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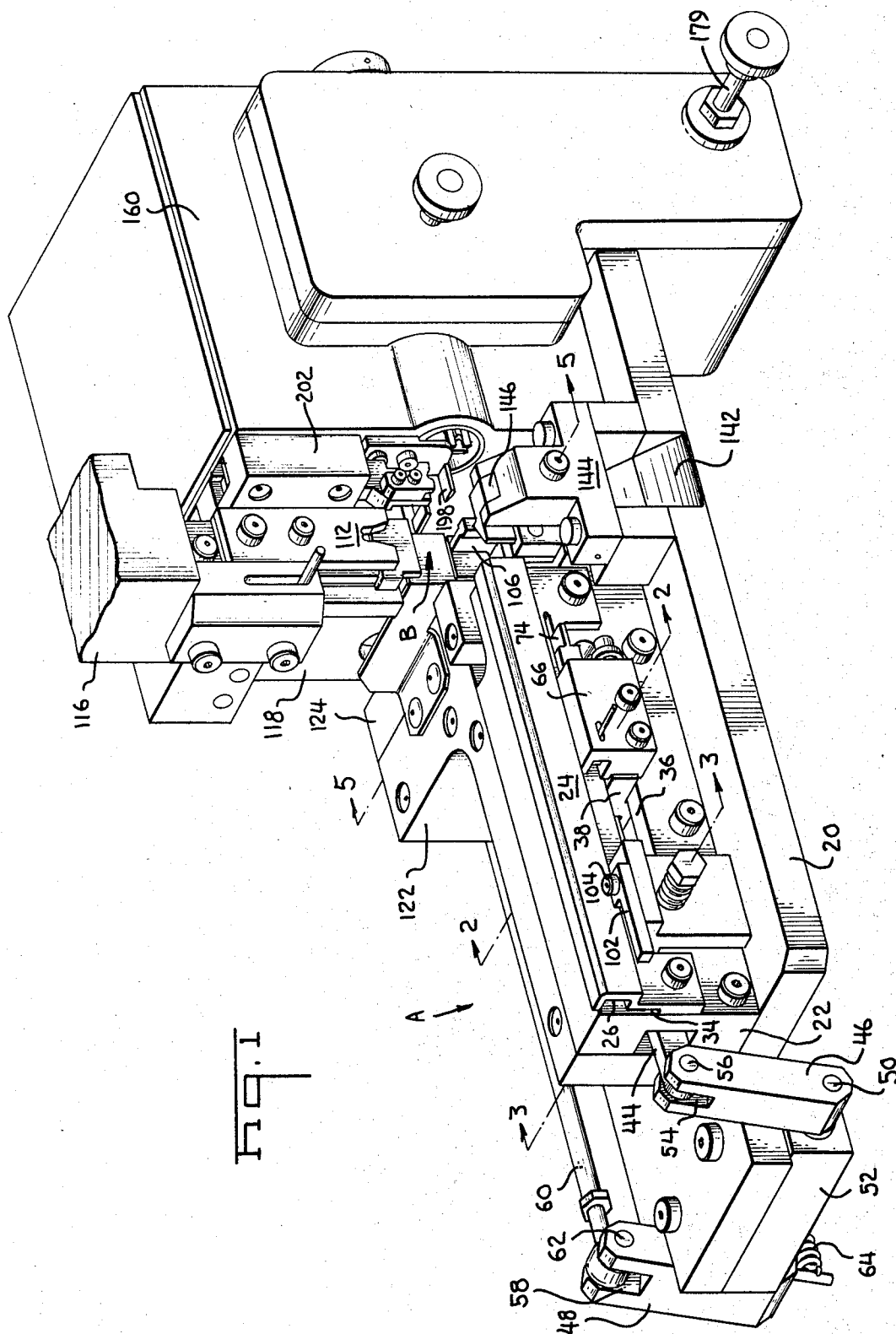
W. LE ROY BUSLER

