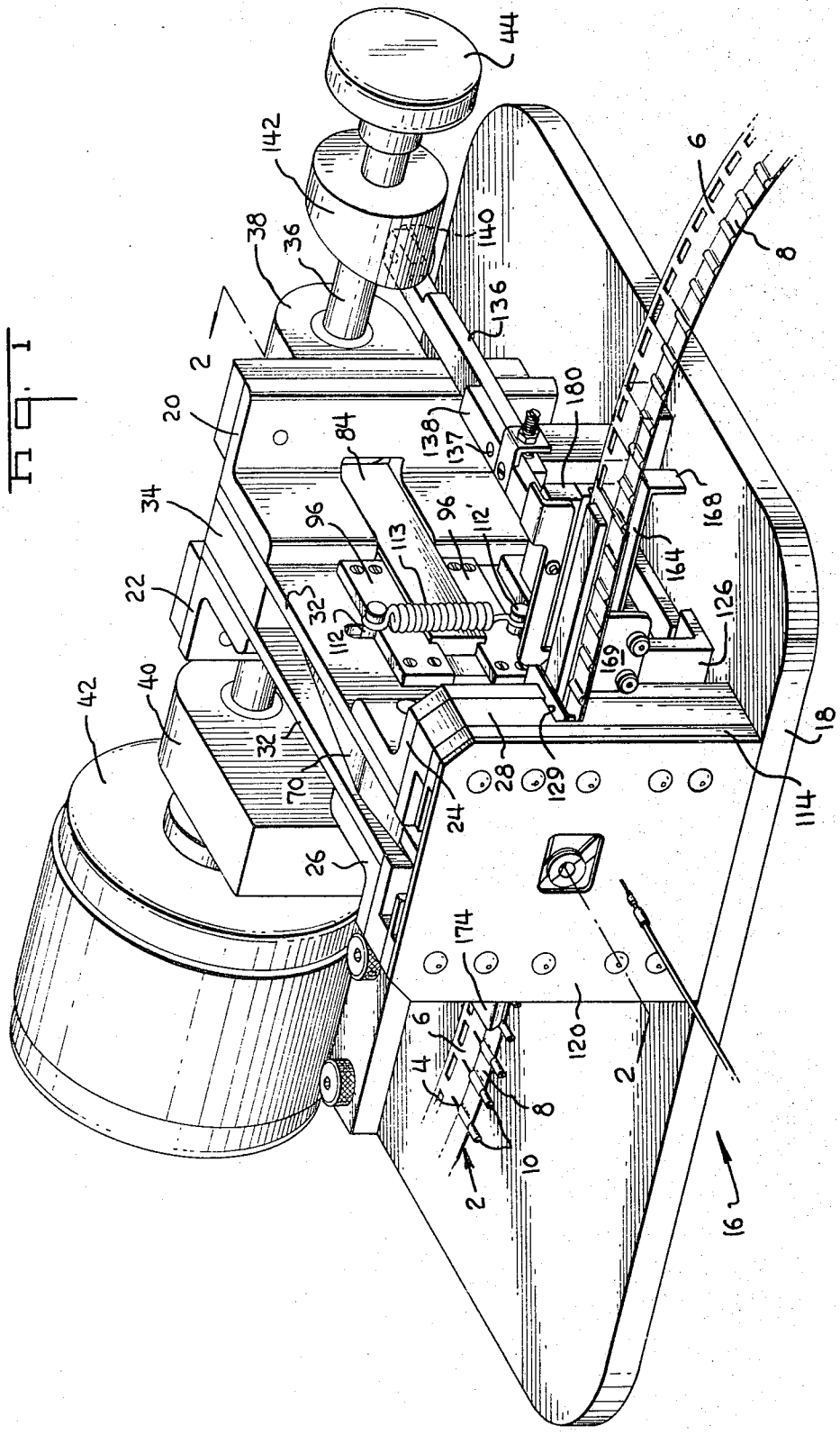
Dec. 17, 1968 H. E. COOTES 3,416,213

CRIMPING APPARATUS FOR ELECTRICAL TERMINALS

Filed Aug. 16, 1966 6 Sheets-Sheet 1

Fig. 1



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CRIMPING APPARATUS FOR ELECTRICAL TERMINALS

