United States Patent [19]

Adams et al.

[11] **3,895,434**

[45] **July 22, 1975**

[54] **ASSEMBLING ELECTRICAL CONNECTING DEVICE TO CORDAGE**

[75] Inventors: **George Phillip Adams; Frederick David Gavin, Jr.; Anthony Pete Natale,** all of Baltimore, Md.

[73] Assignee: **Western Electric Company, Incorporated,** New York, N.Y.

[22] Filed: **Aug. 27, 1974**

[21] Appl. No.: **501,007**

[52] **U.S. Cl.** ..... **29/628;** 29/203 R; 29/203 S; 29/630 R; 29/630 A; 228/1

[51] **Int. Cl.**[2] **H01R 43/00**

[58] **Field of Search**..... 29/628, 629, 630 R, 630 A, 29/203 R, 203 P, 203 S, 206, 208 R, 208 E, 208 F, 33 R, 33 M, 203 D, 203 DT, 203 DS; 81/9.51, 9.5 R; 228/1, 13, 44, 47

[56] **References Cited**

UNITED STATES PATENTS

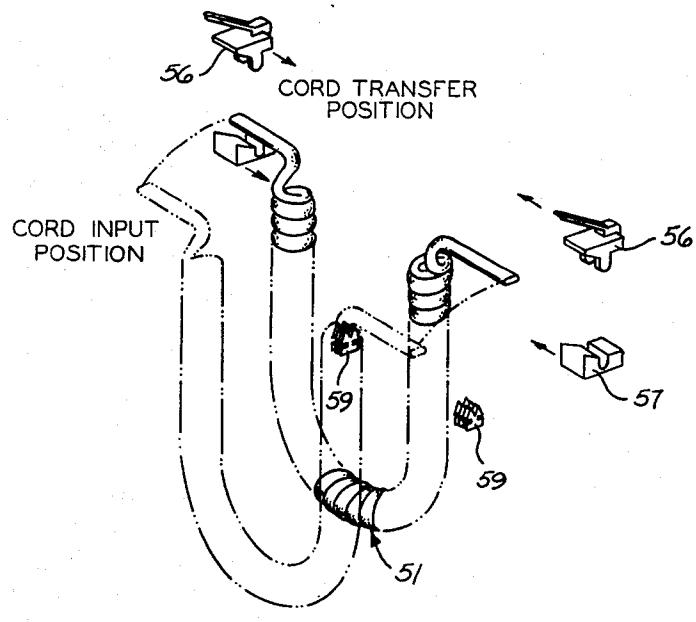
2,086,998	7/1937	Gilbert	29/206
3,504,416	4/1970	Schick	29/203 DT
3,641,646	2/1972	Folk	29/203 R
3,761,869	9/1973	Hardesty et al.	339/99 R
3,835,445	9/1974	Hardesty	29/629
3,839,787	10/1974	Brown et al.	29/629

Primary Examiner—Richard J. Herbst
Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—E. W. Somers

[57] **ABSTRACT**

In order to assemble modular plugs, comprised of two mating dielectric parts and plural blade-like terminals, to each end of a jacketed telephone cord, an operator positions each unfinished end of a length of cordage in a transfer device and then initiates the operation of an assembly apparatus. The transfer device transfers each end of the cord to a workholder while mating dielectric parts are fed separately to each of two assembly positions and in vertical alignment with a horn and anvil of ultrasonic bonding facilities. One of the parts in each assembly position is supported on the anvil while the other part is held in the horn. Each of the workholders is turned rotatably to move the cordage end held therein into the assembly position and into vertical alignment with the spaced apart portions of the modular plug. The jacket is removed from the end portions of the cord to expose the individually insulated conductors whereafter the anvil is moved upwardly to position the conductors in conductor-receiving troughs in the one part. Simultaneously, the horn is lowered to engage the other part with the one part and bond the parts together. The blake-like terminals are moved upwardly through the anvil and into terminal-receiving grooves in the one part and into electrical engagement with the conductors. Excess lengths of the conductors are severed and together with the stripped jacket are removed. The workholders are returned to initial positions and cammed open to release the plugged cord ends and permit the finished cord to drop into a receptacle.

15 Claims, 38 Drawing Figures



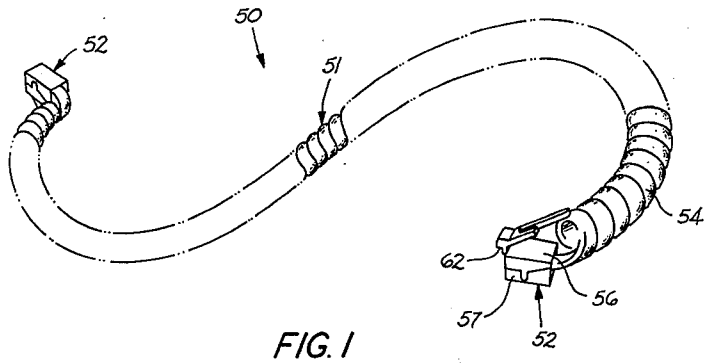

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FIG. 1

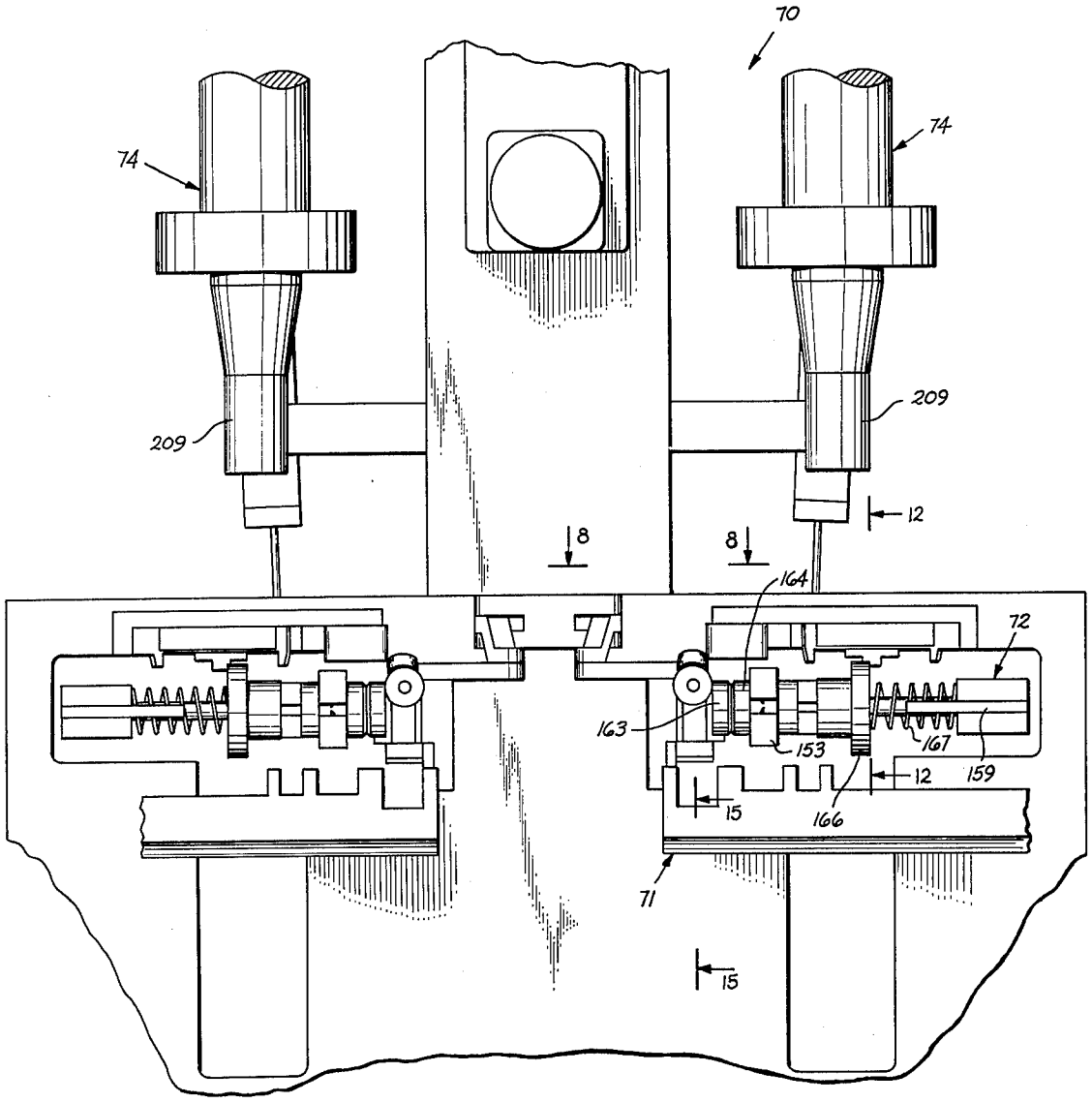
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FIG. 5

