Feb. 17, 1959 E. E. FOLKENROTH 2,873,511

INSULATION STRIPPING APPLICATOR AND METHODS OF APPLICATION

Original Filed April 27, 1953 3 Sheets-Sheet 1

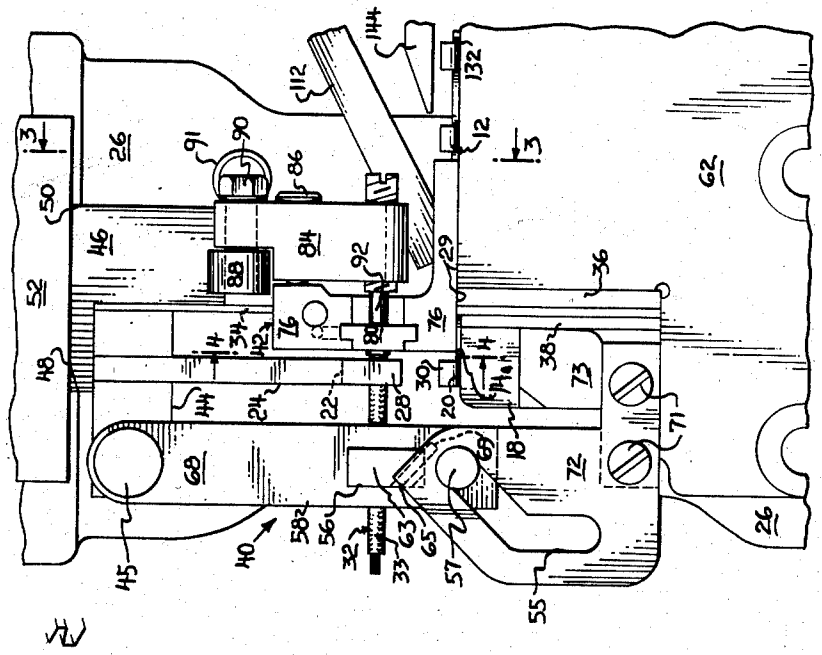


FIG. 2

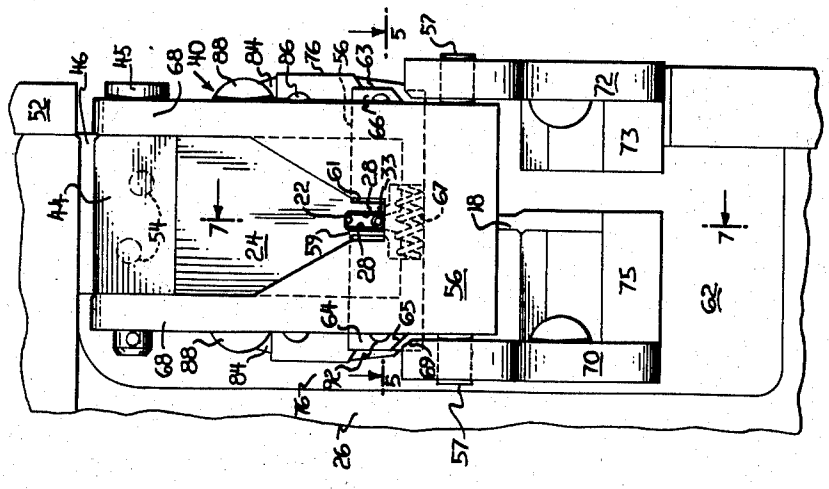


FIG. 4

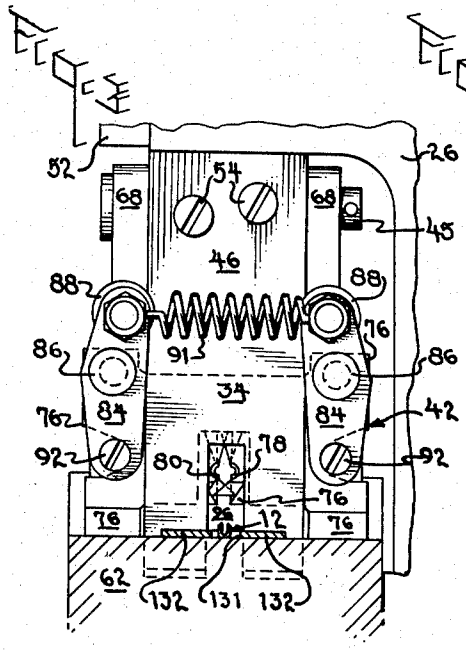
INVENTOR.
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Curtis, Morris + Safford.

