing contacts to a flat multi-conductor ribbon tape, it is possible also to carry forth many of the advantageous features thereof into another embodiment characterized by an electrically controlled air or liquid-powered machine which is far simpler in construction and less expensive to manufacture than machines heretofore available, and at the same time provides greater versatility, as will become apparent from the following description of such an embodiment, considered in connection with the FIGS. 16-20 of the Drawings.

Thus, referring to FIG. 16 in particular, a machine embodying this invention is shown having a power cylinder device 115, which may be either air or hydraulically actuated, supported above an elongate vertical housing 112 which is mounted on a base or support 100. A piston rod 117 extending vertically downward from the power cylinder device 115 has its lower end fixedly secured to a plunger 145 in the vertical housing 112 and serves to support the power cylinder device 115. A vertically oriented tubular member 124 is secured within the housing 112 for receiving the plunger 145. Secured to the lower region of the housing 112 is a mechanism generally indicated by the reference numeral 180 for feeding a carrier strip 181 of contacts to the machine, and therebelow a table 182 is disposed in a horizontal plane for supporting a multi-conductor ribbon or cable 122. The table 182 is rotatable in its horizontal plane, as will be described hereinbelow, and also serves to support the anvil 120.

While not being shown, a reel for supplying the carrier strip 181 is rotatably supported from a frame member 132 vertically extending from the base 100. Also not shown is an electric power source and fluid pressure means for operating the power cylinder device 115 in a known manner so as to move the piston rod 117 downward.

Referring now to FIG. 17, wherein the interior of the housing 112 is shown, it may be seen that the plunger 145, while being axially movable within the tubular member 124, is at the same time prevented from relative rotation with the tubular member 124 through the provision of a pin 148 extending diametrically through the plunger 145 near the upper end thereof and being received in diametrically opposed vertical slots or channels 183 in the tubular member 124. The pin 148 also serves to secure a tubular sleeve member 184 to the plunger 145 and to prevent relative axial or rotational movement therebetween. The sleeve 184, on the other hand, is snugly fitted but axially slidable within the tubular member 124.

Disposed within the lower portion of the tubular sleeve 184 is one end of a contact holder member 18 having a bore 185 therein which is biased downwardly and away from the plunger 145 by a spring member

139 compressed between the bottom of the bore 185 and the plunger 145, being positioned in surrounding relation about an axial projection 145' of the plunger 145. The contact holder member 118 is prevented from being ejected from the sleeve member 184 by the biasing force of spring 139 through the provision of an annular flange 118' on the upper end of the contact holder member 118 which is seated upon an internal shoulder 184' adjacent the lower end of the tubular sleeve 184. Depending from the plunger projection 145' is a ram 146 which is slidably within a channel 47 in the contact holder member 118, as may be best seen in FIGS. 17 and 18.

Except for the method of driving the plunger 145, the portion of the machine version of the invention just described operates substantially in the same manner as the portable tool version.

Hereinafter the power cylinder device 115, the plunger 145, sleeve 184, tubular member 124, and the contact holder member 118 may all be considered as forming a tool head which is generally designated by the reference numeral 190. The tool head 190 is rotatable about a vertical axis for a purpose to be set forth hereinbelow through the provision of radial bores 186 in the tubular member 124 and a pin 187 of a tool head rotary selector device generally indicated by the reference numeral 188. The tool head rotary selector device 188 as shown in FIG. 17 is shown as having a housing member 189 fixedly secured to the housing 112 which defines a generally horizontally oriented cylindrical recess in which is received the pin 187. The pin 187 has a flange 191 disposed thereon slightly spaced from the end thereof receivable in the radial bores 186 and being of a diameter slightly greater than the diameter of the radial bores 186, and a spring is disposed between the housing 189 and the flange 191 so as to urge the end of the pin 187 into the radial bores 186 whenever the same are aligned. A knob 193 is provided on the other end of the pin 187, being disposed outside the housing 189, such that by pulling upon the knob 193, the pin 187 will be pulled back therewith so that the end thereof will be retracted from the radial bore 186. In this manner, the tool head 190 may be rotated about a vertical axis, namely the axis of the plunger 145, and depending upon the number of radial bores 186 provided in the tubular member 124, any number of selective rotary positions may be provided.