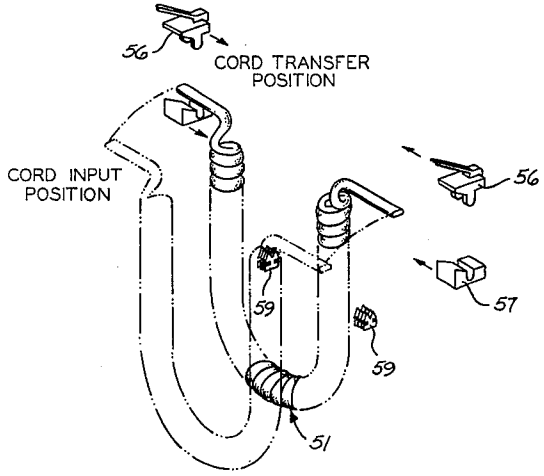


FIG. 2A

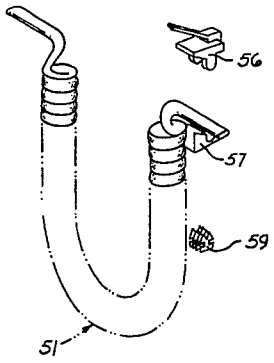


FIG. 2B

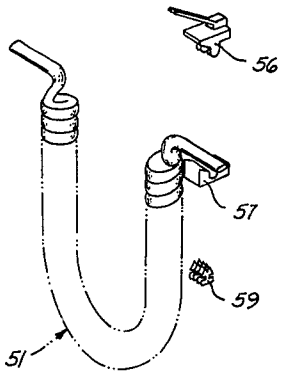


FIG. 2C

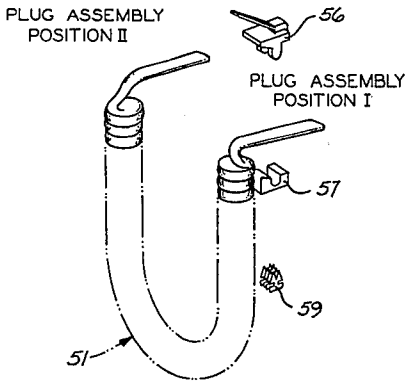


FIG. 2D

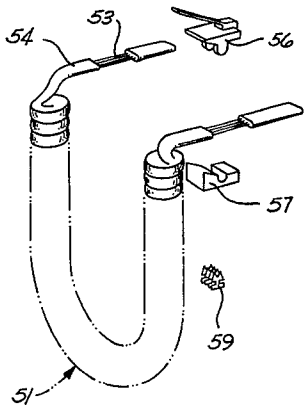


FIG. 2E

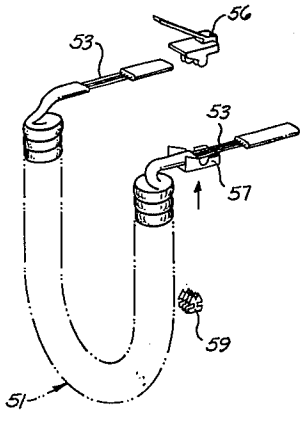


FIG. 2F

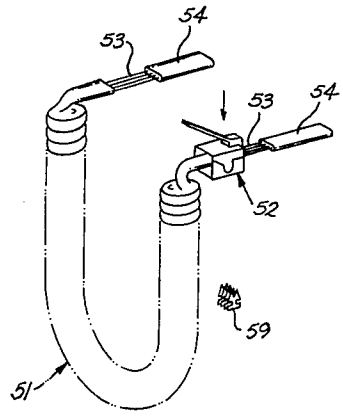


FIG. 2G

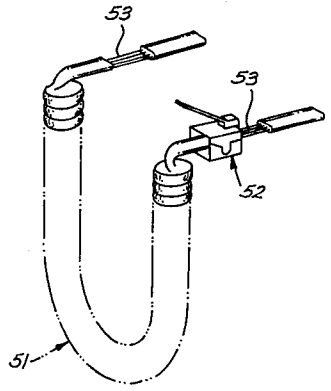


FIG. 2H

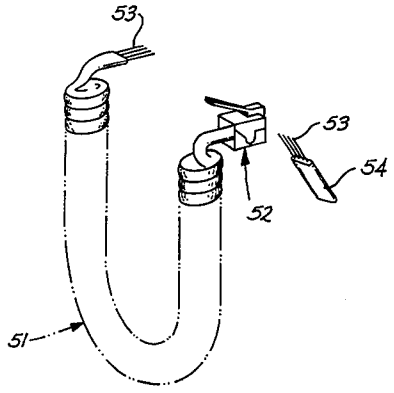


FIG. 2I

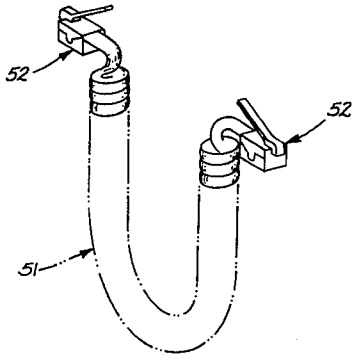
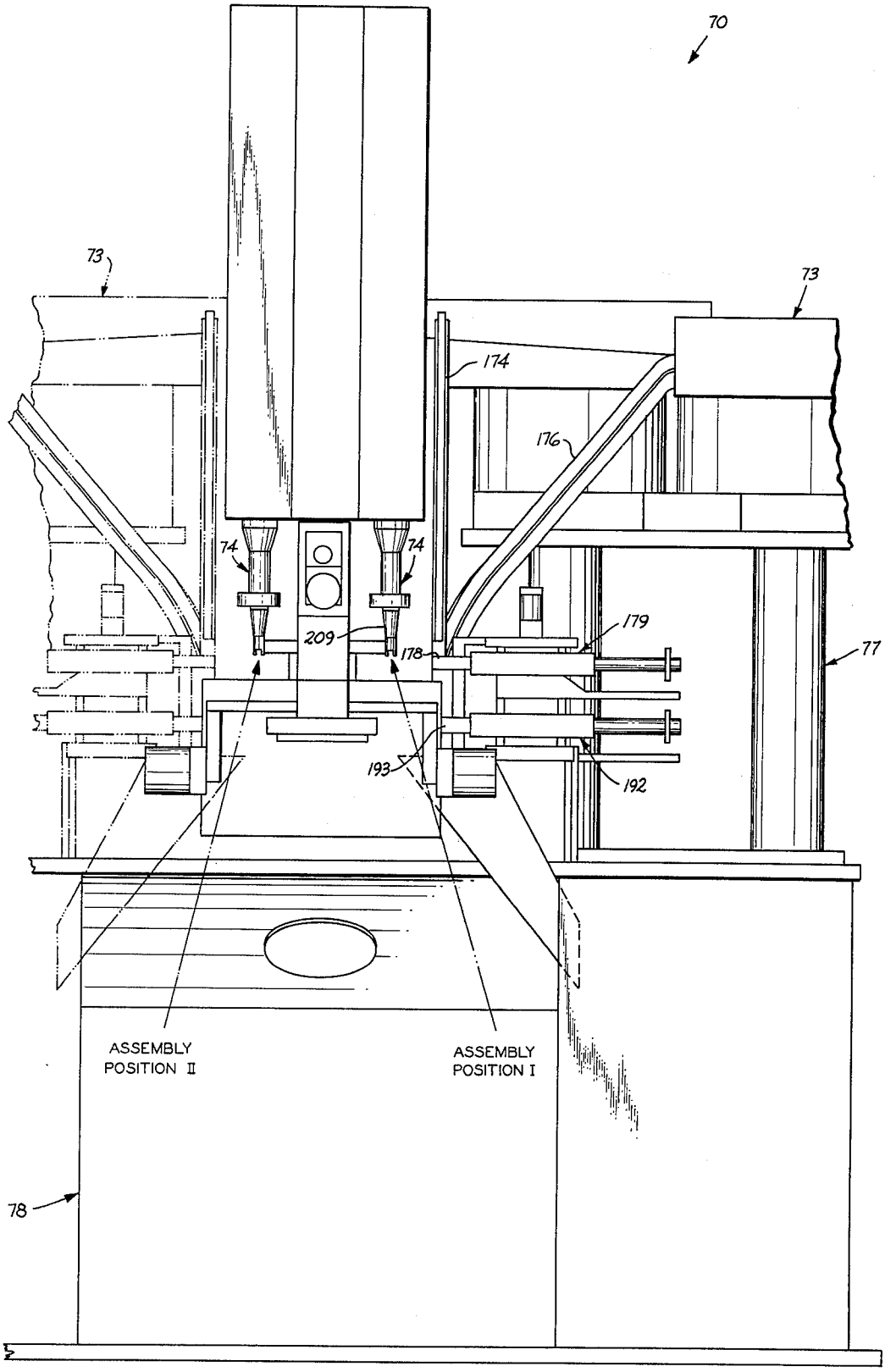


FIG. 2J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ASSEMBLY POSITION II
ASSEMBLY POSITION I
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FIG.3

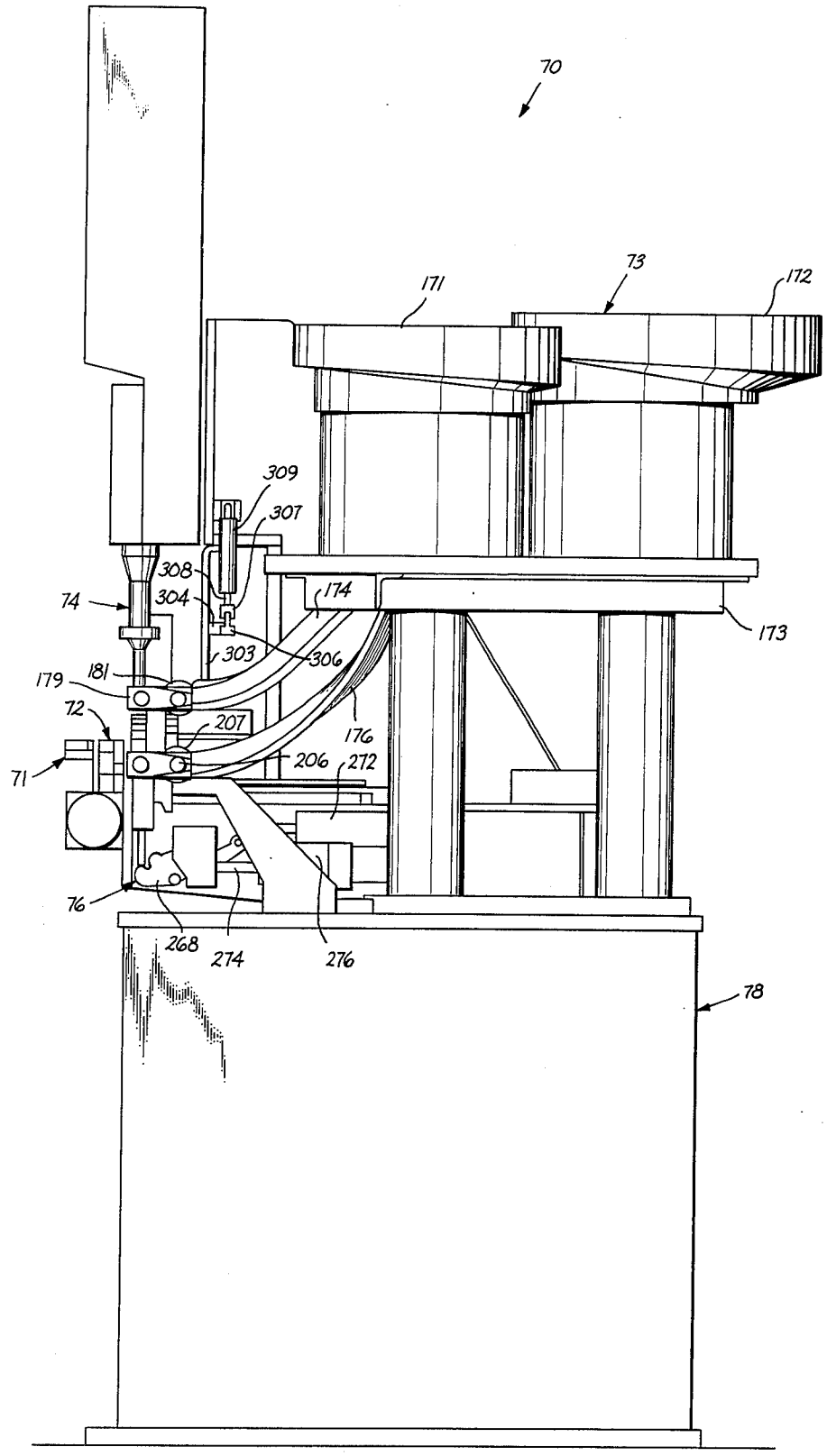
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FIG. 4