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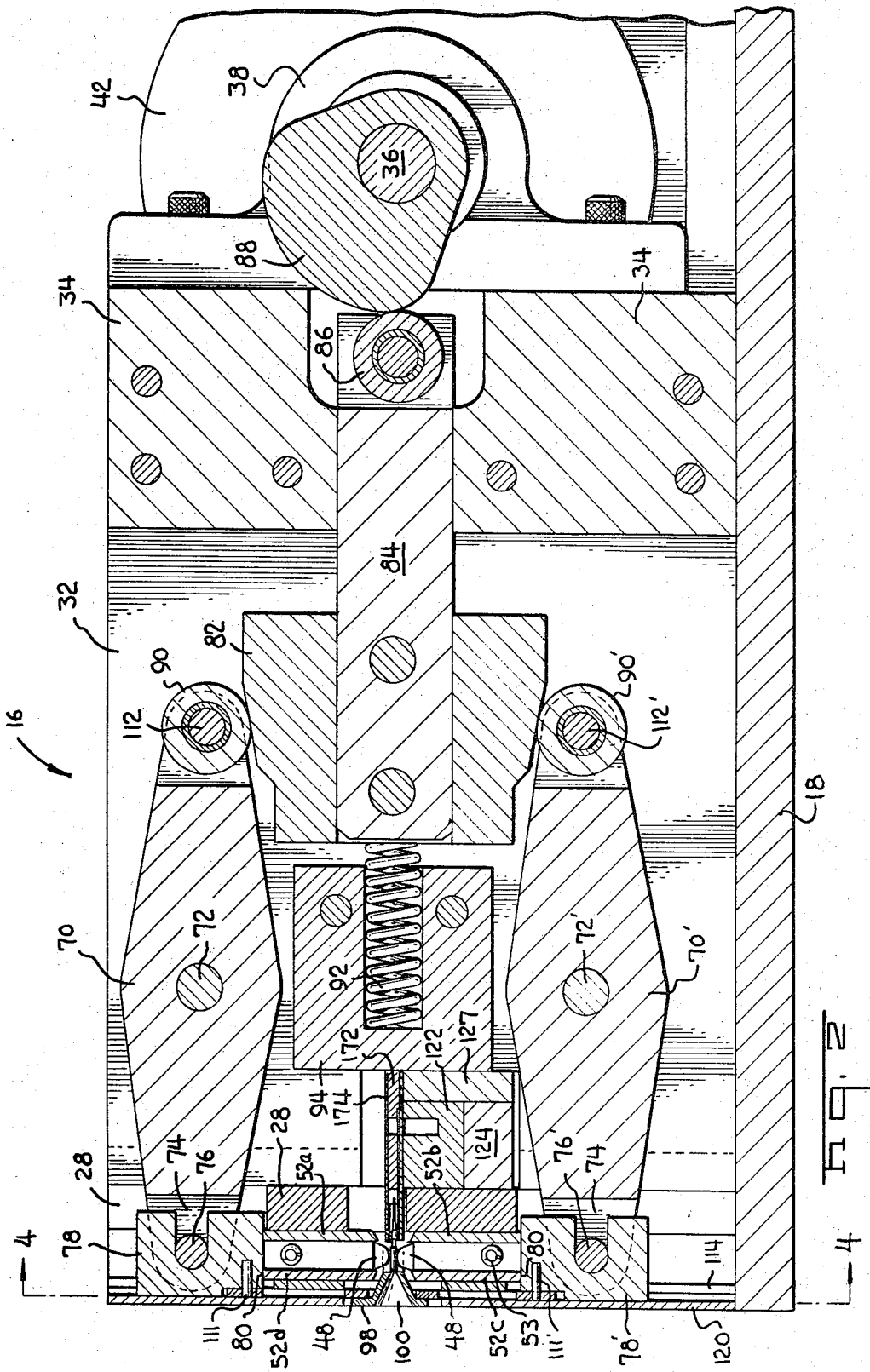


Fig. 2

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CRIMPING APPARATUS FOR ELECTRICAL TERMINALS

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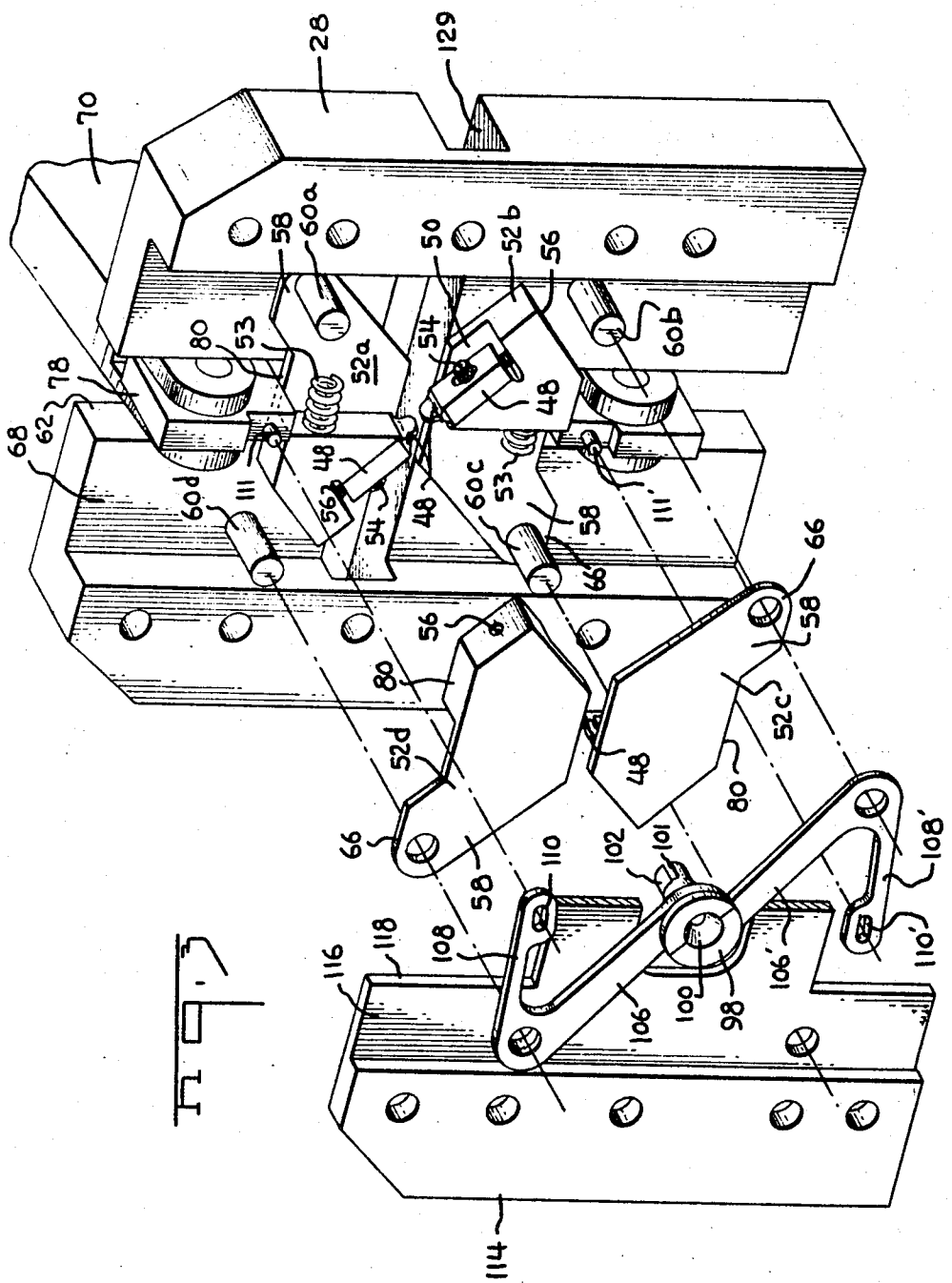