3,348,286

CRIMPING AND FORMING MACHINE

Filed May 12, 1966

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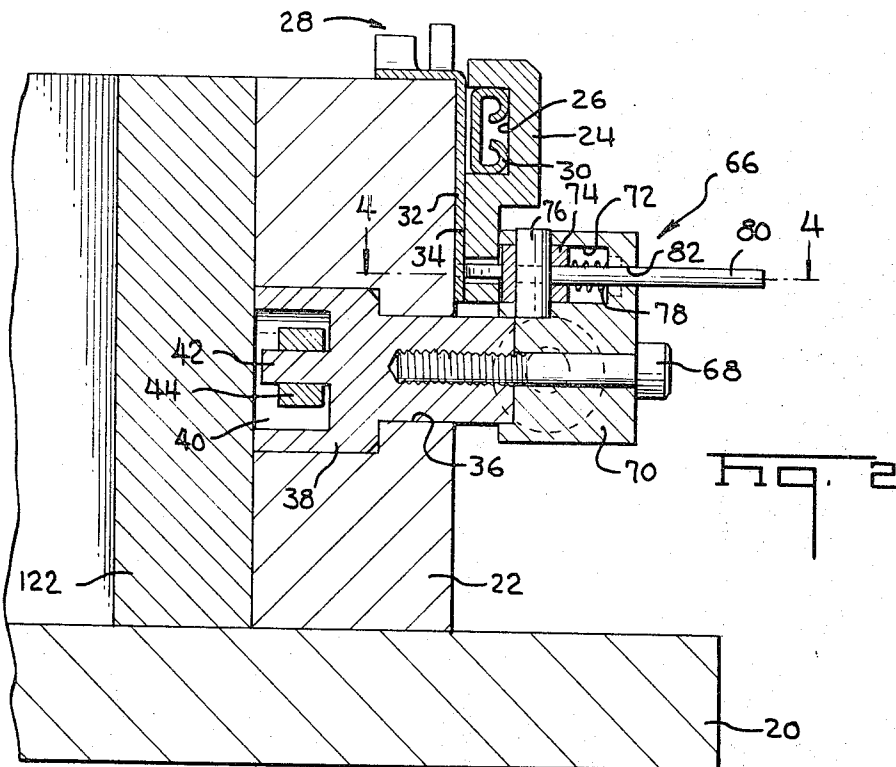
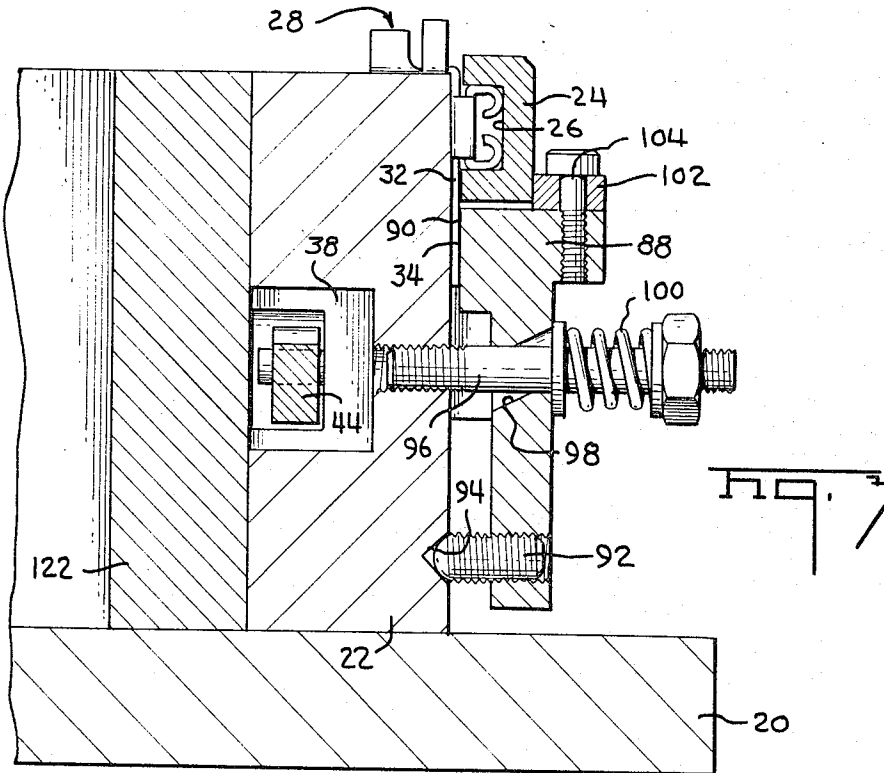
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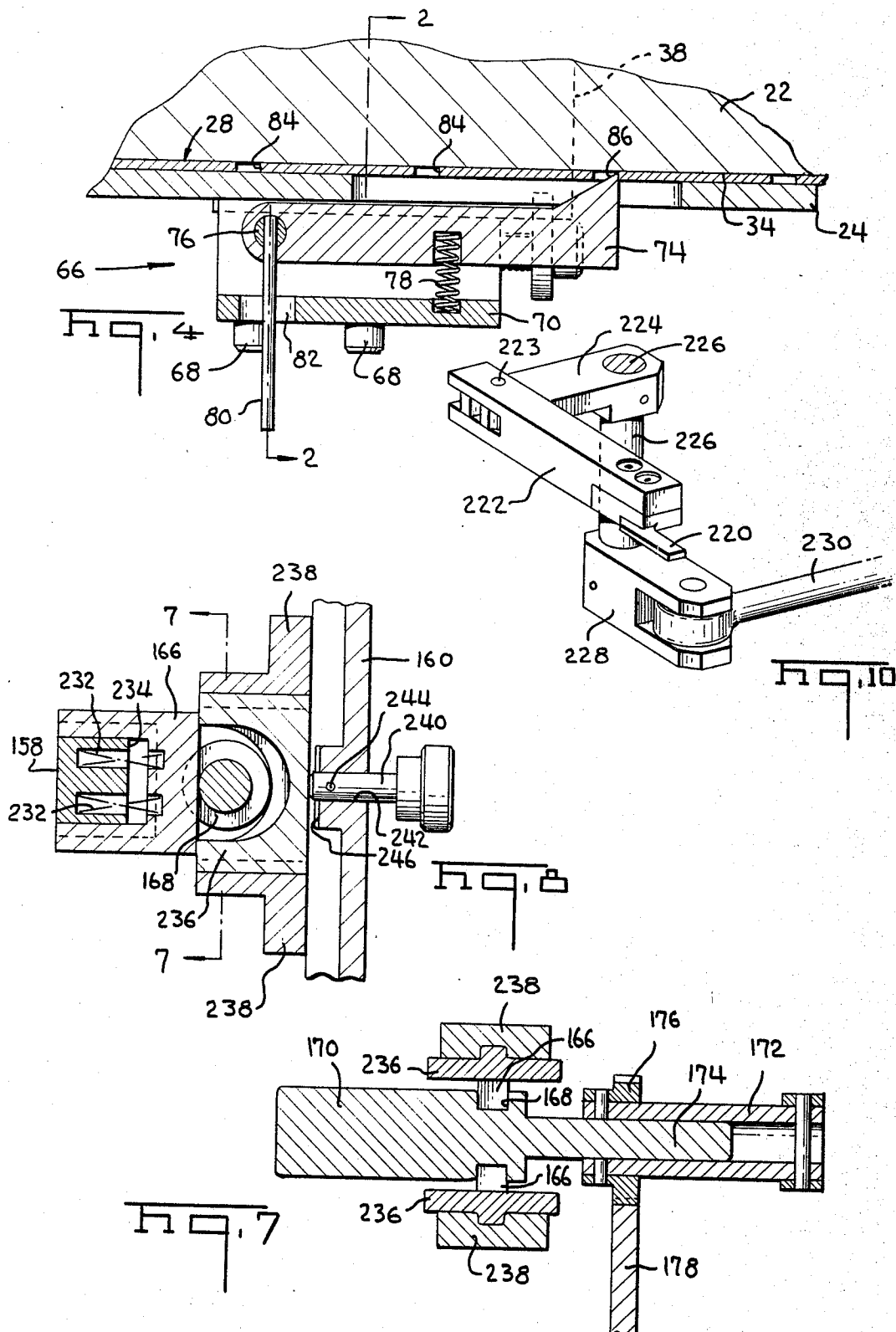