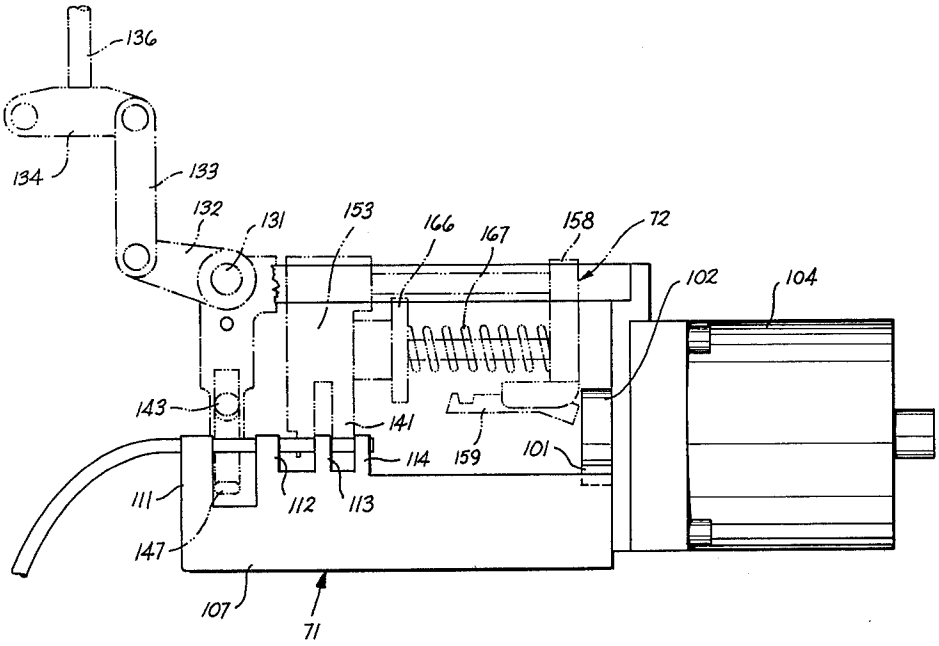
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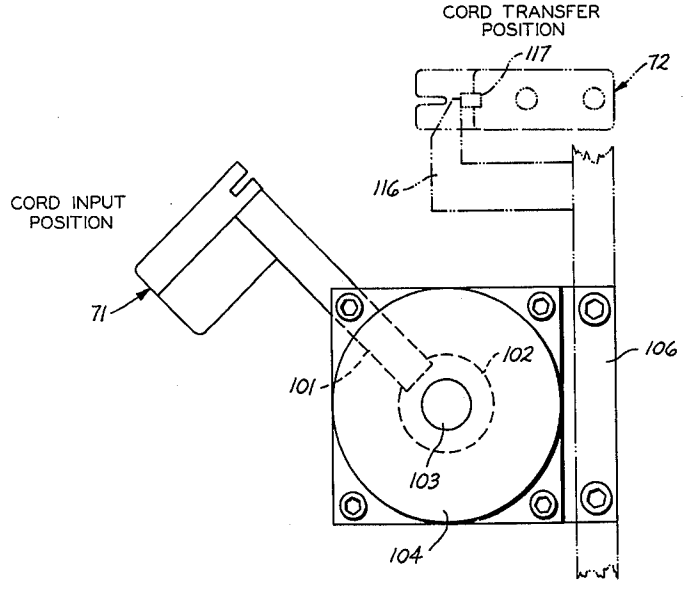
FIG. 6


CORD TRANSFER POSITION
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CORD INPUT POSITION
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FIG. 7

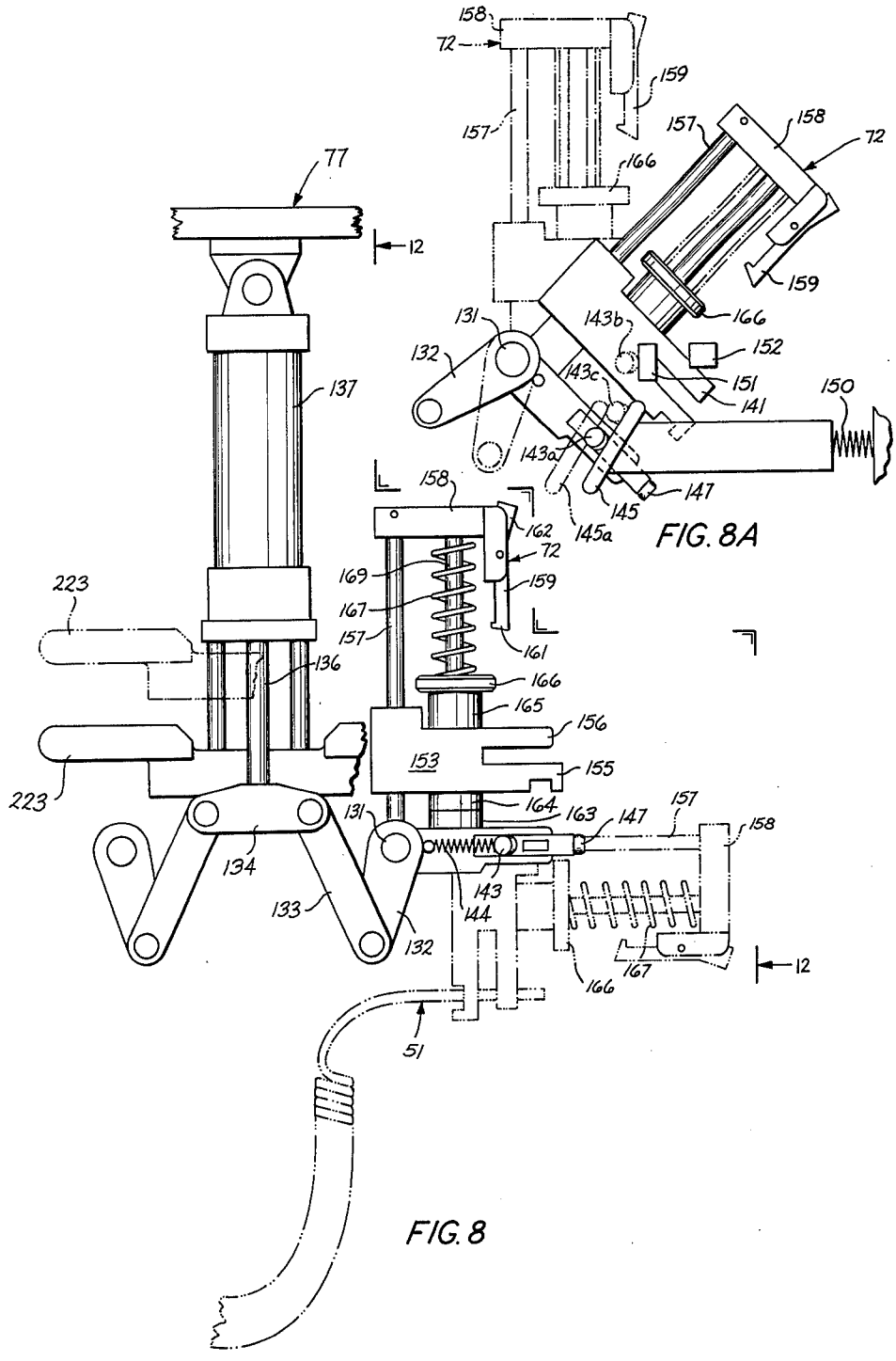
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FIG. 8A

FIG. 8

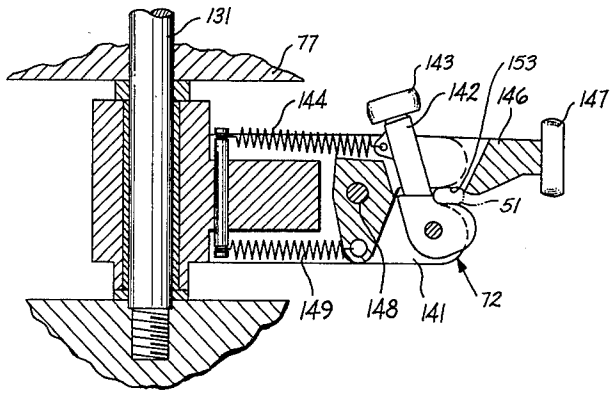


FIG. 9

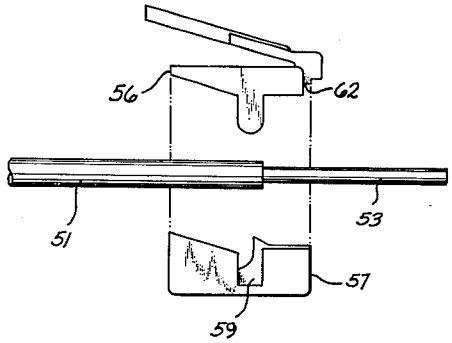


FIG. 11

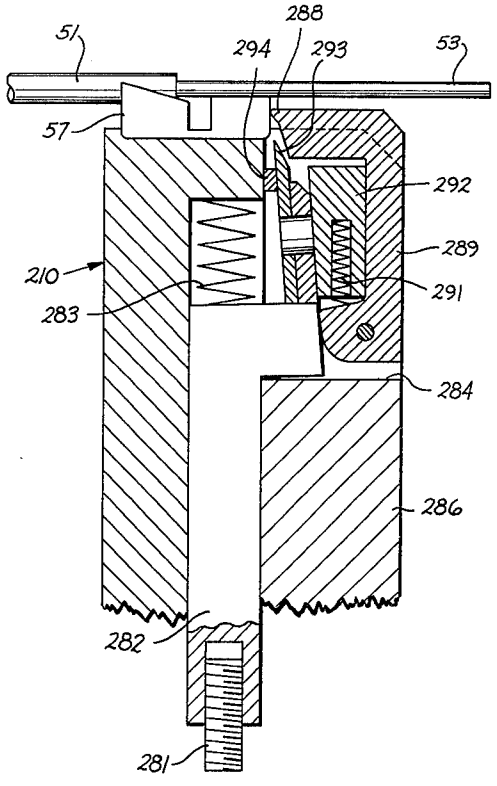
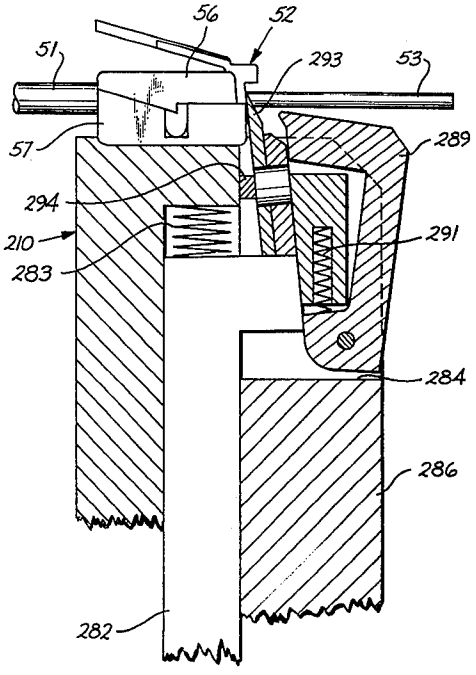