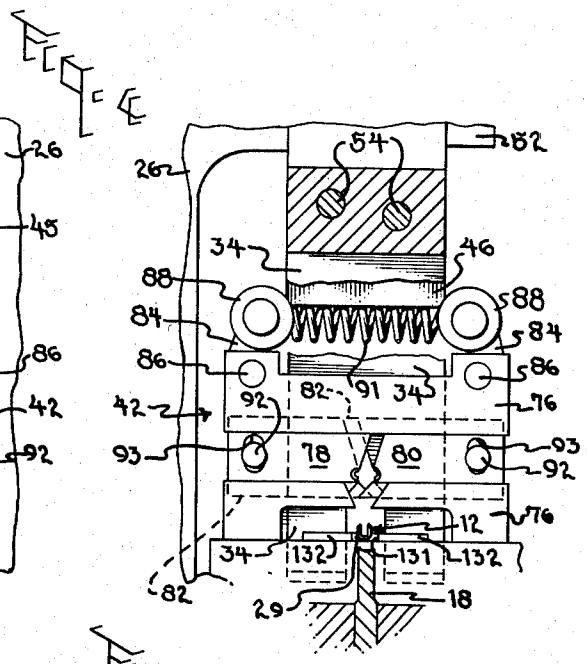
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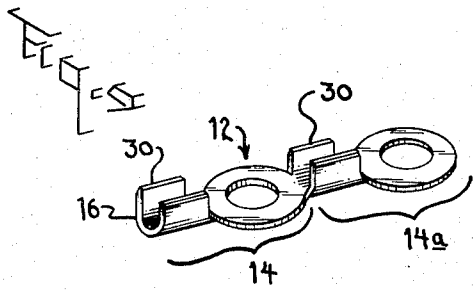
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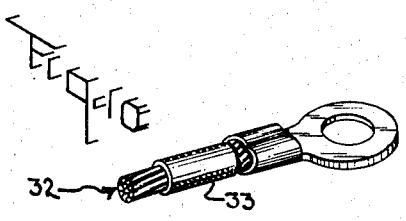
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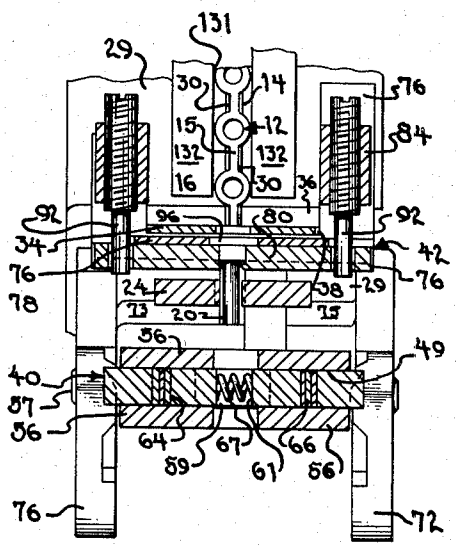