Turning now to FIGS. 18 and 18A, the contact carrier strip feed mechanism 180 is shown having a pair of blocks 195 and 195', the former of which is fixedly secured to the lower end of the tubular member 124 and the latter of which is fixedly secured adjacent the lower end of the contact holder member 118. Both of the blocks 195 and 195' have peripheral portions which are generally arcuate in configuration and guide plates 196 and 196', respectively, of similar configuration are secured thereto in slightly spaced relation by screws 197. A channel is provided in the contact holder member 118, as shown in FIGS. 17, 18 and 18A, for permitting at least one edge of the carrier strip 181 having the contact pin edges to be pushed through the ribbon or cable therein to slide therethrough. Thus, the carrier strip of contacts is fed in the direction of the arrow in FIG. 18A between the block member 195 and guide 196, then between the block 195', and finally through the channel in the contact holder member 118, wherein each contact is designed to be removed from the strip

by the actuation of the ram 146, whereupon as shown in FIG. 16, the carrier strip emptied of its contacts passes through a slot provided in the base or support 100.

The block 195 is provided with a vertical bore 198 in which is slidably received a guide pin 199 having its lower end affixed to the lower block member 195'. Pivotaly secured to the block 195 is a pawl 200 which is spring biased for rotation in a counter clockwise direction, as viewed in FIGS. 18 and 18A, by a spring member 201 compressed between the pawl 200 and a recess 202 formed in an offset portion of the block 195. Another pawl 203 is pivotally secured to the block member 195' also being normally urged in a counter clockwise direction, as viewed in FIGS. 18 and 18A, by a spring 204 disposed in a recess 205 formed in an offset portion of the block member 195'. As may be seen in these Figures, looking first at FIG. 18, wherein the contact holder member 118 is in its elevated position being out of contact with the multi-conductor ribbon or cable, the blocks 195 and 195' are relatively close to each other so that the spring 204 urges pawl 203 into engagement with the carrier strip 181 so that further feeding thereof is prevented while the pawl 200, because of the angular orientation of its finger, is in a position to ride over the carrier strip 181 as it is being fed. Upon downward movement of the contact holder member 118, however, the blocks 195 and 195' become further separated, whereby the pawl 200 under the biasing force spring 201 is permitted to engage the carrier strip 181 which is being drawn from the supply reel through the movement of the block 195' away therefrom. After the contact 119 has been inserted into and crimped into the multi-conductor ribbon or cable, the plunger 145 is returned to its original position under the action of spring 139, and during this return, block 195' is moved in the direction of block 195 so that pawl 200 is operative to feed the carrier strip 181 in the direction of the contact holder 118 for placing a new contact 119 in position beneath the ram 146, while the pawl 203 is now permitted to ride over the carrier strip because of the angular orientation of its finger.

In FIG. 17, there is shown a leaf spring connected to the contact holder member 118 and extending therebeneath at an angle such that it is compressed when it comes down upon the multi-conductor ribbon or cable upon downward movement of the contact holder member 118, and actuation of the ram 146. Thus, upon completion of the crimping operation, when the ram 146 is withdrawn into the contact holder member, the spring 210 is operative to kick the ribbon or cable and the contact crimped therein away from the small opening in the bottom face of the contact holder member 118 through which the contact 119 has been forced by the ram 146. In FIGS. 18 and 18', a guide member 211 is shown in phantom being designed to prevent the contact from moving side ways out of tool after crimping has occurred.

Referring now to FIG. 19, there is shown a multi-conductor ribbon or cable feeding mechanism which is similar to that described earlier with reference to the portable tool embodiment, but having means for automatically feeding the ribbon after each successive contact is crimped against its respective conductor. Thus, the mechanism is generally indicated by the reference numeral 121 and is characterized by an arm 222 pivotable about a substantially center point 223, a second

arm 224 substantially parallel with arm 222 and being pivotable about a substantially center point 225, and linking arms 226 and 227 connected respectively to the ends of arms 222 and 224 and interengaged by a threaded member 228. Arm 222 is normally biased for movement in a counter-clockwise direction by a spring member 229 and arm member 224 is normally biased for movement in a counter clockwise direction by the biasing force of a spring 165 acting on plunger 164 of the cable or ribbon indexing mechanism, which otherwise is the same as that shown in the portable tool embodiment. Upon downward movement of the contact holder member 118 and the ram 146, therefore, the spring 229 moves the arm 222 in a counter-clockwise direction, thereby freeing arm 224 for movement in the same direction, and movement of arm 224 is effected through the action of spring 165 upon completion of the crimping operation, the arm 222 being moved in a clockwise direction through engagement of the upwardly moving lower block member 195' with an arm 230 on the end of the arm 222, thereby stretching the spring 229. Downward movement of the links 226 and 227 follow, such that arm 224 is also moved in a clockwise direction whereupon the other end of the arm 224 urges the plunger 164 upward against the biasing force of spring 165 for causing a pawl, not shown, to engage rack 163 of a lower index plate 125 of the multi-conductor cable ribbon feeding mechanism. The index plate 125 is thus moved in a direction to place a succeeding conductor on the multi-conductor strip in position above the anvil for a succeeding crimping operation.