FIG. 20



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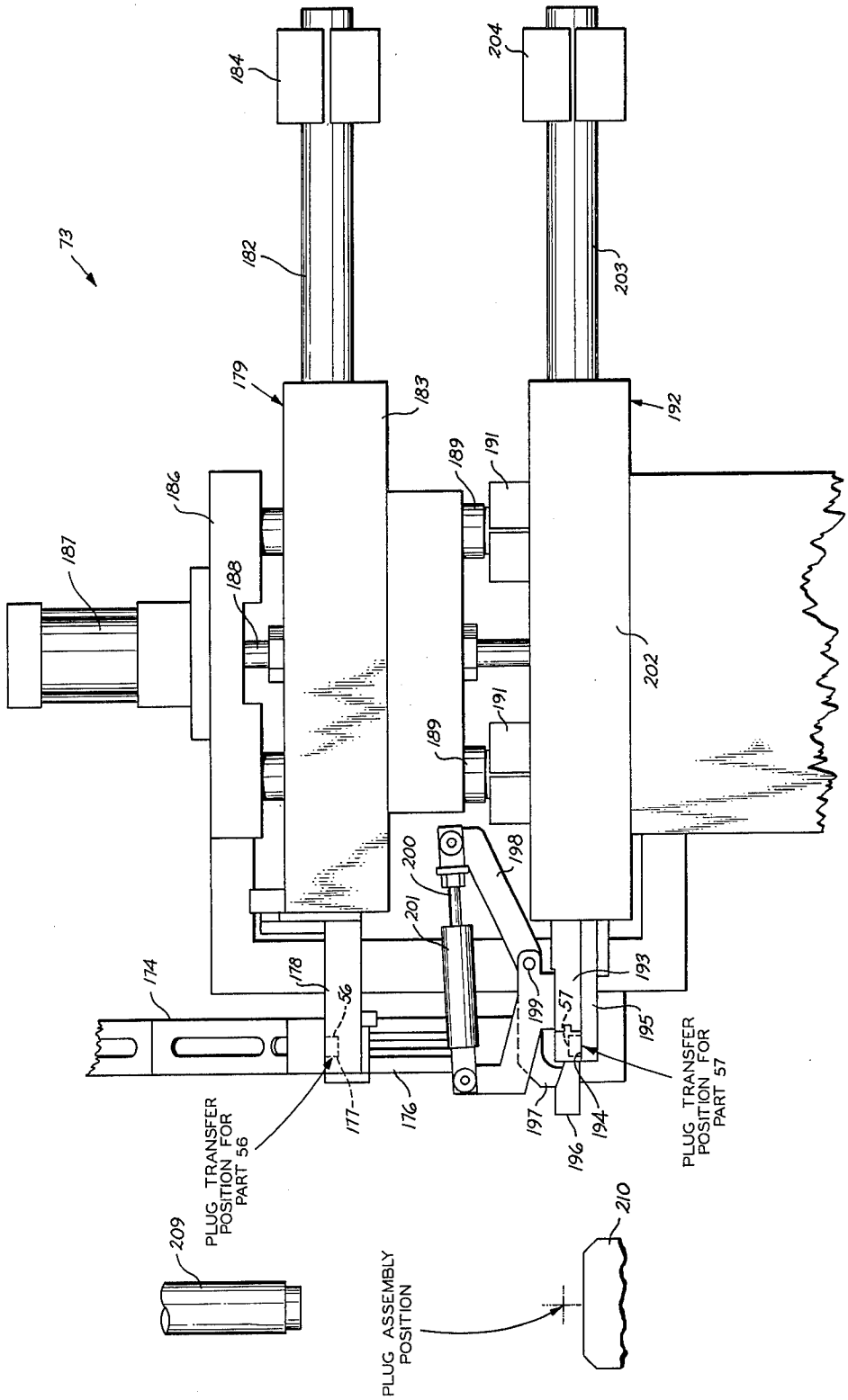
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PLUG TRANSFER POSITION FOR PART 56
PLUG TRANSFER POSITION FOR PART 57
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PLUG ASSEMBLY POSITION

FIG. 10

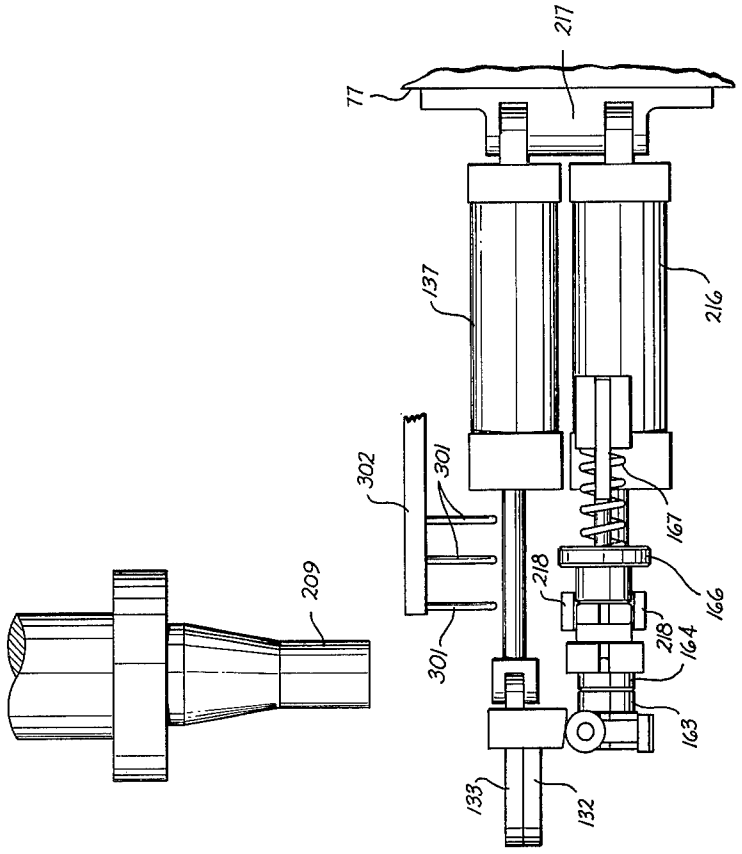


FIG. 12

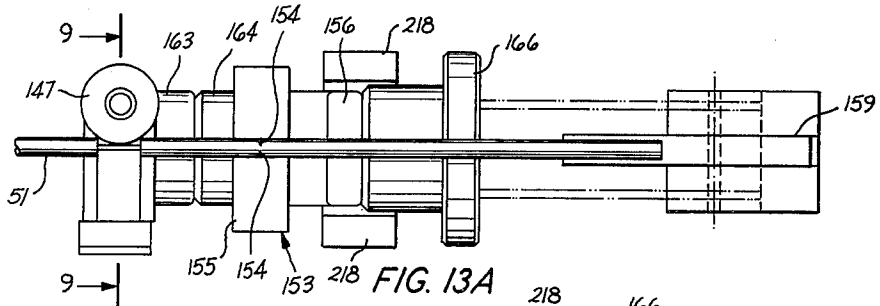
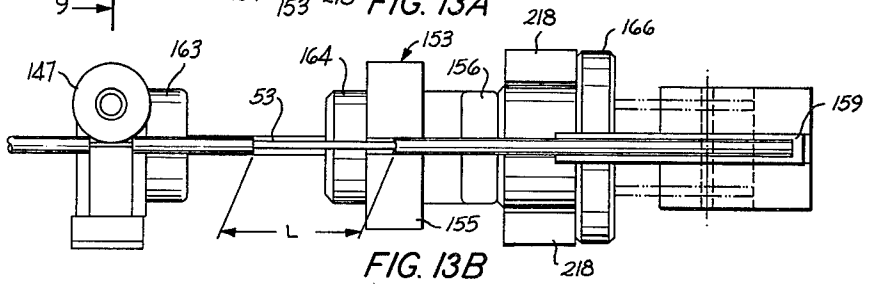


FIG. 13A



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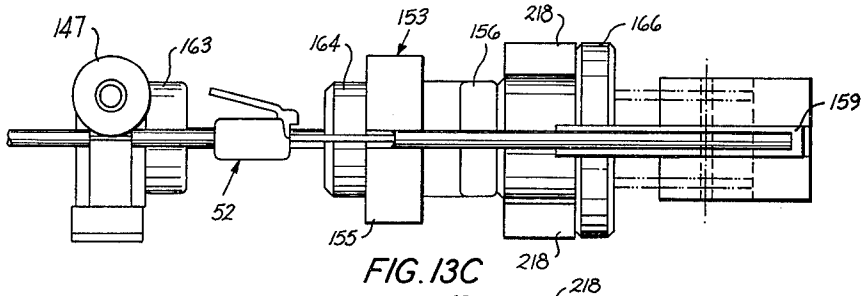
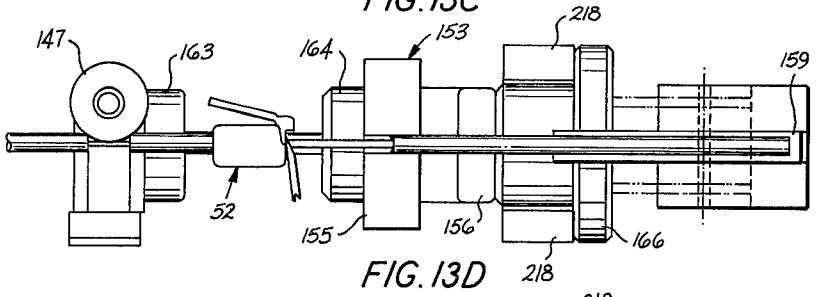