FIG. 3

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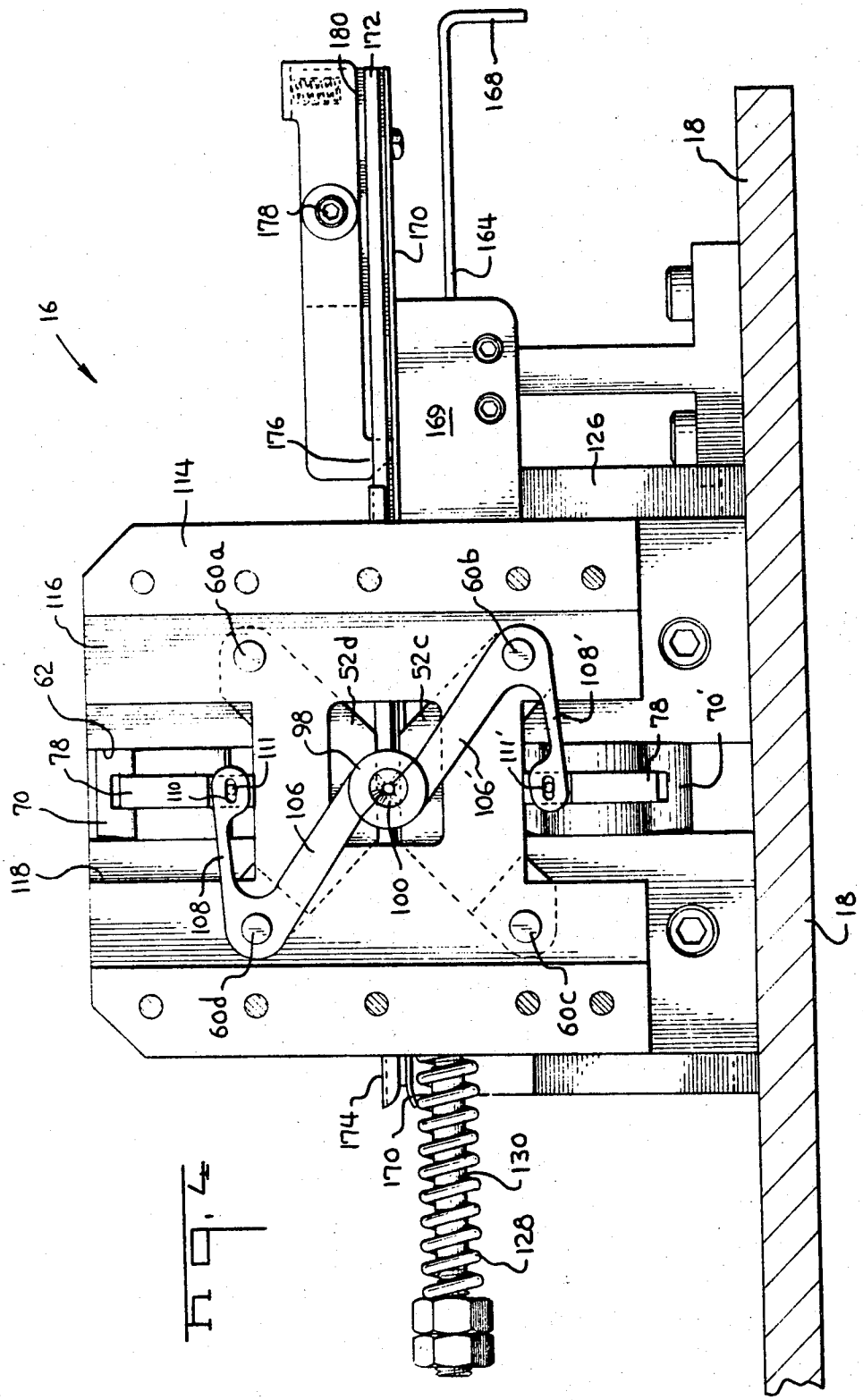