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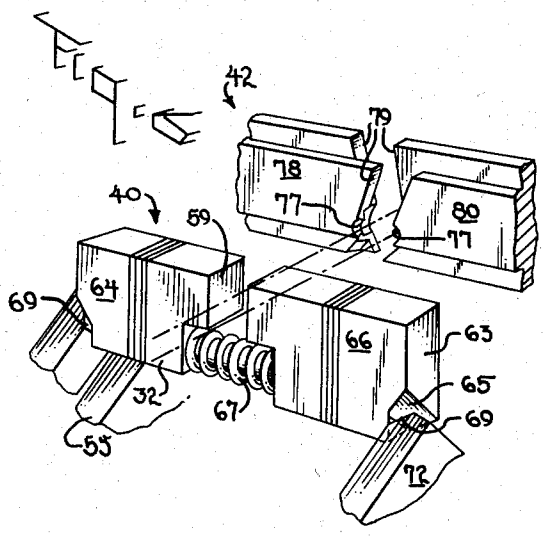
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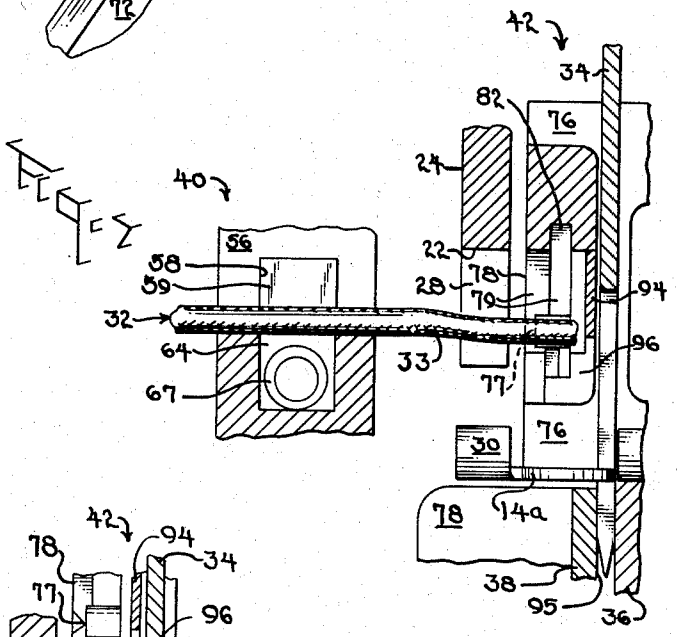
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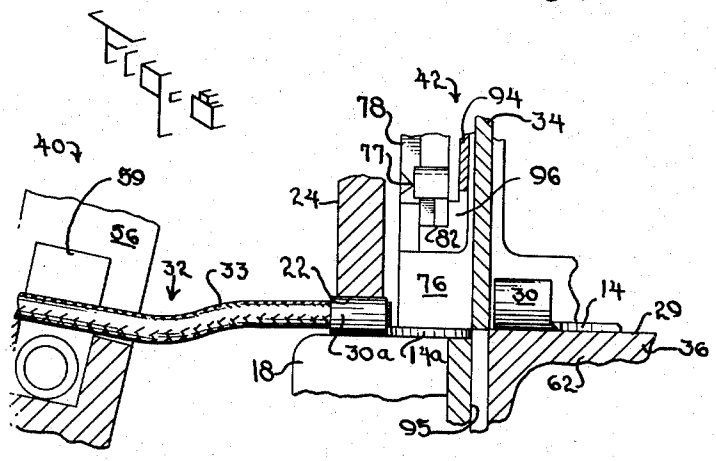
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INSULATION STRIPPING APPLICATOR AND METHODS OF APPLICATION