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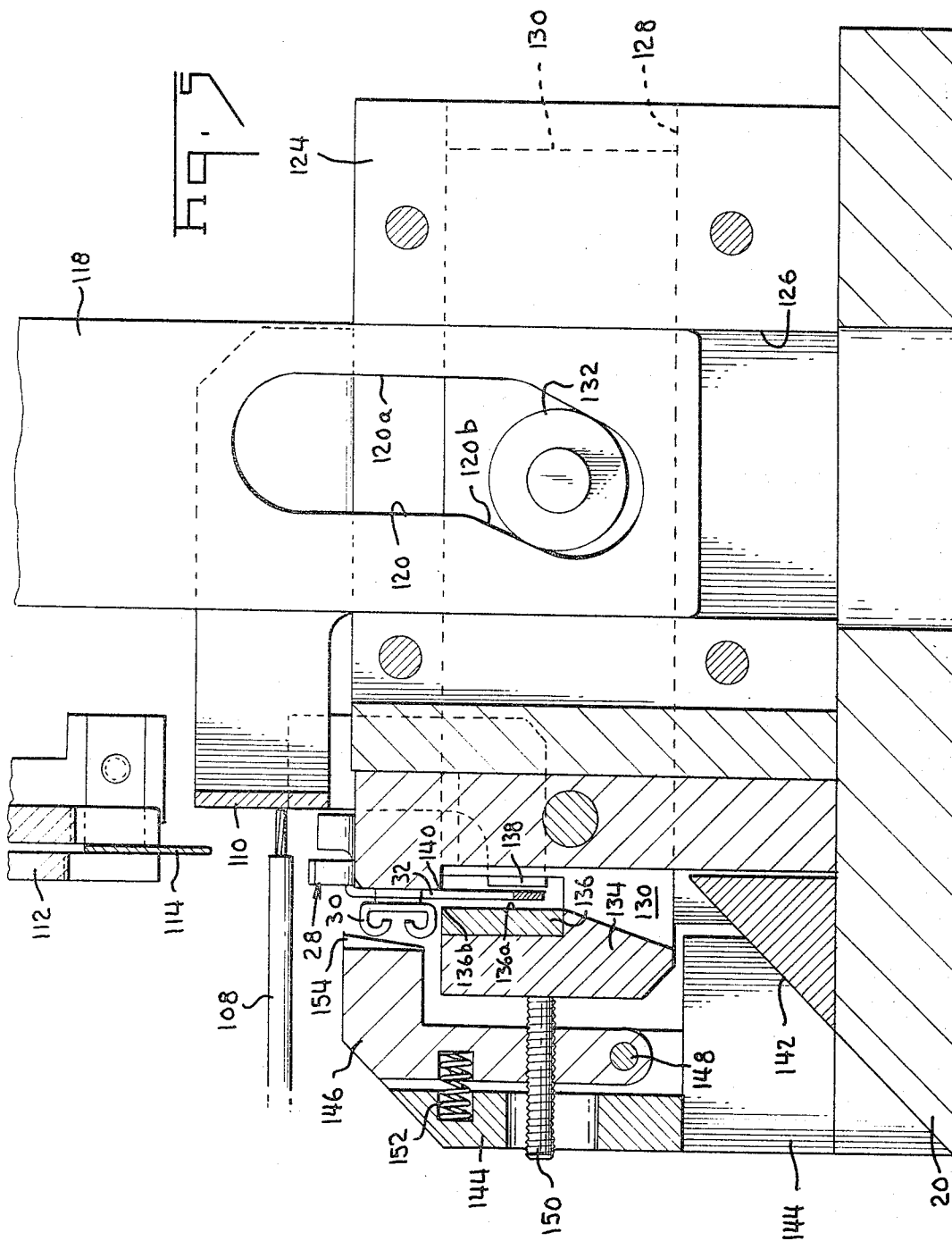
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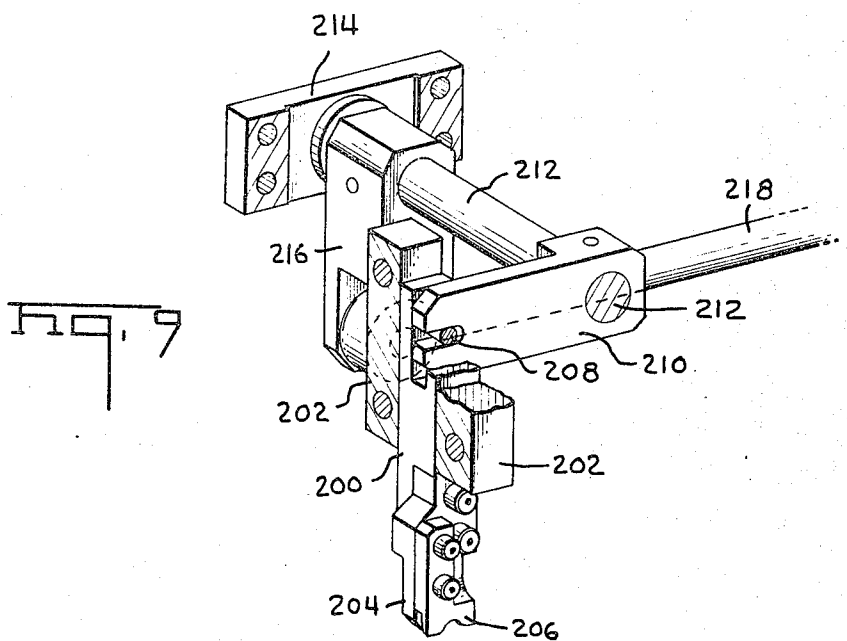
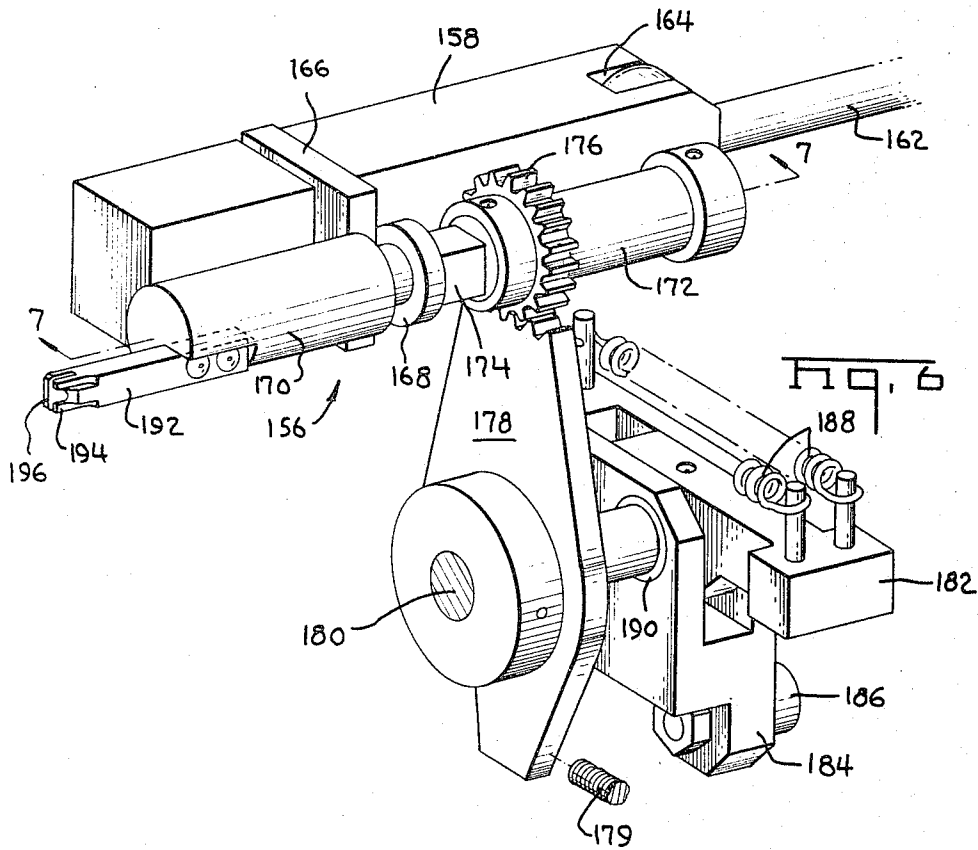
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CRIMPING AND FORMING MACHINE