Fig. 4

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CRIMPING APPARATUS FOR ELECTRICAL TERMINALS

Filed Aug. 16, 1966 6 Sheets-Sheet 5

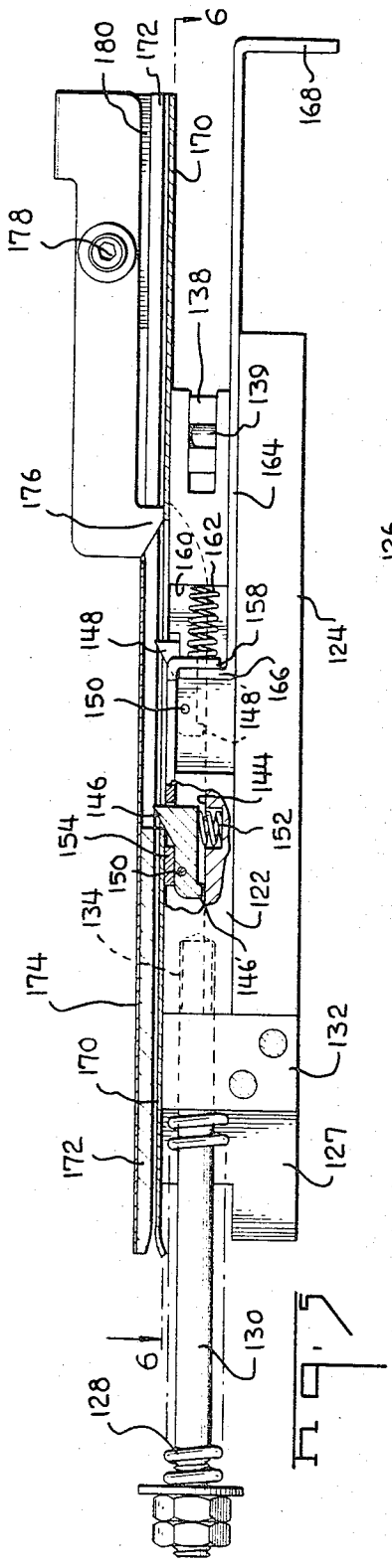


FIG. 5

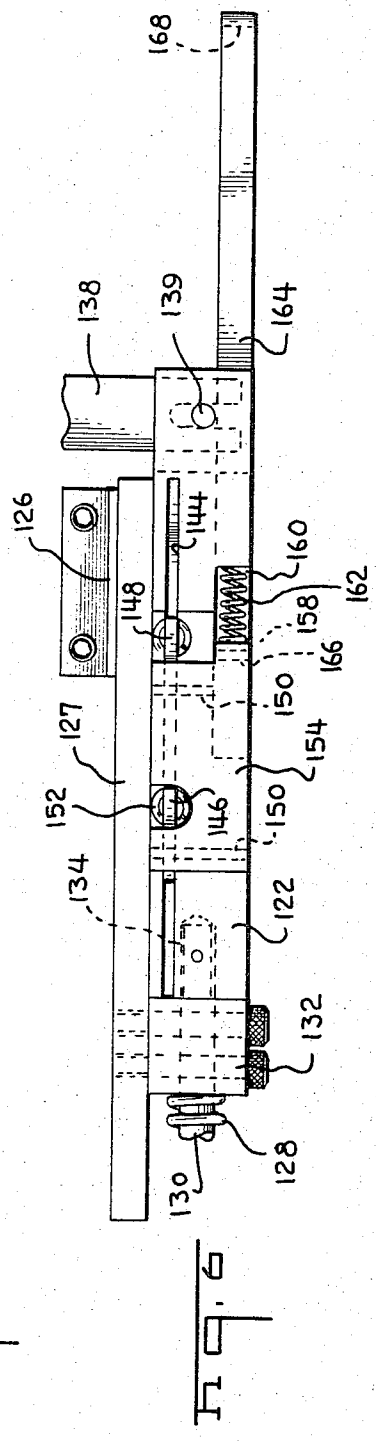


FIG. 6

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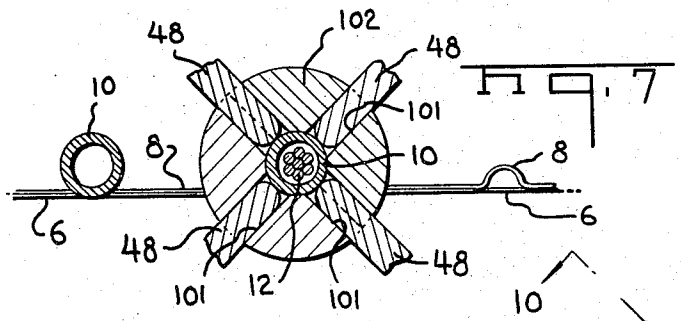