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United States Patent Office 2,873,511 Patented Feb. 17, 1959

2,873,511

INSULATION STRIPPING APPLICATOR AND METHODS OF APPLICATION

Earl E. Folkenroth, Harrisburg, Pa., assignor to AMP Incorporated

Application February 28, 1956, Serial No. 577,956

2 Claims. (Cl. 29—155.55)

This invention is a divisional application of my co-pending application, Serial No. 351,158, filed April 27, 1953 and relates to apparatus and method for applying electrical connectors to insulated wire and comprises a novel combination of means for stripping a portion of the insulation from an insulated wire and for pressure-crimping connectors onto such wires.

Electrical connectors with wire-engaging ferrule portions have for some time been applied to wires and conductors by compressing the ferrule portion and an insulation-stripped wire portion inserted therein between crimping dies which forge the assembly compactly together.

Automatic connector applying machines, such as disclosed and claimed in Carlson Patent No. 2,396,913, issued March 19, 1946, have been developed in many forms; they utilize continuous strips of connector-forming portions by severing portions from the strip and crimping them as connectors or terminals onto wires at rates measured in hundreds, or even thousands, of connections per hour.

There have been various production line arrangements of machines for pressure-applying connectors and machines which cut measured lengths of insulated wire from a reel and prepared the ends of the cut lengths for insertion into the connector-applying machines; there have been other, more complicated machines in which insulated wires were bared and connectors thereafter applied at the bared portions. All of these were complex, costly, and limited in application. Stranded wire conductors are in common use and demand; in the machines of the prior art it has happened too frequently that between the stripping operation and the connector applying operation a strand or two would be unintentionally bent or dislodged from parallelism with the main bundle of stripped strands with the result that the bent or dislodged strands would not be caught and crimped inside the connector barrel or ferrule. This gave two main sources of trouble: (1) the crimped connection would not be up to full strength or quality because of less metal in the crimped cross section than the dies had been adjusted to close upon and (2) the strand or two not caught in the crimp could cause short circuits and arcing when the equipment went into use. My invention provides a commercially feasible automatic machine having insulation-stripping means that operate automatically and substantially simultaneously with a connector crimping operation so as to overcome the disadvantages inherent in the prior art.

An object of this invention is to provide simple, compact, and inexpensive apparatus for pressure-crimping electrical connectors onto insulated wire which obviates the preliminary operation of stripping away a portion of the insulation, and/or the use of elaborate insulation-stripping apparatus. I accomplish this object by providing a novel combination of insulation-stripping means and connector crimping dies such that an insulated wire inserted into the apparatus is automatically and almost

simultaneously bared of insulation and the bared portion positioned in or operably near the wire-engaging portion of a connector and then promptly crimped therein to form a secure connection. Other objects consist of providing means to perform these steps which is adapted to use in a standard press means of ordinary power and which further may be completely operated by a single operating cycle of such press means. Another object is to provide apparatus which meets all of the above objects and which further is readily adaptable to different press means, different types and sizes of wire, and different electrical connectors. Another object is to accomplish all of the above objects in a fashion which cooperates with the automatic connector feeding and severing means in automatic connector-applying machines. A major objective resides in the provision of a commercially feasible single-cycle stripper-crimper assembly containing a readily accessible wire gathering region and which will automatically and substantially instantaneously carry out a stripping and connector-applying operation whenever a wire is thrust into the wire gathering region. Yet other objects and novel advantages will be in part pointed out as the description proceeds and in part will become apparent therefrom.

In this specification and the accompanying drawings I have shown and described a preferred embodiment of my invention and suggested various modifications thereof; but it is to be understood that these are not intended to be exhaustive nor limiting of the invention but, on the contrary, are given for purposes 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 various forms, each as may be best suited to the conditions of a particular use.

The invention accordingly consists in the features of construction, combinations of elements, methods of operation and arrangements of parts as will be exemplified in the structure and sequences and groups of related steps to be hereinafter described and the scope of the application of which will be set forth in the accompanying claims.

In the drawings:

Fig. 1 is a front elevational view of my novel applicator mounted in a preferred press means, adjacent parts of the press means being shown and other parts being broken away;

Fig. 2 is a side elevational view of the applicator and press means as they are shown in Fig. 1;

Fig. 3 is a back elevational view taken as indicated at 3—3 in Fig. 2;

Fig. 4 is a cross-sectional view taken as indicated at 4—4 in Fig. 2;

Fig. 5 is a horizontal sectional view taken as indicated at 5—5 in Fig. 1;

Fig. 6 is an enlarged expanded isometric view of my novel wire stripping means with other portions of the applicator omitted for clarity;

Fig. 7 is a fragmentary vertical sectional view, on an enlarged scale, taken at the line 7—7 of Fig. 1;

Fig. 8 is similar to Fig. 7 but showing the parts as they would appear at the bottom dwell of a crimping cycle of the press means;

Fig. 9 shows in side elevation a portion of a strip of connectors used in the applicator; and

Fig. 10 shows a wire after insertion into the wire gathering region of the machine with a connector applied to its stripped end.