In FIG. 20, it may be seen that the cable 182 to which the multi-conductor ribbon or cable is affixed by the clamp plate 126 and the lower index plate 125, as shown in FIG. 19, is rotatably secured to the base 100, being supported on a horizontal platform 240 thereof. Rotation of the table 182 is permitted in the same manner as is rotation of the tool head 190, a table rotary selector device generally indicated by the reference numeral 241 being affixed to a depending portion thereof. The table rotary selector device 241 includes a housing 242, a pin 243 having a flange 244 adjacent one end thereof being slidably disposed within the housing 242 and urged in an upward direction, as viewed in FIG. 20, by a spring 245, and a knob portion 246 outside the housing for manually moving the pin 243 to withdraw the same from its locking position. The platform 240 is provided with a series of apertures 247 being arranged in a circular path adjacent the periphery thereof and in corresponding relation to the radial bores 186 in the tubular member 124, such that by operation of the knob 246, the pin 243 may be withdrawn from one of the holes 247 to permit the table 182 to be rotated about the platform 240 to a selected one of the remaining holes 247, whereupon the knob 246 may be released to permit the pin 243 to reengage the selected hole 247 for locking the table 182 in its desired position.

Accordingly, the operation of the machine version of this invention should be clear, especially in light of the description of the operation of the portable tool version, with the exception that instead of manually operating a ram trigger mechanism, in this case an electric switch is pressed for actuating a pressure cylinder to move the piston rod 117 downward and thereby to move the plunger 145 downward in the housing 112.

Greater versatility is provided with this machine by making the tool head 190 and the able 182 rotary to selected angular positions. In this manner, should a multi-conductor ribbon or cable of such width as to preclude full installation of contacts 119 thereacross, because of limited throat depth of the support 100, be employed, it is possible to rotate the tool head 180° and the table 182 180°, whereupon the other side of the ribbon or cable is disposed below the tool head 190 so that the contacts 119 may be secured thereto pointing in the same direction as the contacts 119 secured to the other side of the ribbon or cable.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is to be understood therefore within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by letters patent of the United States is:

1. A tool for securing contacts to flat multi-conductor cable comprising:

- a housing;
- a contact holder reciprocally disposed in said housing;
- an anvil connected to said housing and disposed in line with said reciprocally movable contact holder;
- a ram reciprocally disposed in said contact holder for movement toward and away from said anvil;
- means for urging said ram in a direction away from said anvil and for urging said contact holder toward said anvil;
- means for overcoming said contact holder urging means for moving said contact holder in said housing away from said anvil, whereby said cable may be inserted between said contact holder and said anvil; and
- means for overcoming said ram urging means for moving said ram through said contact holder for driving a contact disposed in said contact holder through said cable.

2. A tool for securing contacts to flat multi-conductor cable as set forth in claim 1, further comprising:

- means for holding said flat multi-conductor cable in said tool with conductor strip thereof disposed between said contact holder and said anvil and aligned between said movable ram and said anvil; and
- indexing means for selectively moving said cable holding means in a direction to position a succeeding conductor strip of said cable between said contact holder and said anvil in alignment between said movable ram and said anvil.

3. A tool for securing contacts to flat multi-conductor cable as set forth in claim 2, wherein said ram driving means comprises:

- a plunger movably disposed in said housing in a direction in line with said contact holder and said anvil, said ram being secured to said plunger for movement therewith; and
- a trigger pivotably mounted on said housing and connected at one end to said plunger for causing said plunger to be moved in the direction of said contact holder and said ram to be moved through said contact holder in the direction of said anvil.