FIG. 7

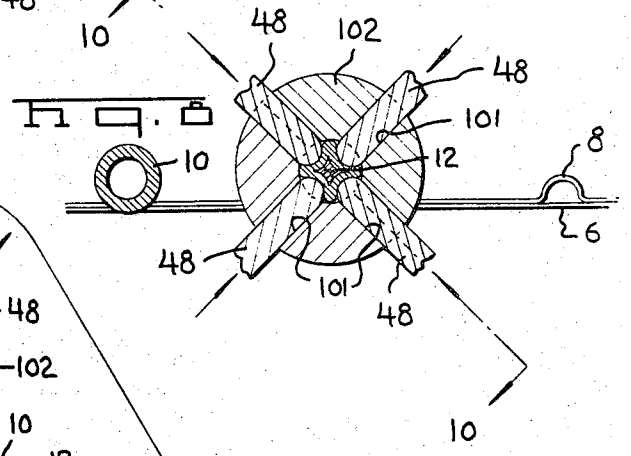


FIG. 8

FIG. 9

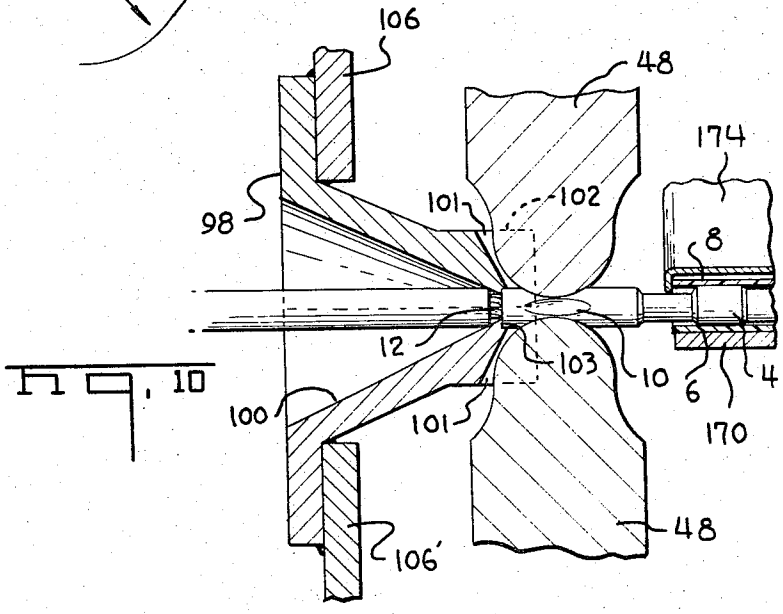


FIG. 10

United States Patent Office 3,416,213 Patented Dec. 17, 1968

3,416,213

CRIMPING APPARATUS FOR ELECTRICAL TERMINALS

Harold Edwin Cootes, Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Filed Aug. 16, 1966, Ser. No. 572,713
7 Claims. (Cl. 29—203)

This invention relates to apparatus for crimping elecrical terminals in strip form onto the ends of wires.

An object of the invention is to provide an improved crimping apparatus for terminals in strip form. A further object is to provide a device which is capable of forming an indentation type crimp with a high degree of precision. A still further object is to provide a device which can be used for crimping terminals of varying sizes. A still further object is to provide an apparatus which can be operated by relatively unskilled personnel and which will produce consistently high quality crimped connections.

These and other objects of the invention are achieved in a preferred embodiment thereof comprising means for feeding a strip of terminals to an operating or indenting zone in which there are disposed a plurality of radially directed indentors. Terminal gripping means are provided in this zone which close into gripping engagement with the leading terminal of the strip and precisely center this leading terminal with respect to the indentors. When the leading terminal is thus held and centered with respect to the indentors, the operator closes a suitable foot switch and drives the device through its operating cycle during which the indentors are driven into the terminal, the indentors are retracted, and gripping device releases its grip on the terminal, the terminal strip is fed so that the next adjacent terminal is positioned in the operating zone, and the gripping means is thereafter closed to grip this next adjacent terminal in preparation for the next operating cycle.

In the drawings:

FIGURE 1 is a perspective view of a preferred form of apparatus in accordance with the invention;

FIGURE 2 is a sectional side view taken along the lines 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary perspective view, with some parts exploded, showing the indentors and the gripping means and the manner in which these parts are mounted in the operating zone;

FIGURE 4 is a frontal view of the apparatus with the cover plate removed to show the manner in which the terminal gripping means is mounted, this view being taken along the lines 4—4 of FIGURE 2;

FIGURE 5 is a fragmentary front view with parts broken away of the strip feeding mechanism;

FIGURE 6 is a plan view of the mechanism of FIGURE 5 taken along the lines 6—6 of FIGURE 5;

FIGURE 7 is a fragmentary front view, on an enlarged scale, showing the manner in which the leading terminal of the strip is held in the operating zone and the relationship of the indentors to this leading terminal at the beginning of the operating cycle;

FIGURES 8 and 9 are views similar to FIGURE 7 but showing the positions of the parts at successive stages of the operating cycle; and

FIGURE 10 is a view taken along the lines 10—10 of FIGURE 8.

The disclosed embodiment of the invention is adapted to crimp terminal 4 in the form of a continuous strip or belt onto the ends of wires. The terminals are mounted on a belt 2 which is composed of a relatively wide bottom strip 6 and a binding strip 8 which extends along the forward edge, as viewed in FIGURE 1, of the strip 6. These two strips are of suitable plastic material such as polypropylene and are provided with spaced-apart pilot holes

by means of which the strip is fed to the operating zone of the apparatus. The wire barrel portions 10 of the terminals extend forwardly beyond the edge of the strip and are engaged by the indentors when the leading terminal of the strip is crimped onto a wire.

The disclosed form of apparatus 16 comprises a base plate 18 on which is mounted a frame structure comprising four upstanding angle brackets 20, 22, 24, 26 spaced from each other. A housing block 28 is secured by fasteners 30 to the laterally extending arms of the forward brackets 24, 26 and parallel spaced-apart side plates 32 extend between, and are secured to, the brackets 20, 24 and 22, 26. A spacer block 34 is positioned between, and secured to, these side plates at the rearward ends thereof in the vicinity of the brackets 20, 22.

Power is supplied to the apparatus by means of a shaft 36 which is mounted in pillow block bearings 38 on the rearward sides of the brackets 20, 22. This power shaft is coupled by means of a single revolution clutch 40 to the output shaft of a suitable electric motor 42. The clutch 40 may be of any suitable single revolution type and is arranged such that the shaft 36 will be driven through a single revolution when the operator closes a switch such as a conventional foot switch. Advantageously, a handwheel 44 is mounted on the end of the shaft 36 to permit it to be turned over by hand during adjustment or repair, and for loading and removing terminal strip from machine.