These drawings illustrate different aspects of a preferred form of my novel applicator—an assembly which, driven by adequate press means, applies a connector to an insulated wire after first stripping the insulation from the wire to give a consistently high quality, low-unit-cost

connection. The applicator shown was adapted to use on a standard series of commercially available automatic connector applying machines. These machines are powered by a compressed air cylinder, have readily interchangeable crimping dies, and a readily adjustable mechanism for feeding a strip of connectors into the applicator; further disclosure of typical presses may be obtained by reference to the copending applications of Harold E. Cootes, Serial No. 65,645 and George J. Handel, Jr., Serial No. 65,646, both filed December 16, 1948.

The accompanying drawings include a showing of adjacent parts of the air press means disclosed in these applications, and Fig. 2 shows the feed finger 112 and drag plate 144 of the connector strip feed mechanism on these machines.

The strips of connectors used in these and other automatic machines generally consist of individual connectors formed from a continuous strip of sheet metal stock commonly with small joining portions of the stock left to hold the connectors together. In machines such as exemplified by Carlson Patent No. 2,396,913, the strip is fed intermittently to locate repeatedly the end connector of the strip in the crimping area of the machine, between a pair of opposed crimping dies, whereupon the end connector is severed from the strip and crimped onto a wire. This automatic feeding, severing and crimping of the connectors permits the operator merely to insert a wire into a connection-forming region thus to start the power stroke of the machine. Where the connectors have channel-like ferrule-forming portions rather than completed, tubular ferrules, the die means and ferrule portions may be adapted so to cooperate that the sides of the ferrule channel scrape the sides of a crimping die having a channel-like cavity to gather into the ferrule a wire end merely placed between it and this die cavity. This cooperation is more fully disclosed in Macy Patents Nos. 2,557,126 and 2,600,012.

The applicator shown in the drawings is adapted for use with a strip 12 of connectors 14 having channel-like ferrule forming portions 16; use of other connector wire-engaging portions will readily occur to those skilled in this art.

Figs. 1 through 5 show a machine press means which includes a rugged casting 26 in which a ram 46 is constrained to vertical movement by guide faces 48 and 50 (see Fig. 2) of the casting 26 and an end plate 52. A pedestal on the casting 26 forms a support for an adjustable bed 62 upon which the lower parts of the applicator assembly are mounted. In this preferred form of press means the parts normally occupy the relative positions shown in Figs. 1 and 2 when the ram 46 is at the top of its stroke. Parts not shown, an air cylinder, bell crank, and toggle link, drive the ram 46 downwardly toward the bed 62 when the operator actuates the machine. Also, as the ram 46 moves downwardly, the strip feed finger 112 (Fig. 2) is withdrawn to the right to engage the connector adjacent the end connector 14*a* currently being crimped. Parts not shown spring-bias the feed finger 112 downwardly and forwardly (to the left in Fig. 2), and cause this finger 112 to drop behind this next connector and to index the strip 12 forward one connector length when the ram 46 ascends after a crimping operation, placing the next connector in position to be crimped. The withdrawal of the feed finger 112 is accomplished by a cam surface on the ram 46 which drives a push rod, and thus the feed mechanism, in the withdrawal movement. A drag plate 144 (Fig. 2) is spring-loaded downwardly upon the strip 12, preventing it from sliding back away from the crimping area. The strip 12 is also held by side plates 132 which form a strip-channel 131 (Fig. 5) between them. These driving mechanisms are all shown in detail in the above-referred-to applications of Cootes and Handel, the indication of a one-stroke cycle automatic connector-applying machine with which my novel applicator advantageously cooperates being sufficient for the present application.

The applicator is generally that part of such connector-applying machines which, driven by the press means, severs a connector from the strip and crimps it onto the end of a wire. In Figs. 2, 5, and 7, the strip of connectors 14 is seen resting in guide channel 131 with the end connector 14*a* located over a lower crimping die. This lower die illustratively consists of an anvil 18 having a crimping surface 20 which cooperates with the crimping surface 22 on the upper die or crimper 24. The crimper 24 shown is of that type having a deep channel-like cavity whose side walls 28 are adapted to slide frictionally along the upturned side walls 30 of the channel-like ferrule-forming portion 16 of the end connector 14*a* and, with the crimping surface 22, to curl these side walls 30 over to gather a wire end, such as that of the representative wire 32, in the ferrule channel, as the crimper 24 moves down over the anvil 18. The final movement of the downward stroke of the ram 46 then presses the connector side walls 30 and the enclosed wire end compactly together, as is shown in Fig. 8.