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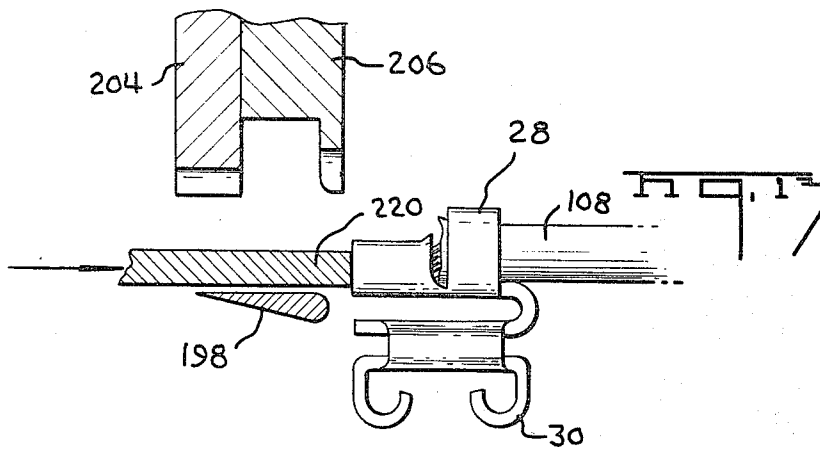
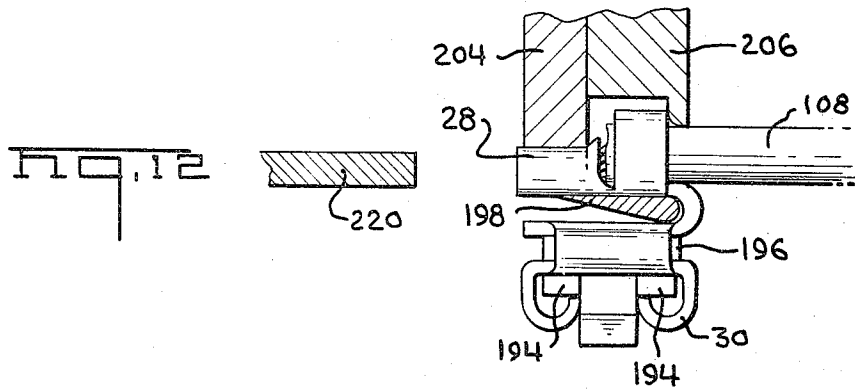
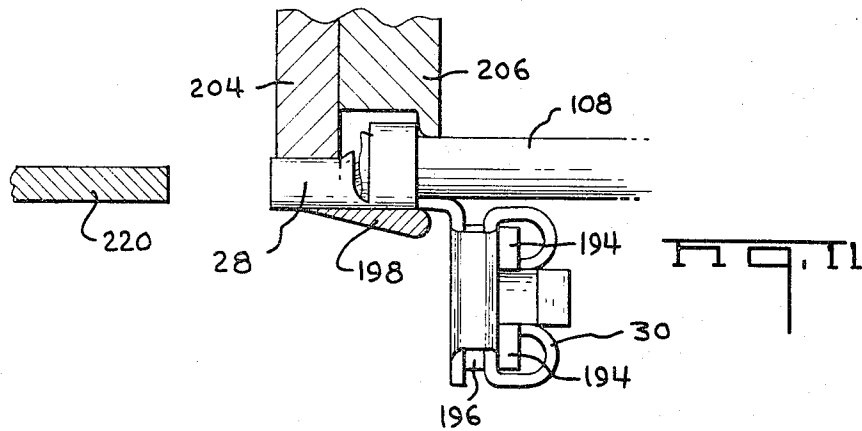
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CRIMPING AND FORMING MACHINE