Referring now to FIGURE 3, the terminals are crimped by indentation, the indenting operation being carried out by four indentors 48 which are located at equally spaced intervals around a common center and radially directed towards the common center. These indentors are contained in a channel-like recess 68 of the housing block 28 and are adjustably mounted by means of screws 54 in recesses 50 of mounting blocks 52*a*, 52*b*, 52*c*, and 52*d*. In order to permit adjustment of the positions of the indentors, set screws 56 are threaded through the mounting blocks and bear against the rearward sides of the indentors. Each of the blocks 52*a*–52*d* has an integral laterally extending arm 58, the end portion of which is offset as shown at 66. The offset portions of these arms are mounted on pins 60*a*, 60*b*, 60*c*, and 60*d* which are mounted in the block 28 on opposite sides of the recess 68. The axes of these four pins must form a substantially perfect square in order to achieve the high degree of precision required for the indenting operation. As is shown best in FIGURE 3, the arrangement of the mounting blocks 52*a*–52*d* and the arms 58, 66 on each block is such that the arms in the two upper blocks 52*a*, 52*d* overlap each other as do the arms on the lower blocks 52*b*, 52*c*. Springs 53 are interposed between the opposed sides of the upper and lower pairs of arms to bias the indentors radially outwardly with respect to the axis on which the leading terminal is located. The blocks and arms are moved radially inwardly along arcuate paths by application of forces to the sides 80 of the blocks as will be described below.

Referring now to FIGURE 2, the four arms 52*a*–52*d* are swung about the axes of the pins 60*a*–60*d* by means of rocker arms 70, 70′ mounted on spaced-apart parallel axes 72, 72′ extending between the plates 32 adjacent to, and behind, the housing block 28. At their forward ends, these rocker arms are slotted as shown at 74 and pins 76, 76′ extend between the spaced-apart sides of the slots. Adaptors 78, 78′ are mounted on these pins and are so located that they will bear against the previously identified sides 80 of the blocks 52*a*–52*d*. At their rearward ends, the arms 70, 70′ are provided with cam followers 90, 90′ which bear against the surface of a reciprocable cam 82 mounted on a slide 84. Cam followers 90, 90′

are mounted on pins **112, 112'** which extend beyond the plates **32**. Extension springs **113**, extending between corresponding ends of these pins, bias the right hand ends (as viewed in FIGURE 2) of the rocker arms towards each other and against the cam **82**. The slide **84** extends rearwardly between the plates **32**, through block **34** and has a cam follower **86** on its end which bears against a cam **88** on the shaft **36**. Slide **84** is biased rightwardly as viewed in FIGURE 2 and against the cam **88** by means of a spring **92**, disposed in a fixed block **94** mounted between the plates **32**, which spring bears against the forward end of the slide as shown. In order to guide the slide member along a precisely predetermined path, slots are provided in the plates **32** and portions of the slide extend through these slots and bear against guide plates **96** secured to the external surfaces of the plates **32**.

Referring now to FIGURES 3, 5, and 7, it is highly desirable to precisely center the leading terminal of the strip with respect to the indentors when it is crimped onto the strands **12** of the wire. In the disclosed embodiment, a strip feeding operation and this centering operation are carried out at the end of each operating cycle so the fed terminal is centered with respect to the indentors at the beginning of the next operating cycle. The centering means comprises a generally conical gripper having a funnel-like opening **98** and a cylindrical end portion in which there is provided a cylindrical opening conforming to the outside diameter of the wire barrel portion of the terminal. A shoulder **103** is provided at the transition between the cylindrical section **102** and the conical surface **100** of the funnel to locate the end of the contact accurately as shown in FIGURE 10. The cylindrical section has openings **101** to permit the indentor tips to pass therethrough as illustrated in FIGURE 10. As is also shown in FIGURE 10, the angle of the surface of the funnel **100** and the width of this funnel at its inner end are such that the end of the insulation cannot be pushed against the end of the terminal and the end of the terminal is firmly seated in the shoulder **103**. This arrangement ensures that all of the strands **12** of the wire will be guided into the terminal and will not be deflected and left out of the terminal.

This conical gripper is formed in two identical sections which are mounted on arms **106, 106'**. The upper arm **106** extends diagonally from the axis of the terminal towards the pin **60*d*** and is pivotally mounted thereon. Integral with this upper arm is a horizontally extending arm **108** having an enlarged end which is slotted as shown at **110** for the reception of a pin **111** mounted in the adapter **78**. The lower arm **106'** is similarly mounted on the pin **60*b*** and has a corresponding horizontally extending arm **108'**. It will be apparent from FIGURE 3 that the arms **108, 108'** are relatively thin and have a relatively small cross-sectional area as compared with the arms **106, 106'**. As will be explained below, the arms **108, 108'** are resiliently flexed during the operating cycle by a slight amount and must have physical properties capable of accommodating this flexure. The arms **106, 108, 106', 108'** constitute bell cranks pivoted on the pins **60*b*, 60*d***.

The arms **106, 106'** are contained in a recess **116** in a plate **114** which is disposed against the front surface of the sides of the housing block **28**. As is apparent from FIGURE 4, the pins **60*a*–60*d*** extend through this plate and into the openings in the arms. The plate **114** is also provided with notches **118** in alignment with the notches **62** in the frameblock **28** for the accommodation of the ends of the rocker arms **78**. The arms **106** are retained in position on the pins **60*a*, 60*d*** by means of a faceplate **120** which is best shown in FIGURE 1.