In Figs. 2, 7 and 8 there is shown spaced behind the crimper 24 a shear blade 34 which cooperates with a shear edge on the feed table 29 at the top of plates 36 and mounted on the bed 62 to cut away the joining portion 15 (Fig. 5) between the edge connector 14*a* and the adjacent connector in the strip, thus severing the end connector 14*a* from the strip as the ram 46 moves downwardly and crimper 24 crimps the connector ferrule portion onto a wire. Shearing by pressing an end of the end connector downwardly away from the supported adjacent connector without the removal of a joining portion 15 may also be used, permitting more economical use of a strip sheet metal stock, as in the strip shown in Figure 9.

My preferred form of wire-stripping mechanism consists of a wire clamping assembly indicated generally at 40 and a wire stripper assembly indicated generally at 42 (Figs. 1 and 2), the wire clamp being arranged to grip and pull forward a wire 32 inserted through it. The gripping and pulling occur as the ram 46 descends, as will be described in greater detail, to accomplish the stripping.

The wire clamping assembly 40 consists of a wire clamp pivot block 44 which is mounted by recessed bolts 54 to the ram 46, which bolts also clamp the crimper 24 and the shear blade 34 in place on the ram 46. A wire clamp holder 56 has a laterally transverse guideway 58, in which two wire clamp jaws 64 and 66 are disposed, and is bifurcated into a clevis having two arms 68 which fit over the ends of pivot block 44 and are pivotally held thereon by pivot pin 45. Extending laterally outward from each side of wire clamp holder 56 at its lower end are follower pins 57 which ride in cam slots 55 in left and right side cams 70 and 72 respectively mounted on the press bed 62 by bolts 71.

Figs. 1 and 6 show how the clamp jaws 64 and 66 have their outer ends formed into cam followers. These followers comprise outer flat surfaces 63 disposed between lead faces 65 which slope inwardly at angles of about 45°. The flat surfaces 63 and lead faces 65 meet along a line at an angle of about 35° from the horizontal. Side cams 70 and 72 carry at their upper edges cam surfaces 69 disposed to engage lead faces 65 and flat surfaces 63 to move the wire clamps 64 and 66 together as they are carried downwardly with the ram 46. The right side cam 72 is mounted on a support block 73 which in turn is mounted on the bed 62, while the support block 75 for the left side cam is also a holder for the anvil 18.

The wire clamps 64 and 66 have opposed wire gripping surfaces 59 and 61. These surfaces are adapted to grip and pull a wire inserted therebetween. The wire clamp jaws 64 and 66 are urged laterally apart by a spring 67 disposed between recessed areas in the adjacent faces of these jaws. As the ram 46 descends, the entire wire clamp assembly 40 is driven downwardly, the follower

pins 57 guiding the clamp jaws 64 and 66 away from the crimping dies 24 and 18 while cam surfaces 69 drive the clamp jaws 64 and 66 laterally together to grip a wire 32 inserted between them.

The wire-stripper assembly 42 includes a wire stripper guide block 76 mounted on the upper surface of the bed 62, left and right wire stripper blades 78 and 80 slidably disposed in a stripper blade guideway 82 in the guide block 76, left and right stripper blade rocker arms 84 pivotally mounted to the guide block at 86, two follower rollers 88 on pivot pins 90 at the upper ends of rocker arms 84, and two stripper blade drive pins 92 extending from the lower end of arms 84 through short vertical slots 93 in blades 78 and 80. The rollers 88 and the upper portions of arms 84 are urged together by a spring 91 between the pivots 90 of the two rollers 88, thus urging apart the two drive pins 92 and stripper blades 78 and 80. The rollers 88 are thus abutted against the lower corners of the ram 46 (see Figs. 3 and 4) when the ram is at rest; spring 91 pulls the rollers partly around the corners and spaces them apart slightly less than the width of the ram 46 so that the descent of the ram causes the two rollers 88 to move laterally apart as the ram 46 passes between them; the rollers 88 ride on the lateral faces of the ram 46 as it completes its descent. The rocker arms are thereby rotated about pivots 86 and the stripper blades 78 and 80 are driven together by drive pins 92.