FIG. 13C



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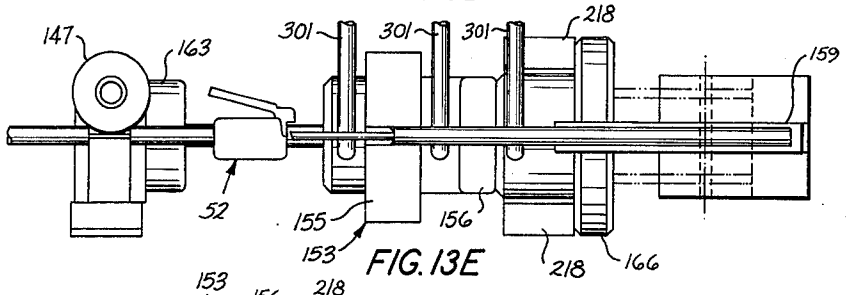

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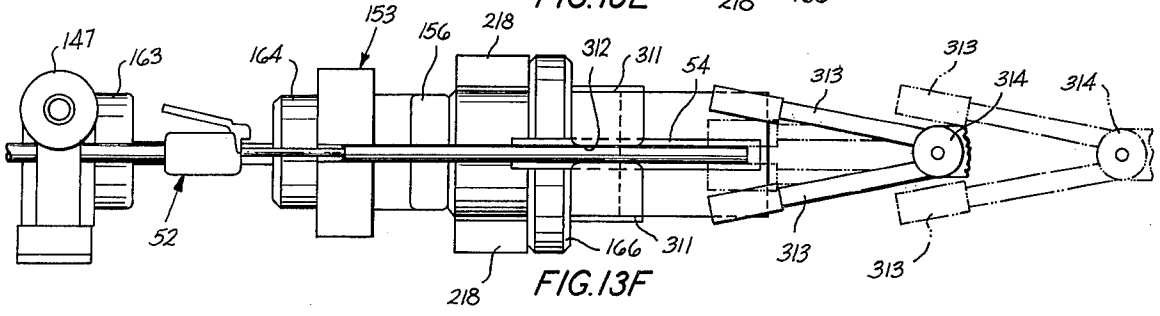
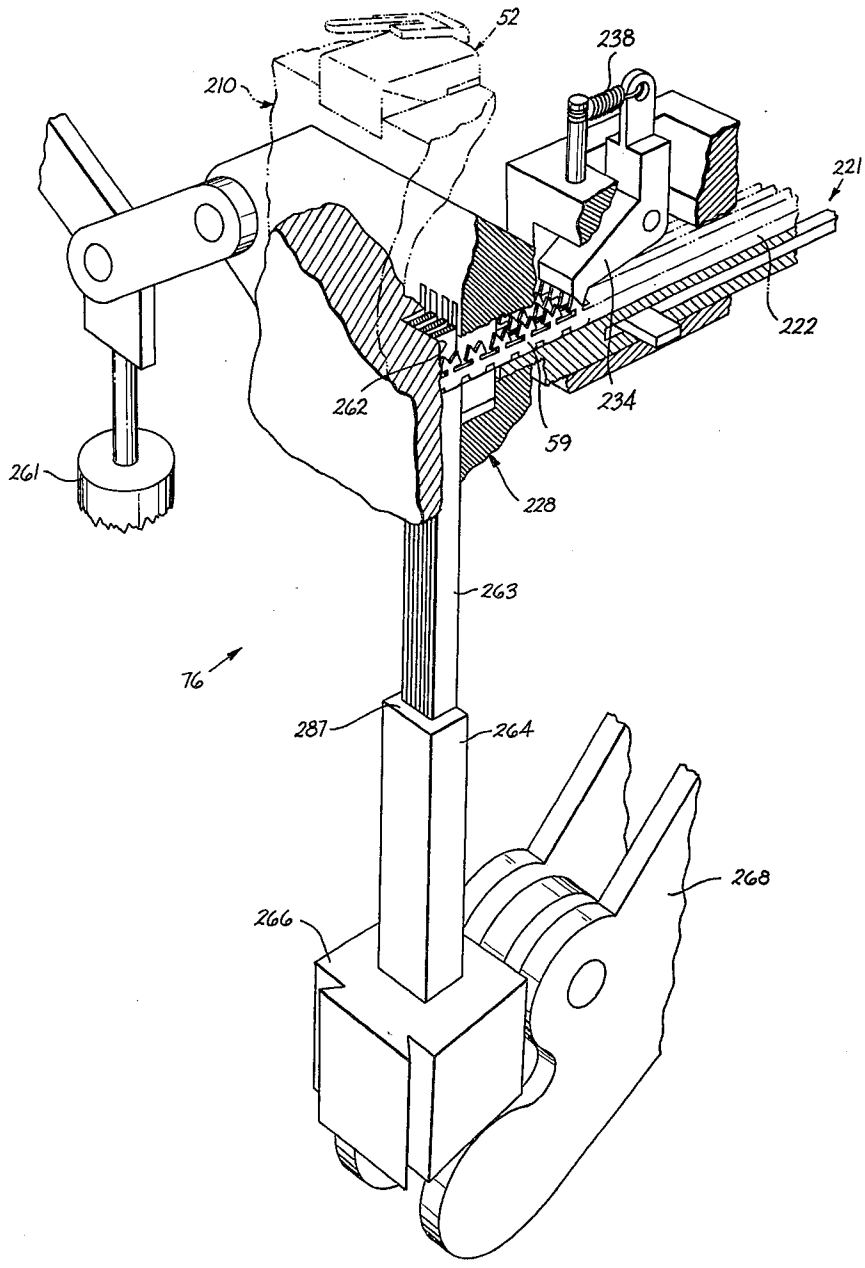


FIG. 13F



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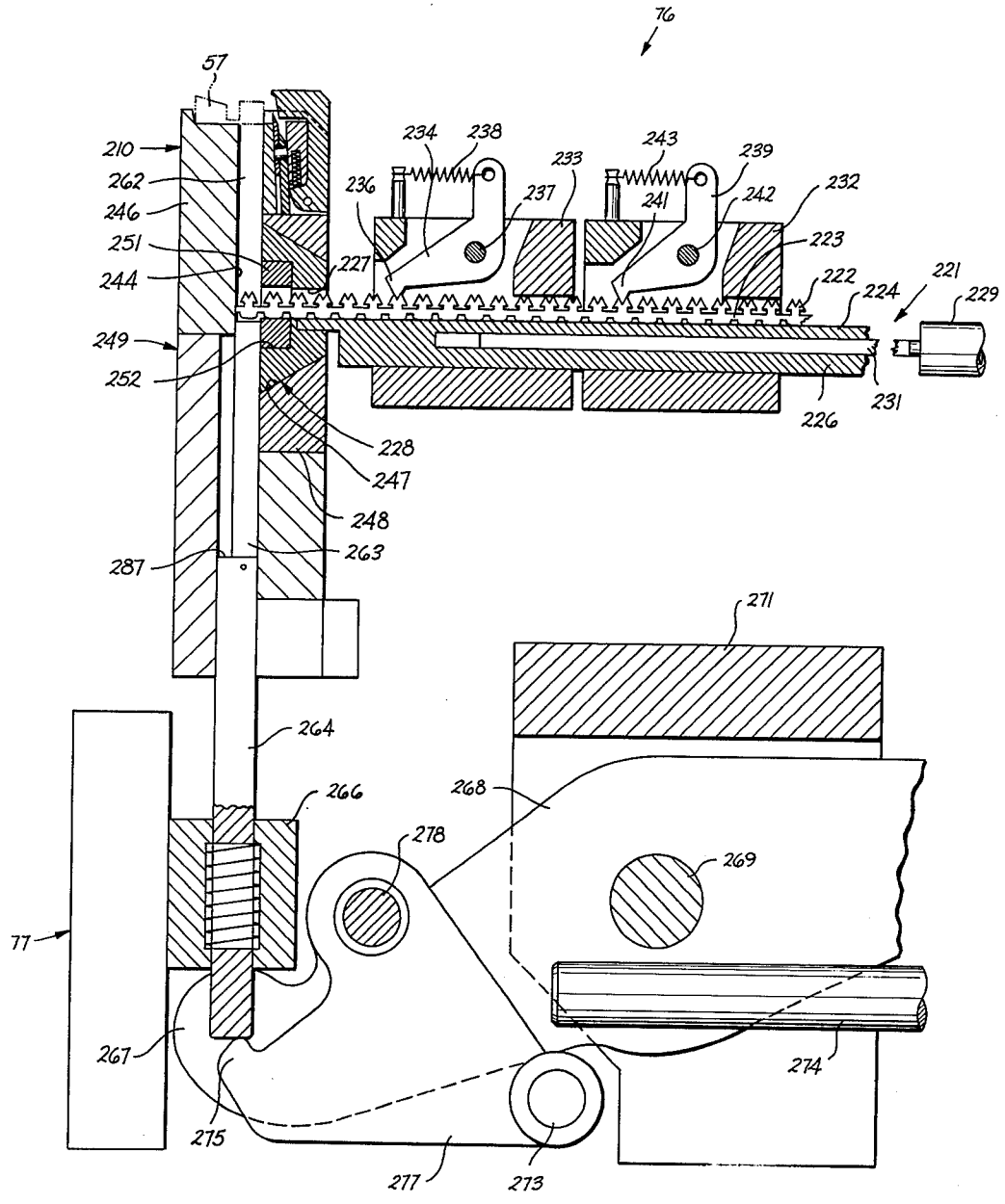
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FIG. 15

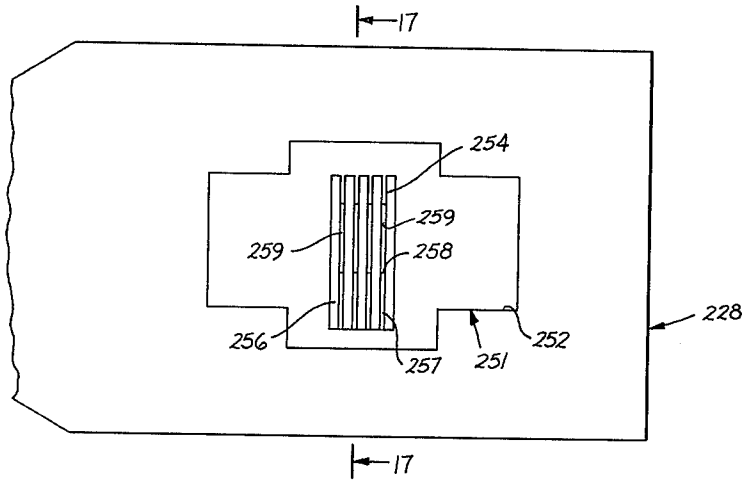


FIG. 16

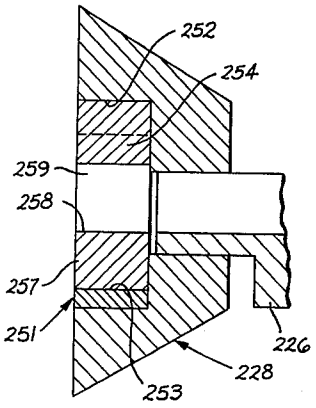
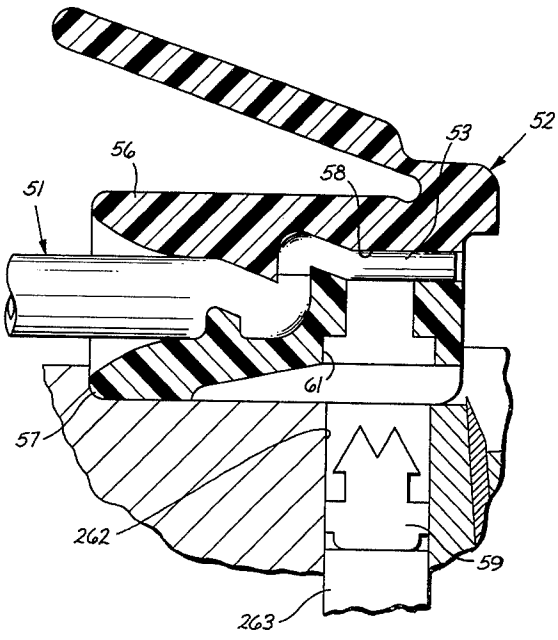