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CRIMPING AND FORMING MACHINE

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8 Claims. (Cl. 29—33)

ABSTRACT OF THE DISCLOSURE

A crimping and forming machine is provided for feeding a strip of electrical connectors to a working station, severing the lead-end connector from the strip, crimping or otherwise cold forging the lead-end electrical connector to a wire conductor, and forming the crimped connector into its desired final configuration.

There are numerous varieties of electrical connectors which are designed to be secured to the end of a wire conductor. In practice these electrical connectors are formed by progressive die techniques wherein the connectors acquire their final desired shape. The so shaped connectors are then fed through a crimping machine or applicator whereat the connector is applied to the end of a wire conductor. There are instances, however, where connectors assume complex configurations and subsequent crimping of the connector to a wire conductor would be extremely difficult if not impossible. During a crimping operation the ferrule portion of the electrical connector must be rigidly supported on a crimping mandrel. If the electrical connector is so designed that in its final configuration a portion of the connector lies directly beneath the crimping ferrule then the problem arises as to how to adequately support the ferrule during the crimping operation.

The apparatus of the instant invention is concerned with applying to the end of a wire conductor an electrical connector of complex configuration having a portion directly underlying the crimping ferrule. Therefore the above-noted problem exists and is overcome by the instant invention. To allow for proper crimping of the connector there is provided apparatus which will receive the electrical connector in a semi-formed condition wherein the crimping ferrule is disposed away from the remainder of the connector to thereby allow for the accommodation of a crimping mandrel. The instant apparatus is designed to effect the crimping operation and to subsequently form the crimped connector into its final configuration.

It is therefore an object of the present invention to provide a crimping and forming apparatus for an electrical connector.

A further object is to provide an apparatus which will form an electrical connector into its final configuration subsequent to the securing of the connector to a wire conductor.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purpose of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings, in which like reference numerals refer to like parts:

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FIGURE 1 is a perspective view of an apparatus made in accordance with the teachings of the present invention;

FIGURE 2 is a cross-sectional view of the feeding mechanism taken along the line 2—2 of FIGURES 1 and 4;

FIGURE 3 is a cross-sectional view taken along the line 3—3 of FIGURE 1 showing the drag arrangement for preventing retrograde movement of the connector strip;

FIGURE 4 is a cross-sectional view taken along the line 4—4 of FIGURE 2 and showing further details of the feed mechanism;

FIGURE 5 is a cross-sectional view taken along the line 5—5 of FIGURE 1 and showing the applicator mechanism;

FIGURE 6 is a partial perspective view showing the connector forming mechanism;

FIGURE 7 is a cross-sectional view taken along the line 7—7 of FIGURE 6;

FIGURE 8 is a fragmentary sectional view of a disabling mechanism for the connector forming apparatus;

FIGURE 9 is a partial perspective view of the connector hold-down mechanism;

FIGURE 10 is a partial perspective view of the connector ejecting mechanism; and

FIGURES 11—13 are fragmentary views of the electrical connector as it is held, formed, and ejected.

Turning now to the drawings and in particular to FIGURE 1 there is shown the overall mechanism which constitutes a preferred embodiment of the present invention. A feeding mechanism A is provided for feeding electrical terminals in strip form to a crimping and forming station B. The feeding mechanism is secured to a support plate 20 which is suitably secured to the bed of a press (not shown). A C-shaped support 22 is secured to plate 20 and carries thereon an elongated guide member 24. A channel 26 is formed in the guide member 24 and cooperates with the support 22 to form a passageway through which the terminal strip is fed. As best seen in FIGURES 2 and 3 the terminals 28 being supplied in strip form have a tab receiving portion 30 which nests within the channel 26. The terminals 28 further have a web portion 32 forming part of the strip, which portion 32 is received in the passageway 34 formed between the guide 24 and the support 22.

The support 22 has an elongated slot 36 formed therein for receiving a connector block 38. The block 38 has a grooved portion 40 with an integral pin 42 disposed therein. The pin 42 engages the apertured end of a drive link 44, best seen in FIGURE 1.

A pair of crank arms 46 and 48 are pinned to a shaft 50 rotatably mounted in a block 52, which block is secured to the support plate 20. Crank arm 46 has a bifurcated end 54 for receiving the end of the drive link 44. Link 44 is pinned to crank arm 46 as indicated at 56. Crank arm 48 is bifurcated at 58 for receiving a connecting rod 60 which is pinned to the crank arm 48 as indicated at 62. A spring member 64 extends between the crank arm 48 and the support plate 20 for biasing the crank arm in a counter clockwise direction as seen in FIGURE 1. The connecting rod 60 is driven by suitable means such as a cam which will axially reciprocate the rod 60 to thereby oscillate the crank arms 46 and 48 to thereby cause reciprocation of the drive link 44. As viewed in FIGURE 1 the connecting rod 60 will be driven to the right thereby causing clockwise movement of the crank arm 48 and thereby clockwise movement of the crank arm 46 through the shaft 50. Clockwise rotation of the crank 46 will cause rightward movement of the drive link 44. The spring 64 will return the parts to their normal position.