The stripper blades 78 and 80 have semicircular conical insulation cutting and stripping edges 77 (Figs. 5 and 6) and mating angularly disposed wire guiding surfaces 79. These wire guiding surfaces 79 are arranged so that those on each blade overlap those of the other blade. When the blades 78 and 80 are closed to their wire stripping position by the descent of the ram 46 the surfaces 79 guide the wire to be stripped into the desired position for proper stripping. The angular guiding surfaces 79 center each wire between the insulation cutting and stripping surfaces 77 as the blades 78 and 80 are closed and minimize any likelihood that a strand of the metal conductor may be nicked or unintentionally removed during the stripping operation.

In many commercial applications it is desirable that the electrical connections be of a quality higher than would be apt to result where even a single fine strand of the conductor had been removed during the stripping operation. This is because the crimping dies are designed to function, and do function, to extremely fine tolerances and where a strand has been removed from the conductor in the region of the crimp there is less metal present in the crimped region than the crimping assembly was adjusted for and accordingly a correspondingly inferior crimp results. Where quality connections are desired a metal-sensing unit may be employed in combination with the stripper. Such a unit may operate on capacitance or magnetic flux principles whereby the presence of a strand of copper, for example, in the removal insulation sheath in passing through a region within the sensitivity of the unit will unbalance a circuit to stop the machine or give a visible or audible signal to an attendant indicating that the conductor in the machine no longer has the proper cross section of conductive metal in the region of the crimp.

By stripping and crimping in a single operation I eliminate any chance that a strand from a stripped end may be bent and of parallelism with the main bundle of strands to a position where it may miss the ferrule portion or barrel of a later-applied connector or terminal; accidental bending back of a strand or two is bad not only because the optimum crimped connection cannot result but also because a loose strand or two projecting from the insulation sheath at the mouth of the terminal may cause serious electrical disturbances through short circuits, arcing, etc., later on when the equipment is in use; this difficulty I overcome by my combined stripping and crimping operation which eliminates all opportunity for any strand to be unintentionally bent from parallelism with every other strand of the bundle. By combining a metal-sensing unit arranged to detect every piece of removed insulation which includes any of the electrical conductor I eliminate any chance of a low quality crimp because less than the total number of strands have been left by the stripper.

In the rest (upper) position of the ram, the elements are as shown in Figs. 1 through 7 and feed finger 112 has been pulled forward to locate properly the end connector 14*a* over the anvil 18 as described above. The wire clamp jaws 64 and 66 are open and the stripper blades 78 and 80 are being urged apart by springs 67 and 91 respectively. The crimper 24 is so elevated that an insulated wire may be inserted between the gripping surfaces 59 and 61 of the wire clamp jaws 64 and 66 through the channel-like cavity of the crimper and between the wire stripper blades 78 and 80. A wire stop 94 is advantageously disposed behind the stripper blades 78 and 80 at a distance from their cutting edges 77 equal to the length of bare wire needed for a particular connection. With the inserted insulated wire 32 abutted against this stop a cycle of the press is started and the ram 46 begins to descend. Preferably this stop will be of the micro-switch type which automatically will close a circuit to actuate a press cycle as soon as the wire is inserted far enough into the machine. This switch is not shown on the drawing in order to simplify the showing, but is mounted and related to the other parts shown in the same way as is now ordinary in such sensitive switch controls in automatic machinery.

The initial descent of the ram 46 drives rollers 88 laterally outward and thus drives the insulation cutting edges 77 of the stripper blades 78 and 80 through the insulation sheath 33 of the wire 32 as shown in Fig. 7 and maintains these edges 77 abutted together and slidably abutted against the conductive wire core as rollers 88 roll on the descending ram 46. The wire clamp holder 56 is driven down by the ram 46 and guided longitudinally outwardly by follower pins 57 in cam slots 55, the initial descent also driving cam followers 63 and 65 of the wire clamp jaws 64 and 66 past the cam surfaces 71 of side cams 70 and 72, closing the jaws 64 and 66 to grip the wire 32 between their surfaces 59 and 61. Thus the wire 32 is gripped and pulled away from and out of the stripper blades 78 and 80, leaving the thus severed end portion of the wire insulation 33 behind the stripper blades and bringing forward a wire 32 with a bared end portion. This operation necessarily leaves every strand in parallelism in a compact bundle ready to be embraced as a unit by the ferrule or barrel of a connector. Meanwhile, the crimper 24 is also being driven toward the anvil 18 as the wire 32 is being drawn through the crimping cavity side walls 28.