FIG. 17



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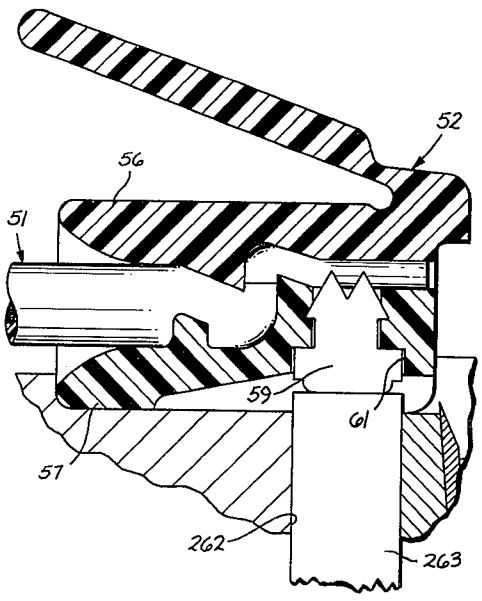

FIG. 19

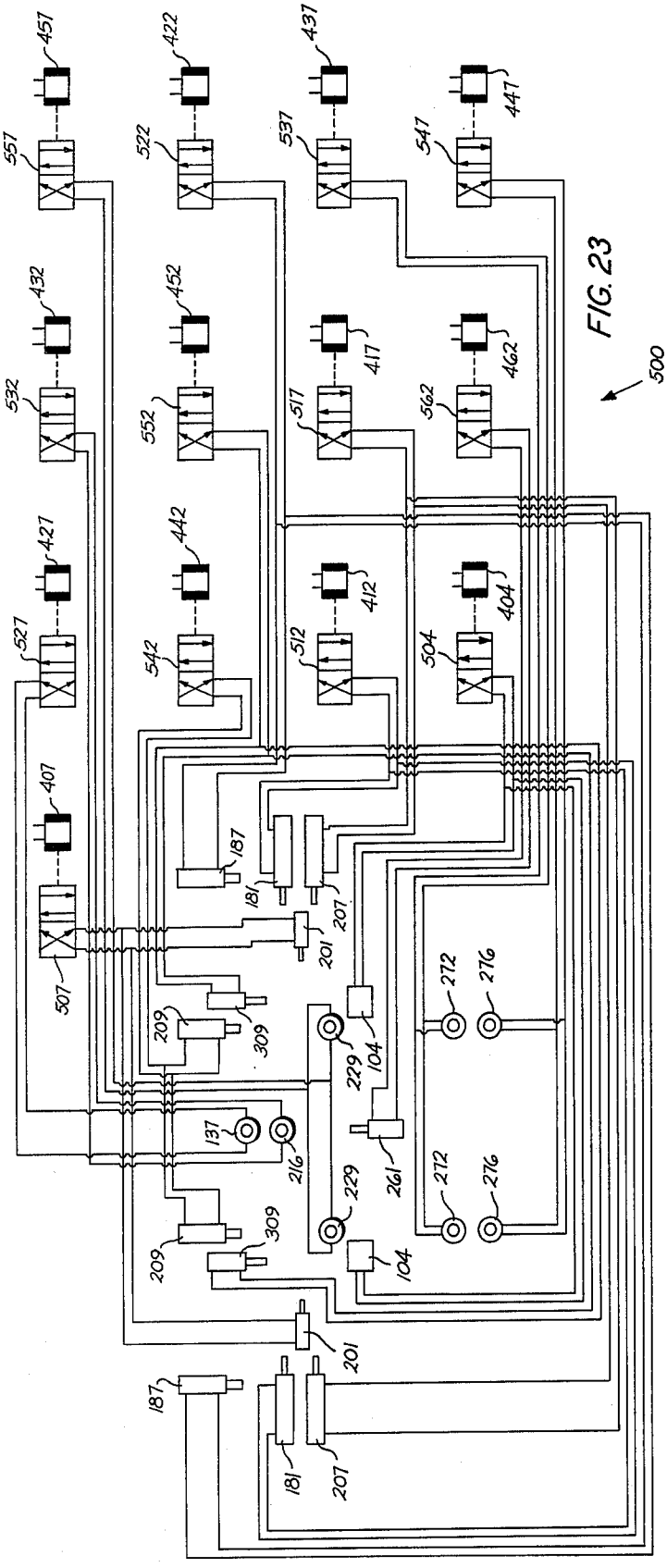
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FIG. 23

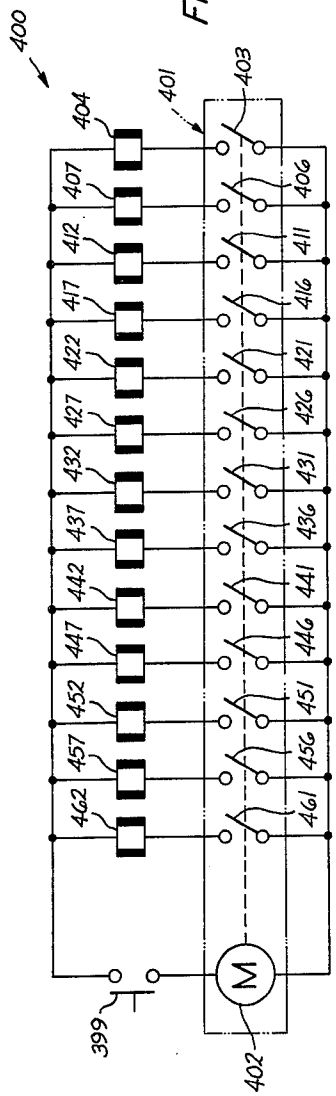
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FIG. 22

ASSEMBLING ELECTRICAL CONNECTING DEVICE TO CORDAGE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to assembling electrical connecting devices to cordage, and more particularly, to methods of and apparatus for providing telephone cords with modular plugs which may be inserted by a subscriber into a jack in a telephone handset.

2. Technical Considerations and the Prior Art

In the field of individual subscriber telephone station equipment, there have been some recent advances which increases subscriber flexibility for product replacement. Specifically, telephone cords, both line and retractile, are now being equipped with miniature plugs which are capable of being inserted by a customer into telephone handsets specially provided with mating jacks. In like manner, a customer may readily disconnected the line or spring cord or both from the telephone handset. The innovations are part of a broad improvement in telephone cords referred to as modularity.

Modularity permits replacement of cords by the customer for reasons of style change or to simply replace worn cords. The savings in time and costs should be readily apparent. Modular plugs and jacks are disclosed and claimed in U.S. Pat. Nos. **3,699,498** and **3,761,869** issued in the names of E. C. Hardesty, C. L. Krumreich, A. E. Mulbarger, Jr. and S. W. Walden.

Because of the miniature dimensions of the elements of the plug, for example, it is beneficial to provide apparatus which may be used to expeditiously assemble the plugs. This is especially true with respect to the assembly of miniature terminal blades with a dielectric housing. Apparatus for accomplishing this assembly is disclosed and claimed in a copending application Ser. No. **346,556,** filed Mar. **30, 1973,** now Pat. No. **3,839,787** in the names of W. B. Brown, deceased, and F. D. Gavin and assigned to the assignee of the present invention.

The success of the modularity program also depends in part on the capability of providing apparatus for assembling the modular miniature plugs to each end of a retractile cord. Such an apparatus may include the apparatus of the hereinbefore referred to Brown-Gavin application for inserting terminal blades into the dielectric housing and into electrical engagement with the conductors comprising the cord.

Priorly, with the advent of the modularity program, the assembly of the plugs to the cords was accomplished manually. An operator would strip the cord jacket from an end portion of the cord to expose the nylon covered tinsel conductors. At another station, another operator positions two dielectric parts, which comprise the housing, in ultrasonic bonding facilities and positions the end portion of the cord in engagement with one of the parts so that the conductors are received in conductor-receiving troughs formed therein. Next, the other one of the plastic parts is bonded ultrasonically to the one part to complete the housing and enclose the parts after which the excess lengths of the conductors are severed at a third work station. Subsequently, at a fourth work station an operator inserts each plug into a cavity and causes apparatus, such as that disclosed and claimed in the Brown-Gavin application Ser. No. **346,556,** filed Mar. **30,**

1973, now Pat. No. **3,839,787,** operated to insert terminal blades thereinto.

Clearly, this highly manual method of assembly involves undesirably several unnecessary steps. A method of assembling cords to plugs which could be implemented by automatic machinery would be most beneficial.

SUMMARY OF THE INVENTION

With these and other objects in mind, this invention contemplates inserting each end portion of an unfinished cord into a transfer device which is caused to transfer each end portion into securing engagement with a workholder. The workholder is moved to position the free cord end in an assembly position in alignment with two spaced parts which when assembled comprise a dielectric housing. Then a portion of the jacket of each end portion of the cord is removed partially therefrom and a lower one of the parts moved into engagement with the cord end while the portion of the jacket maintains the exposed portions of the conductors in a spaced relationship to facilitate the bonding of the other one of the parts to the one part after which blade-like terminals are inserted into the one part into electrical engagement with the cord conductors. Ecxess ends of the conductors are removed and the cord end with the dielectric housing and the terminals, which comprise a plug, attached to the cord are returned to an initial position and ejected from the workholder.