The reciprocatory movement of drive link 44 will impart like reciprocation to the connector block 38 which is secured to the end thereof. A feed carriage 66 is connected by screws 68 to the connector block 38. The feed carriage 66 is best shown in FIGURES 2 and 4 and comprises a block 70 through which the screws 68 extend. A channel 72 is formed in the block 70 for receiving a feed pawl 74 which is pivotally secured to the block 70 by the pin 76. A spring 78 biases the feed pawl 74 into engagement with the terminal strip 28. To allow the terminal strip 28 to be manually fed there is provided a means for moving the feed pawl 74 out of engagement with the strip, which means comprises a lever 80 which passes through the pin 76 and through an opening 82 provided in the block 70. As seen in FIGURE 4 clockwise movement of the lever 80 will cause clockwise movement of pawl 74 thus moving the pawl out of engagement with the strip. The terminal strip is provided with a series of equally spaced apertures 84 which apertures cooperate with the tip 86 of the pawl 74 to effect feeding movement. It is evident at this point that reciprocation of the drive link 44 will cause like reciprocation of the feed carriage 66 through the connector block 38. As seen in FIGURE 4 rightward movement of the feed carriage 66 will cause the tip 86 of the pawl 74 to engage an aperture 84 in the terminal strip to advance the said strip a predetermined length. Upon return movement of the drive link 44 the feed carriage 66 will be caused to move to the left (FIGURE 4) during which movement the pawl will ride out of the aperture 84 and thereby slide along the strip without effecting movement of the strip.

In order to insure that the terminal strip 28 remains stationary during retrograde movement of the feed carriage there is provided a drag arrangement best seen in FIGURE 3 which resiliently engages the web portion 32 of the strip. The drag arrangement comprises a pressure block 88 which has a forward face 90 which engages the terminal strip 28 in a resilient manner. Pressure block 88 is pivotally mounted by means of a pivot screw 92 which nests in a V-groove 94 formed in the forward face of the support 22. A bolt 96 is threaded into support 22 and passes through a dovetailed slot 98 formed in the pressure block 88. A coil spring 100 surrounds the bolt 96 and acts to bias the block 88 in a counter clockwise direction as seen in FIGURE 3 to thereby maintain the block in contact with the strip 28.

It is sometimes desirable to remove the drag on the terminal strip, such as during initial threading of the machine, and for this purpose there is provided an eccentric lever 102 pivotally secured at 104 to the pressure block 88. Rotation of the lever 102 will cause the eccentric portion thereof to engage the side of guide member 24 to thereby move the block 88 away from strip 28 against the bias of spring 100.

As the terminal strip 28 is fed to the crimping and forming station B the terminal at the lead end of the strip will be positioned with the crimping ferrule lying above the crimping mandrel 106. It can be seen that the tab receiving portion 30 of each individual terminal is disposed so as not to interfere with the positioning of the crimping mandrel relative to the ferrule. With the lead end terminal so positioned on the mandrel a wire conductor 108 will be manually or automatically fed to a position wherein the stripped wire end of the conductor is disposed above the crimping ferrule. The axial positioning of conductor 108 is determined by an abutment 110 disposed so as to be contacted by the lead end of the conductor. Lying above the crimping mandrel 106 is a conventional crimping head 112 having a resilient stripper element 114 mounted thereon. The crimping head is mounted for vertical reciprocating movement into and out of cooperation with the mandrel 106 by means of a press ram 116, a portion of which is shown in FIGURE 1.

Also secured to the press ram 116 is a drive member 118 mounted for vertical reciprocating movement with

the press ram and having a cam slot 120 formed therein, the said slot having a generally vertically extending portion 120a and an angularly extending portion 120b.

An L-shaped support member 122 is secured to the support plate 20 and the support 22 and forms therewith the channel in which the drive link 44 reciprocates. To the support 122 there is connected a guide block 124 having a vertical way 126 in which the drive member 118 is guided. A suitable cover plate (not shown) is secured to the guide block 124 in order to retain the drive member 118 in its way.

Block 124 is further provided with a horizontal way 128 in which is mounted a cutter carriage 130. The carriage 130 has a cam roller 132 secured thereto and engageable within the cam slot 120. It is evident from FIGURE 5 that downward movement of the drive member 118 will cause the cam slot 120 to engage the roller 132 to move the carriage 130 to the right. Subsequent upward movement of the drive member 118 will return the carriage 130 to its original position shown in the figure.

The carriage 130 has an extension 134 on which there is mounted a shear blade 136 having shear faces 136a and 136b. The shear face 136a cooperates with a stationary shearing blade 138 to sever the lead end terminal from the remainder of the terminal strip while the shear face 136b cooperates with the stationary shear blade 140 to sever the electrical terminal from the small web which connected the terminal to the main strip. The severed portion of the web and terminal strip will fall down an inclined ramp 142 and be suitably disposed of.

A mounting block 144 is positioned adjacent the crimping and severing area and carries thereon a clamping arm 146 pivotally connected to the block 144 by a pin 148. A threaded abutment member 150 is secured to the clamping arm 146 and abuts against the extension 134 of the cutter carriage 130. A spring member 152 is disposed between the clamping arm 146 and a vertical extension of the mounting block 144 to thereby bias the arm 146 in a clockwise direction as seen in FIGURE 5. The clamping arm 146 has an L-shaped clamping face 154 as seen in FIGURES 1 and 5. This face 154 is operative to engage two sides of the terminal 28 to retain the said terminal in position.