4. A tool for securing contacts to flat multi-conductor cable as set forth in claim 3, further comprising:

means for limiting the pivotal movement of said trigger in both directions of rotation; and

means for preventing movement of said trigger in one direction of rotation after said trigger has been moved in the other direction until said movement in said other direction has been completed to its limit, and for preventing movement of said trigger in said other direction of rotation after said trigger has been moved in the said one direction until said movement in said one direction has been completed to its limit.

5. A tool for securing contacts to flat multi-conductor cable as set forth in claim 3, further comprising:

an arcuate rack fixedly secured to said housing;

a pawl pivotably mounted to said trigger opposite said end thereof being pivotably connected to said housing for engaging said arcuate rack and for locking said trigger against movement in one direction of rotation after said trigger has been moved in the other direction until said movement in said other direction has been completed through a predetermined angle, and for locking said trigger against movement in said other direction of rotation after said trigger has been moved in the said one direction until said movement in said one direction has been completed through the same predetermined angle.

6. A tool for securing contacts to flat multi-conductor cable as set forth in claim 3, wherein said means for urging said ram in a direction away from said anvil and for urging said contact holder in a direction toward said anvil comprises a spring compressed between said movable plunger and said contact holder in said housing.

7. A tool for securing contacts to flat multi-conductor cable as set forth in claim 6, wherein said means for moving said contact holder away from said anvil comprises:

a cam connected through said housing to said contact holder for moving said contact holder away from said anvil against the biasing force of said spring; and

a lever connected to said housing and said cam for actuating said cam.

8. A tool for securing contacts to flat multi-conductor cable as set forth in claim 2, wherein said indexing means and said holding means comprise:

an index supporting mechanism secured to said housing;

an index plate slidably disposed in said index supporting mechanism;

a clamp plate;

means for fixing said clamp plate to said index plate for securing said flat cable therebetween in a plane wherein said cable is disposed between said contact holder and said anvil;

rack means formed on one surface of said index plate; and

means for selectively engaging said rack of said index plate for moving said index plate through a distance equal to the spacing between conductor strips in said cable.

9. A tool for securing contacts to flat multi-conductor cable as set forth in claim 8, further comprising:

a drag plate secured to said index supporting mechanism and having one surface thereof in relative sliding engagement with said index plate; and means for adjustably controlling the force between said drag plate and said index plate for controlling the ease of sliding of said index plate in said index supporting mechanism.

10. A tool for securing contacts to flat multi-conductor cable as set forth in claim 9, wherein said selective means for indexing said index plate comprises:

a plunger movably disposed in said index supporting mechanism for movement in a direction perpendicular to the direction of travel of said index plate; a pawl carried by said plunger and engageable with said rack; and means normally biasing said plunger in a direction away from said index plate whereby said pawl is disengaged from said rack.

11. A tool for securing contacts to flat multi-conductor cable as set forth in claim 10, further comprising:

adjustable stop means for establishing one end position of the movement of said index plate, whereby the engagement of said plunger-operated pawl with said rack may be accurately set.

12. A tool for securing contacts to a flat multi-conductor cable comprising:

a housing;

an anvil connected to said housing;

a contact holding means having a ram movable therein being disposed in line with said anvil for holding a contact to be secured to a conductor strip of said cable and for maintaining said contact at a predetermined width while said ram drives said contact through said cable; and

means for operating said ram for driving said contact in said contact holder through said cable to said anvil and bending the portion of said contact passing through said cable back into said conductor strip of said cable.

13. A tool for securing contacts to a flat multi-conductor cable as set forth in claim 12, further comprising:

means for holding said flat multi-conductor cable in said tool with a conductor strip thereof disposed between said contact holder and said anvil and aligned between said movable ram and said anvil; and

indexing means for selectively moving said cable holding means in a direction to position a succeeding conductor strip of said cable between said contact holder and said anvil and in alignment between said movable ram and said anvil.

14. A tool for securing contacts to a flat multi-conductor cable as set forth in claim 13, wherein said means for operating said ram comprises:

a hand manipulatable trigger pivotally secured at one end to said housing;

means normally urging said trigger toward an inoperative position wherein said ram is disposed in said contact holding means spaced a predetermined distance from said anvil; and

means for precluding said trigger urging means from moving said trigger to its inoperative position once said trigger has been moved in a ram-driving direc-

tion until said trigger has moved through a predetermined arc for operating said ram for completely driving said contact through said cable and bending said portion of said contact back through said cable into said conductor strip thereof.