More particularly, methods and apparatus are provided for assembling miniature electrical connectors in the form of plugs to each end of a retractile or line telephone cord. An operator causes each end of the cord to be clamped in a transfer device and then causes each of the cord ends to be moved into engagement with a workholder at a cord-transfer position. Then the workholder is caused to be moved pivotally to position each cord end in an assembly position in alignment with a horn and an anvil of ultrasonic bonding facilities. Priorly, mating plastic parts which are to comprise the plug housing have been fed to the assembly position with one of the parts vacuumly held by the horn and the other part supported on the anvil. Facilities are operated to remove a jacket from an end portion of the cord and expose individually insulated conductors. The anvil is raised to cause the exposed conductors to be positioned in associated ones of conductor-receiving troughs formed in the other part supported on the anvil and the horn moved downwardly to engage and bond the one part with the other part. Then insertion rams are actuated to move a plurality of blade-like terminals along individual passageways in the anvil and to insert the terminals in terminal-receiving grooves in each of the other parts and to engage electrically the conductors received therein. Excess lengths of conductors extending beyond the plug are severed and ejected after which the workholder is returned pivotally to the cord-transfer position whereat the cord end is released from the workholder. A die is moved in one direction transversely of the anvil to align slots in the die with the passageways in the anvil. A plurality of strips of terminals are advanced to position a leading, partially formed, terminal in each strip in an associated partially enclosed passageway in the anvil. Then the die is moved in a direction opposite to the one direction to sever the leading portion of each strip to form a terminal and to

complete the enclosure of the passageways in the anvil in preparation for another cycle of operation.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will appear from the following detailed description of a specific embodiment thereof when read in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of a retractile telephone cord having a moldular plug assembled to each end thereof;

FIGS. 2, A to J, are a sequence of perspective views of the steps of a method embodying the principles of this invention for assembling the plugs to the cord;

FIG. 3 is a front elevation view of an apparatus for assembling a plug to each end of a cord;

FIG. 4 is a side elevational view of the apparatus of FIG. 3;

FIG. 5 is a plan view of the apparatus of FIG. 3;

FIG. 6 is an enlarged plan view of a transfer device into which an operator positions one end of a cord and a workholder to which the cord end is transferred;

FIG. 7 is an end elevational view of the transfer device;

FIGS. 8 and 8A are enlarged plan views of the workholder shown in a cord-transfer and in an assembly position;

FIG. 9 is a front elevational view of a portion of the apparatus for feeding a base and a top portion of each plug into an assembly position;

FIG. 10 is a detail view of a portion of the workholder;

FIG. 11 is a detail view of the relative positions of the base, top and stripped cord end prior to assembly;

FIG. 12 is an enlarged view of the workholder and facilities for removing scrap material therefrom;

FIGS. 13A – 13E are a sequence of views of the workholder shown in the assembly position and showing the stripping of a portion of the cord jacket to expose individually insulated conductors;

FIG. 13F is side elevational view showing the workholder and an alternate embodiment for removing the stripped jacket and excess lengths of conductors which have been severed;

FIG. 14 is a perspective view of a portion of the apparatus for completing the forming of terminal blades and inserting same into a plug top and into electrical engagement with the conductors positioned therein;

FIG. 15 is a side elevation view of the terminal insertion facilities;

FIGS. 16 and 17 are enlarged views of a die used to form the terminal blades;

FIGS. 18 and 19 are enlarged views showing the insertion of the terminal blades;

FIGS. 20 and 21 are enlarged views of a device for severing the excess ends of conductors extending beyond a front end of the assembled plug;

FIG. 22 is an electrical control circuit for the assembly apparatus; and

FIG. 23 is a schematic view showing a pneumatic control system for the assembly apparatus.

DETAILED DESCRIPTION

Product Description

Referring now to FIG. 1, there is shown a retractile telephone cord, designated generally by a numeral 50, which includes coiled cordage 51 having a plug 52 assembled to each end thereof in accordance with the principles of this invention. The coiled cordage 51 includes a plurality of individually insulated conductors 53–53 (see FIG. 2E) enclosed by a jacket 54. The plug 52 is comprised of two mating parts 56 and 57 which are bonded together ultrasonically and which are referred to as the base and the top, respectively. The part 57 has a plurality of conductor-receiving troughs 58—58 (see FIG. 18) for receiving associated ones of the conductors 53—53 and with which electrical contact is made by associated ones of a plurality of terminal blades 59—59 which are inserted in terminal-receiving grooves 61—61 (see FIG. 18) formed in the part 57 and which communicate with the troughs 58—58. The plug 52 also includes a ledge 62 (see FIG. 11) protruding beyond the troughs 58—58 as well as other features disclosed and claimed in U.S. Pat. Nos. 3,699,498 and 3,761,869.

Overall Apparatus

An apparatus for assembling one of the plugs 52—52 to each end of a retractile cordage 51 is shown in FIGS. 3, 4 and 5 and is designated generally by the numeral 70. The apparatus 70 includes dual assembly positions and assoicated facilities for assembling simultaneously one of the plugs 52—52 to each cord end. As is seen in FIG. 3, these are designated Assembly Position Nos. I and II. Only one of each of the duplicate facilities, specifically those associated with Assembly Position No. I, will be described.

The apparatus 70 includes a transfer device, designated generally by the numeral 71 (see FIGS. 4 and 5) for receiving an unfinished cord end at a cord-input position and for transferring the cord end at a transfer position to a workholder, designated generally by the numeral 72. The workholder 72 is moveable between the cord-transfer position and a plug-assembly position whereat the cord end is aligned with two spaced aligned mating parts 56 and 57 which have been moved thereto by feeding facilities, designated generally by the numeral 73.

Also, as can best be seen in FIG. 3, the apparatus 70 includes bonding facilities, designated generally by the numeral 74, for bonding together ultrasonically repetitively associated aligned mating parts 56 and 57 in the assembly position. The apparatus 70 is also provided with insertion facilities, designated generally by the numeral 76 (see FIG. 4), for completing the forming of partially formed terminals 59—59 and for inserting the terminals in associated ones of the terminal-receiving grooves 61—61 into the part 57.

All of the facilities described are supported by associated elements of framework, designated generally by the numeral 77 which is supported in a base 78.

In order to best described the apparatus 70 and the operation thereof, reference will be made to FIGS. 2A–2J as each portion of the apparatus and its function is described. This will correlate the function of each portion of the apparatus to the product at various phases in the assembly thereof. Following the completion of the description of the apparatus, a cycle of operation will be described with reference to facilities for controlling that operation.

Transfer Device

In order to initiate the operation of finishing a cord 51 by assembling a plug 52 to each end thereof, the ap-

paratus includes the transfer device 71 (see FIG. 6) which has provisions for accepting unfinished ends of the cordage from the operator at the cord-input position and for transferring the cordage to the workholder 72 at the cord-transfer position (see FIG. 2A). Viewing FIG. 2A, it should be noted that the cordage 51 shown in the phantom position is in the cord-input position, and the cordage in solid is in the cord-transfer position. Further, the right-hand side of the cordage 51 is associated with Assembly Position No. I, and the left-hand side with Position No. II.

Referring now to FIGS. 6 and 7, it can be seen that the transfer device 71 includes a crank 101 connected to a hub 102 mounted on a shaft 103 of an air motor 104 supported from a frame 106. The crank 101 is moveable by the air motor 104 cyclically between the associated cord-input position and the associated cord-transfer position.

Still referring to FIG. 6, it can be seen that the crank 101 has a loading bar 107 cantilevered therefrom for holding a cord end. In order to accomplish this, the loading bar 107 is formed with a plurality of spaced U-shaped fingers 111, 112, 113 and 114 into which an operator positions an end portion of the unfinished cordage 51. At the time the transfer device 71 receives an end of the cordage 51 from the operator, the transfer device is in the cord-input position shown in solid lines in FIG. 7.

The transfer device 71 includes provisions for conditioning portions of the workholder 72 for each cycle of operation. Referring to FIG. 7, it may be seen that a bracket 116 is attached to and extends from the frame 106. The bracket 116 has a stud 117 extending therefrom. When the workholder 72 is returned to the cord-transfer position from the plug-assembly position, the stud 117 engages portions of the workholder and as will be described hereinafter in detail, and causes the workholder to be conditioned for the next cycle of operation.

Workholder

The workholder 72 may best be seen by referring to FIGS. 6–9 and is designed to accept the unfinished cord end from the transfer device 71 at the cord-transfer position (see FIG. 2A), turn the cord end through an angle of approximately 90° (see FIGS. 2D and 8) into the plug assembly position, and to hold the cord end while a portion of the jacket is separated (FIG. 2E), the plug 52 assembled thereto (see FIG. 2G), the terminals 59—59 inserted (see FIG. 2H), and excess lengths of the conductors 53—53 severed and ejected (see FIG. 2I) together with the portion of the jacket.

As can best been seen in FIGS. 6, 8 and 9, the workholder 72 is supported from a column 131 mounted in the framework 77. In order to turn the workholder 72, a link 132 is connected at one end thereof to the column 131 and has the other end thereof pinned to a linkage bar 133 which is pinned at the other end thereof to a toggle 134. The toggle 134 is attached to a forward end (nearest the operator position) of a piston rod 136 extending from a cylinder 137.

In the position shown in FIG. 6 with the piston rod 136 withdrawn into the cylinder 137, the workholder 72 is in the cord-transfer position (see FIGS. 2B and 2C and also broken line position in FIG. 8). In the solid line position shown in FIG. 8, the piston rod 136 is extended to turn the linkage bar 132 in a counterclockwise direction to move the workholder to the plug-assembly position (shown in solid lines in FIG. 8 and also seen in FIG. 2D).

The workholder 72 includes a bifurcated member 141 (seen best in FIGS. 8 and 9) with pivotally mounted stud 142 supporting a cam follower 143 between the arms thereof. The stud 142 is biased to the left as shown in FIG. 9 by a spring 144. Also received between the arms of the bifurcated member 141 is a bar 146 which supports a cam follower 147. The cam follower 1467 is biased in a downward or clockwise direction about a pin 148 by a spring 149.

When the workholder 72 is in the cord-transfer position, the cams 143 and 147 are not in engagement with fixed camming surfaces 151 and 152, respectively (see FIG. 8A). Hence, when the transfer device 71 is turned in a clockwise direction as shown in FIG. 7, the cord 51 is caused to be urged into engagement with undersides 153—153 (see FIG. 9) of the arms of the bifurcated member 141. The bar 146 is urged upward against the action of the spring 149. Similarly, the spring 144 is overcome and the stud 142 is urged rearwardly slightly to permit entry of the cordage 51 (see FIG. 9).

Then, when the workholder 72 is rotated through the quarter angle, the cams 143 and 147 are caused to engage the fixed cam surfaces 151 and 152, respectively (see FIG. 8A), to cause the member 146 and stud 142 to secure the cordage 51. This prevents slippage of the cordage 51 during the subsequent assembly and stripping operations. The partial locking of the cordage 51 by the follower 147 is as shown in FIG. 13A.