Feeding of the terminal strip **2** is accomplished by a horizontally reciprocable feed slide **122** (FIGURES 5 and 6) which is supported on a fixed support bar **124**. The support bar **124** in turn is mounted behind the block **28** in alignment with a horizontally extending notch **129** in block **28** by means of a mounting bar **127** secured to brackets **126** which, in turn, are secured to the surface of the base plate **18**. Slide **122** is biased leftwardly, as viewed in FIGURE 5, by a spring **128** which surrounds a rod **130** and which bears against a washer on the left hand end of this rod. The rod **130** extends slidably through a bearing block **132** mounted against the support **124** and is threaded into the slide **122** as shown at **134**. Reciprocation of the slide **122** is accomplished by a cam **142** on the shaft **36** which bears against a cam follower **140** on the end of a feed lever which is made of two parts **136, 138**, for stroke adjustment purposes. This feed lever is pivoted intermediate its ends as shown at **137** and has a pin-slot connection **139** at its forward end with the right hand end of the feed slide. Since the shaft **36** is rotated through a single revolution during each operating cycle, the feed lever is swung about its pivotal axis one time and the strip **2** is fed for a distance equal to the spacing between adjacent terminals thereon.

A relatively narrow slot **144** extends downwardly from the upper surface of feed slide **122** and feed pawls **146, 148** are mounted in this slot on pivot pins **150**. The pawls **146, 148** are normally biased upwardly by springs **152** seated in suitable drilled openings in the upper surface of the slide **122** which bear against the undersides of the pawls as shown in FIGURE 5. The pawls are restrained against upward movement beyond the position shown in FIGURE 5 by an extension of the pawls as shown at **146'** and **148'** which bear against the bottom of slot **144**. A plate **154**, which is slidably mounted in a recess on the top surface of the feed slide **122**, is provided with cut outs to permit the feed pawls to project therethrough so that they can engage the perforations or pilot holes in the belt.

On its right hand end, the cover plate **154** is provided with a depending ear **158** which extends into a recess in the front side of the feed slide **122**. A spring **162** is contained in this recess **160** and biases the ear and, therefore, the cover plate **154** leftwardly is viewed in FIGURES 5 and 6.

The feed slide **122** is shown in FIGURES 5 and 6 in its fully retracted (i.e., leftward) position which it occupies at the beginning of the operating cycle. The slide and the pawls move rightwardly from the position of FIGURES 5 and 6 to feed the terminal strip when the grippers are open and the indentors retracted.

It is desirable to be able to depress the feed pawls and disengage them from the strip when the strip is being removed from the machine. This is accomlished by means of a bar **164** slidably mounted on the upper surface of the support bar **124** beneath the right hand end of the feed slide **122**. This bar has an upwardly extending ear **166** which projects into the recess **160** leftwardly of the depending ear **158** of the cover plate. On its right hand end, the bar **164** has a finger grip section **168** so that this bar can be pulled rightwardly against the biasing force of the spring **162**. Such rightward movement of the bar causes similar rightward movement of the cover plate which rides over the upwardly projecting portions of the pawls and cams, the pawls downwardly and out of engagement with the belt. The bar **164** is held in position by a suitable retaining plate **169** on the face of the support **124**.

The terminals are supported during feeding on the upper surface of a feed plate **170** and are guided by means of a guide plate **172** mounted on the feed plate. This guide plate has an undercut along its left-hand side as viewed in FIGURE 2 which receives a substantial portion of the tape or strip **6**. Finally, a retainer plate **174** is mounted on the upper surface of a guide plate and has a depending lip on its forward edge (FIGURE 10) which assists in guiding the terminals along a straight line path towards the operating zone.

During leftward movement of the feed pawls (when they

are being retracted) it is necessary to hold the portion of the strip which extends from the right hand side of the operating zone against retractile movement. This is done by a latch or detent **176** on an arm pivotally mounted at **178** on a block **180** which in turn is secured to extension of guide plate **172**. This arm can be disengaged from the strip by merely pressing on the right hand side thereof as viewed in FIGURE 5, a suitable spring being provided to bias the arm normally into engagement with the strip.

At the start of the operating cycle, the parts will be in the positions shown in FIGURES 2, 4, 5, 6, and 7. The motor is advantageously arranged to run continuously so that upon engagement of the single revolution clutch **40**, the apparatus will be driven through a single operating cycle. At the beginning of the cycle, the leading terminal of the strip will be relatively tightly held as shown in FIGURE 7 in the gripper **102**, and the indentors will have their tip portions disposed against the surface of the leading terminal. The operator first inserts the strands **12** of the wire into the wire barrel portion of the terminal and then engages the single revolution clutch by means of a suitable foot switch or other control device. During the first portion of the operating cycle, the cam **82** is moved for a short distance leftwardly from the position of FIGURE 2. It will be apparent from an inspection of the location of the cam **82** with respect to the fixed block **94**, that very little leftward movement of this cam takes place during this interval. However, during such movement, the rocker arms **70, 70'** are swung through slight arcs around their pivotal axes **72, 72'**, the upper arm **70** being moved in a counterclockwise direction and the lower lever being moved in a clockwise direction. Such movement of these rocker arms has the effect of applying a downwardly directed force against the sides **80** of the upper two blocks **52***a*, **52***d* and an upwardly directed force against the lower blocks **52***b*, **52***c*. As a result, blocks and their integral arms are swung arcuately about their pivotal axes **60***a*–**60***d* and the indentors are driven radially into the terminals as shown in FIGURE 8. The amount of indentation is very slight, particularly for relatively small terminals as will be readily apparent from a comparison of FIGURES 7 and 8. The pin **111** on the upper rocker arm **70** and the corresponding pin **111'** on the lower arm move vertically towards each other during this interval. This slight movement of these pins causes the arms **108, 108'** to deflect resiliently. As previously noted, the gripper **98** is in engagement with the terminal at the beginning of the operating cycle so that the arms **106, 106'** can not be pivoted about axes of these arms.