The gripped wire 32 is pulled forward by the cam surfaces 55 until it clears the stripper assembly, at which point the cam followers 57 are approximately at the bend in surfaces 55.

Further downward movement of the ram 46 causes wire clamp holder 56 to center the stripped end of the wire in the terminal 14*a*. The side walls 28 of the crimper cavity are scraped by the side walls 30*a* of the end connector 14*a* upon further descent of the ram and the ferrule portion formed by these side walls curls around the bared bundle of strands of the conductor. The final travel, or bottoming, of the ram 46 compresses the parts together to form a secure connection as shown in Figs. 8 and 10.

As the ram rises, the wire with its newly attached connector is lifted from the anvil surface 20 by swinging of arms 56. With the crimped connector and wire clear of the crimping die, feed finger 112 indexes the strip 12 forward and thus places the next connector 14 over the anvil 18. When the ram 46 is again at rest the

clamp jaw cam followers 63 and 65 again clear cam surfaces 69 permitting their spring 67 to open them and finally release the wire 32. The machine is then ready for another complete cycle.

The joining portions 15 of the connector strip 12 are pushed away from the strip by shear blade 34 in cooperation with shear plate 36 and slug plate 38 during the crimping operation and are ejected through an opening 95 in bed 62. The stripped portions of wire insulation fall through the opening 96 in guide block 76 and may ultimately be blown out of the applicator by such means as an air jet (not shown) timed to release a blast of air after the metal-sensing, if any, and as the ram ascends. In such a fashion as this the applicator is kept clear of waste.

From the foregoing it will be seen that wire stripping and crimping means made in accordance with the present invention is well adapted to attain the ends and objects hereinbefore set forth and to be economically manufactured since they are suitable for common production methods and are susceptible to a wide latitude of variations as may be desirable in adapting the invention to different applications.

As various embodiments may be made of the above invention and as changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. The method of forming electrical connections by applying electrical connectors to the ends of insulated stranded wires respectively in successive cycles, each cycle including the steps of disposing a connector in a crimping zone and an insulated wire in a stripping zone, severing the insulation adjacent the end of the wire to define an end segment of insulation, withdrawing the wire relatively from the end segment of insulation so as to strip the segment off the wire, passing the thus stripped insulation segment through a defined path a part of which is sensitive to the presence of metal to detect any strands of wire

cut in the severing operation, disposing the stripped wire in the crimpable portion of the connector in the crimping zone and crimping the connector into intimate engagement therewith, removing the wire and applied connector from the crimping zone, whereby a signal generated during said cycle in response to any such metal detection, during said cycle prior to removal of the wire and applied connector, indicates and identifies the production of each faulty connection and the thus identified faulty connections may be discarded and the repetitive cycling stopped for corrective purposes before the further production of substandard parts.

2. The method of stripping the end segment of insulation from a plurality of insulated stranded wires and applying electrical connectors thereto including the cyclically repetitive steps of, in each cycle: positioning an insulated wire in an operating zone; severing the insulation adjacent the end of the wire to define the end insulation segment to be stripped; gripping the wire adjacent the end segment and, while engaging the end segment to preclude movement therewith, relatively withdrawing the wire so as to strip off the severed end segment; passing the thus stripped insulation segment through a defined path a part of which is sensitive to the presence of metal to detect any strands cut in the severing operation; crimping the stripped wire end to an electrical connector disposed in the operating zone; releasing and removing the wire from the operating zone; and generating a signal in response to metal detection, during said cycle prior to removal of the wire, to indicate the production of and to identify each faulty application whereby the thus identified faulty application may be discarded and the repetitive cycling stopped for corrective purposes before the further production of substandard applications.

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