Upon reciprocation of press ram 116 the crimping head 112 will approach the crimping mandrel 106 while the downward movement of drive member 118 will cause the carriage 130 to move to the right as seen in FIGURE 5. This rightward movement will cause the shear blade 136 to cooperate with blades 138 and 140 to thereby free the terminal from the terminal strip. Rightward movement of carriage 130 also causes the clamping arm 146 to move in a clockwise direction under the influence of a spring 152 due to the fact that extension 134 has moved out of engagement with the abutment 150. While the clamping arm 146 holds the terminal securely against the crimping mandrel 106 the crimping head 112 will complete its descent to effectively crimp the ferrule portion of the terminal to both the center conductor and the insulation of the wire conductor 108. As the ram ascends the parts will return to their initial position shown in FIGURE 5 and the stripping member 114 will free the terminal from the crimping head 112 to ready the terminal for the forming operation to be described.

After the lead end terminal has been crimped or otherwise secured to the wire conductor the terminal is ready for its final forming operation. With reference to FIGURES 1 and 6 there is provided a forming and transfer assembly indicated generally as 156 which is effective to move the crimped terminal from its crimping location to a forming location and thereafter to bend the terminal into its final configuration. A connecting block 158 is provided and suitably guided for axial reciprocation within the machine housing 160. A connecting rod 162 is suitably driven for reciprocation by a cam or the like (not shown) and is secured at one end within the bifur-

cated end 164 of the connecting block 158. The block 158 has a coupling member 166 which is adapted to engage a recess 168 formed in a cylindrical member 170. The cylinder 170 is telescopically received within a second cylinder 172 and is capable of axial movement relative thereto. The cylinder 170 has a rectangular end 174 which mates with a rectangular opening in the cylinder 172 (see also FIGURE 7) whereby rotational movement of the cylinder 172 will cause like rotational movement of the cylinder 170. A pinion gear 176 is fixed to the cylinder 172 and engages a gear sector 178. The sector 178 is pinned to a shaft 180 which shaft is held in suitable bearings within the housing 160. A drive link 182 is pinned to the opposite end of shaft 180 and nests within a bifurcated opening within a crank 184. Crank 184 carries a cam roller 186 which roller is driven by a suitable cam member (not shown). The drive link 182 and crank 184 are connected by means of springs 188 to thereby provide a resilient connection. The crank 184 has a bearing 190 for receiving the shaft 180 however the crank is not pinned to the shaft. It will therefore be seen that actuation of the roller 186 by a suitable cam will cause oscillation of the crank 184 and like oscillation of the drive link 182 through the springs 188. Oscillation of the link 182 will cause rotation of shaft 180 and therefore rotation of the gear sector 178. The sector 178 will cause rotation of cylinder 172 through the pinion 176 and thus rotation of the cylinder 170.

The cylinder 170 has a forming member 192 secured thereto, which member has a pair of fingers 194 at its end. A blade 196 projects adjacent the fingers 194. As the connecting rod 162 is actuated the block 158 will be caused to move linearly to the left as seen in FIGURE 6 thus causing leftward movement of the cylinder 170 and thereby the forming member 192. The member 192 will move into the crimped lead end terminal as seen in FIGURE 11 with the fingers 194 and blade 196 nesting within the terminal. During insertion of the forming member within the terminal the clamping arm 146 will retain the terminal in position with the clamping face 154 being directly opposed to the force exerted by the forming member. The terminal will thus be held with a strong frictional fit onto the forming member 192. With the crimping head 112 having been raised the forming member 192 will move to the right as seen in FIGURE 6 due to force being applied to the connecting rod 162. The member 192 will transfer the lead end terminal to a position on the forming mandrel 198 as seen in FIGURES 1 and 11. With the terminal thus positioned on the forming mandrel 198 and prior to any forming of the terminal a hold-down mechanism is actuated and will now be described in connection with FIGURES 9 and 11.

A clamping head 200 is mounted for vertical reciprocating movement and guided therein by a guideblock 202 secured to the housing 160. The clamping head has clamping faces 204 and 206 for engaging the terminal ferrule and the wire conductor respectively. Head 200 has a pin 208 secured to the upper end thereof which rides in the bifurcated end of a link 210. The link 210 is pinned to a cross-shaft 212 held in a suitable bearing 214 within the housing 160. A second link 216 is pinned to the shaft 212 and is bifurcated at its end to receive a connecting rod 218 which is suitably driven by a cam mechanism or the like (not shown). It can be seen that axial movement of the connecting rod 218 will cause oscillation of the links 210 and 216 thus causing vertical reciprocating movement of the clamping head 200.

With the head 200 in its clamping position as seen in FIGURE 11 against the forming mandrel 198 the cam roller 186 will be actuated to cause rotation of the forming member 192 thus causing the lead end terminal to be formed from its position in FIGURE 11 to its position in FIGURE 12. If the terminal was improperly positioned on the mandrel 198 or if a jam-up should have occurred in the machine there will be no damage to the

forming mechanism due to the overload release accomplished by the springs 188.

The degree of rotation of forming member 192 is controlled by an adjustment screw 179 which is positioned to contact sector 178 and thus limit its movement to thereby limit movement of the forming member. The springs 188 allow for this adjustment and will yield varying amounts depending on the position of screw 179.

With the terminal thus formed into its position shown in FIGURE 12 the connecting rod 162 will be moved further to the right (FIGURE 6) thus causing the forming member 192 to be removed from the terminal. After the forming member has been removed the hold-down mechanism will be released by leftward movement of the connecting rod 218 (FIGURE 9) causing the raising of the clamping head 200. The terminal will thus be no longer clamped to the forming mandrel 198 but will merely be resting thereon.

To effect removal of the terminal and wire conductor from the apparatus an ejector is provided and is best shown in FIGURE 10. An ejector 220 is positioned adjacent the crimping mandrel 198 and is carried on an arm 222 suitably guided within the housing 160 for longitudinal reciprocating movement. The arm 222 carries a pin 223 which is received within the bifurcated end of a link 224. The link 224 is pinned to a shaft 226 which also carries a second link 228 pinned to the shaft. The link 228 has a bifurcated end for receiving a connecting rod 230 driven by a suitable cam mechanism or the like (not shown). It can be seen that rightward movement of the rod 230 (FIGURE 10) will cause counter clockwise movement of the links 224 and 228 and thus reciprocating movement of the ejector 220 from its position shown in FIGURE 12 to that of FIGURE 13. The ejector will thus move the terminal and wire conductor off of the forming mandrel 198 whereafter the terminal and conductor will either be collected in a suitable bin or will be grasped by the hand of the operator and removed from the machine.