After the terminal has been indented as shown in FIGURE 8, the slide **84** is moved rightwardly under the influence of the compressed spring **92**, such rightward movement of the slide member **84** being permitted by virtue of the contour of the cam **88**. During this portion of the cycle, the arms **70, 70'** are swung in opposite directions and the adapters **78** move out of engagement with the blocks **52***a*–**52***d* under the influence of the extension springs **113**. The blocks then move radially away from the crimped terminal carrying the indentors with them. At the same time, the pins **112, 112'** in the arms **70, 70'** cause the levers on which the gripper **98** is mounted to swing arcuately away from the operating zone so that the terminal is released as shown in FIGURE 9. During the final portion of the operating cycle, that is, while the shaft **36** is still going through its single revolution, the cam **142** causes the lever **136, 138** to be swung about its pivotal axis to feed the strip by means of the pawls **146, 148** as previously described.

When it is necessary to adapt the machine to the crimping of a different size of terminal from the size which is being crimped, the necessary changes can be made by merely removing the adapters **78** from the pins **76** and replacing them with a set of adapters which will drive the indentors through the required arc for the new terminal. At the same time, it is also necessary to replace the grippers **98** with a different size pair of grippers conforming to the terminal which is to be crimped. It is thus unnecessary to make any adjustments to the machine when the terminal size is changed.

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

What is claimed is:

1. Apparatus for crimping electrical connecting devices in strip form onto the ends of conductors comprising, means for feeding a strip of said devices to an operating zone, a plurality of indentors disposed in surrounding relationship to said zone, closable terminal gripping means in said zone for gripping the leading terminal of said strip and properly locating said leading terminal with respect to said indentors, said gripping means being normally closed and holding a previously fed terminal centered with respect to said indentors, and means for sequentially driving said indentors into said terminal, retracting said indentors, opening said gripping means, feeding the next adjacent terminal to said operating zone, and closing said gripping means onto said next adjacent terminal whereby, upon insertion of a wire into said leading terminal and actuating said apparatus, said leading terminal is crimped onto said wire and said next adjacent terminal is properly located in said operating zone for the next operating cycle.

2. Apparatus for crimping electrical connecting devices in strip form onto the ends of wires comprising, means for feeding a strip of said devices to an operating zone whereby the leading connecting device of said strip is located in the center of said operating zone, four indentor arms pivoted on separate axes, said axes defining a square with said center of said operating zone defining the center of said square, a first pair of said indentor arms crossing each other on one side of said square and a second pair of said indentor arms crossing each other on the other side of said square, each of said indentor arms having an indentor thereon, said indentors being radially directed towards said leading connecting device, first and second force applying means on said one side and on said other side of said square for applying force to said first and second pairs of indentor arms thereby to drive said indentors towards said leading connecting device, and closable gripping means in said operating zone for holding said leading connecting device precisely centered with respect to said indentors.

3. Apparatus as set forth in claim **2** wherein said force applying means comprises a pair of spaced-apart rocker arms pivotally mounted intermediate their ends on parallel spaced-apart rocket arm axes, corresponding ends of said rocker arms bearing against said first and second pairs of indentor arms whereby, upon pivotal movement of said rocker arms about said axes, said indentor arms are swung about said axes, and camming means for swinging said rocker arms about said rocker arm axes.

4. Apparatus as set forth in claim **3** wherein said closable gripping means comprises a pair of bell cranks, said bell cranks being pivotally mounted on diametrically opposite ones of said separate axes of said indentor arms, said bell cranks having a first arm extending towards said center of said operating zone, end portions of said first arms having means thereon for gripping said leading connecting device, each bell crank having a second arm extending towards said corresponding ends of said rocker arms, and means effective between said rocker arms and said bell cranks for swinging said bell cranks to grip said leading connecting device and to release said leading connecting device after indentation.

5. Apparatus for crimping an electrical connecting device having a wire-receiving opening onto the end of a wire comprising connector device crimping means and connector device gripping and wire guiding means, said gripping and guiding means having a funnel-like opening extending inwardly from one side, said funnel-like opening merging with a cylindrical opening extending to the other side of said gripping and guiding means, the diameter of said cylindrical opening being substantially equal to the outside diameter of said connecting device, and the diameter of said funnel-like opening adjacent to said cylindrical opening being less than the diameter of said wire receiving opening in said connecting device, said crimping means being disposed adjacent to said cylindrical opening whereby, a wire inserted into said funnel-like opening will be guided into the wire-receiving opening of a connecting device held in said cylindrical opening, and said connecting device can be crimped onto said wire by said crimping means.

6. Apparatus as set forth in claim 5 wherein said gripping and guiding means is split along a plane extending through the axis of said funnel-like and cylindrical openings, and including means for moving said two parts away from each other and feeding a strip of said connecting devices to position the leading connecting device of said strip on said axis.

7. Apparatus as set forth in claim 5 wherein said crimping means comprises indentors movable radially through said cylindrical opening in said gripping and guiding means.

References Cited

UNITED STATES PATENTS

2,760,195	8/1956	Berg	72—428 X
3,101,765	8/1963	Batcheller.	
3,155,137	11/1964	Stoltz	72—402
3,264,860	8/1966	Herb.	
Re. 26,146	1/1967	Stoltz	72—397

THOMAS H. EAGER, *Primary Examiner.*

U.S. Cl. X.R.

72—428; 29—243.57; 72—402, 397