15. A tool for securing contacts to flat multi-conductor cable as set forth in claim 14, further comprising:

an arcuate cable-receiving wall formed in said housing adjacent said contact holding means and said anvil for receiving a rolled-up width of said cable.

16. A tool for securing contacts to a flat multi-conductor cable as set forth in claim 14, wherein said cable holding means further comprises:

at least one rear guide means for positioning one edge of said cable in said tool; and
clamp means for clamping at least one other edge of said cable to said indexing means.

17. In a tool having a base, a reciprocating ram cooperating with the base to compressibly form a workpiece therebetween, and trigger means to operate the ram reciprocably, the improvement comprising:

a first frame structure member fixedly secured between said base and a housing containing said ram, and

a second frame member spaced from said first frame member and connecting said base and said housing;

said first frame being in tension upon cooperation of said ram and said base to compressibly form a workpiece, and said second frame member being in compression upon cooperation of said ram and said base.

18. The structure of claim 18, wherein said trigger means is contained for manual actuation between said housing and said second frame member, said second frame member providing a manual grip for an operation adjacent to said trigger means.

19. A mechanism for linearly indexing a workpiece through a tool member for equidistantly positioning a series of working points successively in alignment with said tool member comprising:

means for holding said workpiece in alignment with said tool member,

a rack having a plurality of equally spaced teeth thereon affixed to said workpiece holding means, means for guiding said workpiece holding means in a linear path adjacent to said tool member,

a plunger reciprocally mounted within said guiding means and movable in a path toward and away from said rack and engageable with said rack when in the extreme position, and

a pawl pivotally mounted on said plunger for engaging said rack and advancing said workpiece holding means, whereby the extent of linear movement is defined by the pivotal movement of said pawl from the point of engagement with said rack to the full pivotal extent defined by said plunger engaging said rack.

20. A machine for securing contacts to flat multi-conductor cable comprising:

a base;

a housing secured to said base;

a tool head reciprocally disposed in said housing;

a table for supporting said cable in a preselected orientation below said tool head;

an anvil mounted in said table;

means in said tool head for receiving a carrier strip of said contacts in predetermined orientation;

a ram reciprocally disposed in said tool head for movement toward and away from said anvil;

means for moving said tool head toward said table;

means for retracting said tool head away from said table;

means for feeding said carrier strip of contacts to said receiving means in said tool head; and

means for indexing said cable upon retraction of said tool head.

21. A machine according to claim 20, further comprising:

means for rotating said tool head to any selected one of a plurality of angular positions; and

means for rotating said table to any one of a plurality of angular positions.

22. A machine according to claim 20, wherein said tool head comprises:

a tubular member rotatably disposed in said housing;

a sleeve member axially movable in said tubular member;

a plunger secured to said sleeve member for movement therewith;

means for preventing rotational movement of said sleeve member and said plunger relative to said tubular member.

23. A machine according to claim 22, wherein said means for receiving a carrier strip is a contact holder member slidable within said sleeve member and said ram is slidable within said contact holder member, and further comprising:

means for permitting selective rotation of said tool head to any one of a plurality of angular positions; and

means for selectively rotating said table to any one of a plurality of angular positions.

24. A machine according to claim 20, wherein said means for feeding said carrier strip of contacts to said receiving means comprises:

a first guide block secured to said housing;

a second guide block secured to said tool head and movable therewith toward and away from said first guide block;

means on said first guide block for engaging said carrier strip and for indexing said carrier strip toward said carrier strip receiving means upon movement of said ram away from said anvil; and

means for preventing reverse movement of said carrier strip while said means for indexing said carrier strip is not operating to index said carrier strip.

25. A machine according to claim 24, wherein said means for indexing said carrier strip is a pawl pivotally secured to said first block member and normally biased in a given direction.

26. A machine for securing contacts to flat multi-conductor cable comprising:

a base;

a housing secured to said base;

a tool head reciprocally disposed in said housing;

means for selectively rotating said tool head in said housing to any one of a plurality of angular positions;

a table for supporting said cable in a preselected orientation disposed below said tool head;

an anvil mounted in said table;

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means connected with said table for indexing said cable in a direction to position a succeeding conductor strip of said cable between said tool head and said anvil;
means for selectively rotating said table to any one of 5

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a plurality of angular positions corresponding to said angular positions of said tool head; and
means for moving said tool head in the direction of said anvil.

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