In some applications it may be desirable to effect a crimping operation by the machine with no subsequent forming of the terminal. To allow for this there is a disabling mechanism provided for the forming apparatus and is best shown in FIGURE 8. The coupling member 166 which engages within the recess 168 of the cylinder 170 is biased into its position by a pair of springs 232 acting between the coupling member 166 and a recessed portion 234 of the connecting block 158. The coupling member 166 is therefore capable of movement relative to the connecting block 158. A U-shaped block 236 straddles the recess 168 in the cylinder 170 and engages the forward face of the coupling member 166. The block 236 is mounted for sliding movement within guide members 238 secured to the machine housing 160. A pin member 240 is axially movable within an opening 242 formed in the housing 160 and engages the block 236 at the free end of the pin. The pin 240 carries a detent 244 which is movable in a bayonet slot formed in the housing 160. Leftward movement of the pin 240 (FIGURE 8) will cause the block 236 and the coupling member 166 to move to the left to thereby shift the coupling member 166 out of the recess 168. A 90° rotation of pin 240 will then cause the detent 244 to seat on the shoulder 246 of the bayonet slot thereby holding the pin in the leftward position. It can now be seen that movement of connecting rod 162 will merely reciprocate block 158 and since the coupling member 166 is out of engagement with recess 168 this reciprocation will have no effect on the cylinder 170 and therefore the forming member 192 since the cylinder 170 will no longer be connected to the block 158. The machine will therefore merely carry out a crimping operation and subsequent to the crimping operation the operator will remove the terminal and wire conductor from the machine.

The drive mechanism for the various parts of the apparatus has not been shown in detail since many suitable driving and timing mechanisms could be used, all of which would be within the skill of the art.

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 securing an electrical connector to a wire conductor and for subsequently forming said connector comprising means for intermittently feeding said connectors in strip form to a crimping station whereby the lead end connector is positioned above a crimping mandrel, means for positioning a wire conductor above said lead end connector in a position to be secured thereto, a press ram mounted for reciprocating movement, means responsive to movement of said ram for severing said lead end connector from said strip, means responsive to movement of said severing means for clamping the said lead end connector to said crimping mandrel, a crimping head secured to said press ram and cooperating with said crimping mandrel to secure said wire conductor to said lead end connector, said crimping head being operatively to contact said lead end connector subsequent to the clamping thereof, transfer means operative to engage said lead end connector subsequent to the clamping thereof, transfer means operative to engage said lead end connector subsequent to the crimping thereof and to move said connector from said crimping mandrel to a forming mandrel, hold-down means operative to engage said connector and clamp the said connector to said forming mandrel, means for effecting rotation of said transfer means to cause said connector to be formed around said forming mandrel, means to effect further movement of said transfer means to move said transfer means out of contact with said connector, means to move said hold-down means out of contact with said connector subsequent to withdrawal of said transfer means, and means to eject said connector from said forming mandrel.

2. Apparatus for securing an electrical connector to a wire conductor and for subsequently forming said connector as set forth in claim 1 further comprising overload release means associated with said transfer means whereby rotation of said transfer means is effected through a resilient coupling.

3. Apparatus for securing an electrical connector to a wire conductor and for subsequently forming said connector as set forth in claim 1 further comprising means for selectively disabling said transfer means to thereby prevent the subsequent forming of said connector.

4. Apparatus for securing an electrical connector to a wire conductor comprising means for intermittently feeding said connectors in strip form to a crimping station whereby the lead end connector is positioned above a crimping mandrel, means for positioning a wire conductor

above said lead and connector in a position to be secured thereto, a press ram mounted for reciprocating movement, means responsive to movement of said ram for severing said lead end connector from said strip, and means responsive to movement of said severing means for clamping said connector to said crimping mandrel, and a crimping head secured to said ram and cooperating with said crimping mandrel for securing said wire conductor to said electrical connector.

5. Apparatus for securing an electrical connector to a wire conductor as set forth in claim 4 wherein said severing means comprises a slide member, cam means secured to said slide member, and drive means secured to said press ram and contacting said cam means to effect reciprocation of said slide.

6. Apparatus for securing an electrical connector to a wire conductor as set forth in claim 5 further comprising an abutment secured to said clamping means and contacting an edge of said slide, spring means biasing said clamping means toward said crimping mandrel, whereby movement of said slide in its severing stroke causes said clamping means to approach said crimping mandrel under the influence of said biasing means to thereby clamp the connector to said mandrel.

7. Apparatus for crimping ladder strip terminals onto wires, said terminals having ferrule-forming portions extending laterally of the plane of said strip and having contact portions in the plane of said strip, said apparatus comprising: a crimping head and a crimping mandrel; actuating means for moving said head relatively towards and away from said mandrel along a predetermined path; strip feeding means for feeding a strip of said terminals towards said head with the plane of said strip extending parallel to said path, whereby the terminals of said strip are presented to said head and mandrel with said ferrule-forming portions between said head and mandrel and are crimped onto wires positioned in alignment with said ferrule forming portions of said terminals; and bending means, responsive to said actuating means, for bending the ferrule-forming portions of said terminals towards said plane of said strip to produce crimped terminations having ferrule portions disposed back-to-back with respect to their contact portions.

8. Apparatus as set forth in claim 7 wherein said bending means comprises forming means engageable with the leading terminal of said strip and rotatable about an axis extending parallel to the plane of said strip to bend the contact portion of said leading terminal towards the ferrule portion thereof.

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RICHARD H. EANES, Jr., *Primary Examiner.*