AT this time attention should be directed to still another cam. Referring now to FIG. 8A, it can be seen that a cam 145 is biased to the left by a spring 150 and in engagement with the cam follower 143. The cam 145 and spring 150 are mounted on the general framework 77.

Following the transfer of the cordage end into the workholder 72 and transfer of the plug parts 56 and 57, the rotational movement of the workholder into the phantom line position shown in FIG. 8A causes the cam follower 143 (in position 143*a* in FIG. 8A) to urge the cam 145 to the right. When the workholder 72 is in the phantom line plug-assembly position shown in FIG. 8A, the cam follower 143 assumes the position 143*b* in engagement with the cam 151 to secure the cord as hereinbefore described. It should be observed that once the cam follower 143 moves out of engagement with the cam 145, that cam is biased to the left as viewed in FIG. 8A into the position 145*a*.

The cam 145 has the primary function of causing the cordage 51 to be released from the workholder 72 which the workholder is returned to the cord-transfer position. As the workholder 72 is rotated clockwise as viewed in FIG. 8A, the cam follower 143 rides along an opposite face of the cam 145 (see position 143*c*). This causes the spring 144 to be overcome and the stud 142 (see FIG. 9) to be turned in a clockwise direction to remove the clamping forces applied to the cordage. The finished cord end is permitted to descend by gravity from the workholder 72 into a collection bin (not shown).

With the cordage 51 now securely held within the workholder 72 and after the workholder has been rotated into the solid line position shown in FIG. 8 by the operation of the cylinder 137, the apparatus 70 functions to remove a predetermined length of the jacket 54

to expose the individually insulated conductors 53—53. This will permit the subsequent engagement of the conductors 53—53 with the conductor-receiving troughs 58—58 of the part 57 prior to the bonding step. Although the stripping facilities will now be described, it should be realized that this step does not occur until the workholder 72 has been rotated and this does not occur until parts 56 and 57 have been transferred into the plug-assembly position.

Referring now to FIGS. 6–9 and 12–13A, it can be that the workholder 72 includes a U-shaped stripping head 153 which includes opposed cutting blades 154—154 (best seen in FIG. 13A) held within a notch formed in a leg 155 thereof. The other leg 156 of the stripping head 153 is V-shaped and is designed to hold securely the cordage 51. The head 153 is mounted slidably on a rod 157 which is connected to the column 131 and extends rearwardly of the operator to a cross head 158.

As can be seen in FIG. 8, the crosshead 158 has a latch 159 mounted pivotally thereto and spring-biased in a clockwise direction as viewed in FIG. 8. The latch 159 includes a toothed end 161 and a release end 162. Whebn the workholder 72 is returned to the cord-transfer position from the plug-assembly position, the release end 162 of the latch 159 engages the stud 117 (see FIG. 7). This overcomes the spring-bias and causes the latch to be moved pivotally in a counterclockwise direction as viewed in FIG. 8.

The stripping head 153 is spaced from the bifurcated member 141 by a stop 163 and a gauging button 164. The stop 163 is attached to the bifurcated member 141 while the button 164 is attached to the stripping head 153. The crosshead 158 is attached to the stripping member 153 through a dowel 169 connected to a hub 165 having a flanged end 166. As can best be seen in FIG. 8, a compression spring 167 is disposed concentrically about the dowel 169 to bias the interconnected hub 165, stripping head 153 and button 164 into engagement with the stop 163.

Feeding and Positioning Plug Parts

Although reference has been made to ones of the drawings which depict the workholder 72 in the plug-assembly position, it should be noted that this was done because of the introduction of the workholder at that point in the description of the apparatus 70. Again it should be emphasized that the workholder 72 is not moved into the plug assembly position shown in solid lines in FIG. 8 until leading ones of the parts 56 and 57 have been moved into the plug-assembly position.

This can be observed from a study of FIGS. 2A–2D. In FIG. 2A, the parts 56 and 57 have not yet been fed into the plug-assembly position. This is accomplished in FIGS. 2B–2C while the cordage ends are being transferred from the transfer device 71 to the workholder 72.

Referring now to FIGS. 3 and 4, it can be seen that the feeding facilities 73 associated with each assembly position includes vibratory supply hoppers 171 and 172. The hoppers 171 and 172 have feed tracks 174 and 176, respectively, extending therefrom to plug-transfer positions (see FIG. 10) which are aligned in one direction (see FIG. 4) with the bonding facilities 74.

The track 174 feeds one of the parts 56—56 in seriatim into a nest 177 (see FIG. 10) formed in a block 178 of a transfer device, designated generally by the numeral 179. The block 178 is moveable reciprocally by an air operated cylinder 181 which is best seen in FIG. 4. The block 178 is supported on a slide 182 supported within a housing 183. As can be seen in FIG. 10 one end of the slide 182 is attached to a crossbar 184. The crossbar 184 is attached to a piston rod (not shown) extending from the cylinder 181 attached to the housing 183.

The transfer device 179 also has provisions for moving the block 178 and part 56 supported therein upwardly. The housing 183 is supported from a beam 186 which may be moved upwardly by a pneumatically operated cylinder 187 supported on a column 188. In an unoperated condition, the housing 183 is supported on shoes 189—189 resting in engagement with pads 191—191 of a transfer device, designated generally by the numeral 192.

Similarly, the track 176 performs a gravity feed function of successive leading ones of the parts 57—57 into engagement with the transfer device 192. Simultaneously with the feeding of the parts 56—56, each successive leading one of the parts 57—57 is fed along the track 176 to move a leading one thereof into a nest formed in one end of a block 193 of the transfer device 192. As is seen in FIG. 10, the part 57 is held within the nest formed in part by a top surface 194 of a spring-biased plate 195 and a clamping member 196 connected to one end of a toggle bar 197. Another end 198 of the toggle bar 197, mounted pivotally about a pin 199, is drawn to the left by a piston rod 200 withdrawn into a pneumatically operated cylinder 201. This causes the bar 191 to be turned in a counterclockwise direction as viewed in FIG. 10 to cause the clamping member 196 to clamp and hold the part 57.

The transfer device 192 includes a housing 202 having a slide 203 supported therein. One end of the slide 203 is attached to the block 193 and the other end to a crossbar 204. The crossbar 204 also is connected to a piston rod 206 (see FIG. 4) extending from a pneumatically operated cylinder 207 supported laterally of the housing 202.

After the leading ones of the parts 56 and 57 in the tracks 174 and 176, respectively, are in the transfer devices 179 and 192, respectively, the cylinders 181 and 207 are operated to move the parts 56 and 57 to the left as viewed in FIG. 10 and into vertical alignment with the bonding facilities 74. Then the air cylinder 187 is operated to move the block 178 upwardly to engage the part 56 with the contoured mating end of a horn 209 of the bonding facilities 74. The horn 209 includes provision (not shown) for holding vacuumly each successive one of the parts 56—56.

The movement of the block 193 to the left is accomplished to position the part 57 in vertical alignment with an anvil 210 of the bonding facilities 74. It should be noted that when the block 193 is moved from its plug-transfer positions shown in FIG. 10, that the plate 195 engages a side surface of the anvil 210. Further movement of the block 193 causes the spring-bias of the plate 195 to be overcome thereby uncovering the bottom of the part 57 held by the clamping member 196. Hence, the part 57 is unsupported along a bottom face as it is moved over the anvil 210 but is held securely by the clamping member 196. Moreover, the clamping member 196 is longitudinal of the plane of the drawings so that the toggle bar 197 and associated

linkages do not interfere with the engagement of the anvil **210** with part **57**. The anvil **210** has a top surface thereof provide with a nest contoured to that of the part **57**.

When the block **193** has been moved to the left as shown in FIG. **10** and when the part **57** is aligned vertically with the anvil **210**, the cylinder **201** is operated to extend the piston rod to pivot the toggle **197** and release the clamping member **196** from engagement with the part **57**. This permits the part **57** to descend slightly and come to rest in the nest in the anvil **210**. Since the plate **195** has been removed and since the clamping member **196** has been moved partially, the block **193** may be moved to the right without interference by the part **57**. In this way, the part **57** may subsequently be moved upwardly from the transfer position to engage the stripped end of the cord **51** (see FIG. 2F) and be engaged with the part **56** held vacuumly by the horn **209** and bonded thereto.

Jacket Stripping

In order to strip a portion of the jacket **54** from each end portion of the cordage **51** (see FIG. 2D), a cylinder **216** supported from a bracket **217** connected to the framework **77** (see FIG. **12**) has a pair of spaced arms **218—218** extending laterally thereof (see FIGS. **8, 12** and **13A**) and moveable toward or away from the operator by the cylinder. The arms **218—218** are designed to engage opposed portions of the flange **166** (see FIGS. **13B** and C) and urge the stripping head **153** rearwardly of the operator until the toothed end **161** of the latch **159** engages with flange **166** (see phantom position in FIG. **8A**). This causes the stripping head **153** to move a portion of the tubed jacket **54** axially of the cordage **51** and expose a length "L" of individually insulated conductors **53—53**. The latch **159** locks in under the flange **166** and retains the stripping head **153** in the position shown in FIG. **13C** with the gauging button **164** spaced from the stop **163**.

As can be observed from a comparison of FIGS. 2E and 2F, the severed portion of the jacket **54** is moved axially of the cordage **51** but is not at this time removed from the cordage. Rather, the removal of the several jacket portion is accomplished subsequent to the severance of the excess lengths of the conductors **53—53** (see FIG. 2I). The simultaneous removal of the scrap jacket portion and excess conductor lengths reduces cycle time over the separate removal of each.

The retention of the severed jacket portions in engagement with the conductors **53—53** (see FIG. 2E) also serves a useful function. As can be seen in FIG. 2E, the next step is to move the part **57** into engagement with the cordage **51** such that the individually insulated conductors **53—53** are received in the corductor-receiving troughs **58—58**. The severed lengths of jacket **54** spaced from the remainder of the jacket is of assistance in maintaining the conductors **53—53** spaced apart so as to facilitate their receipt into associated ones of the troughs **58—58**.

Terminal Forming and Insertion and Conductor Severing Facilities

Referring not to FIGS. **14–19** there is shown in detail the facilities **76** for inserting ones of the terminal blades **59—59** in associated ones of the terminal-receiving grooves **61—61** in the top part **57** the plug **52**. Portions of these facilities are claimed in the application Ser. No. **346,556**, filed Mar. **30, 1973**, now Pat. No. **3,839,787**. See also commonly assigned application Ser. No. **311,575** filed Nov. **4, 1972**, now Pat. No. **3,835,445**.

Feed facilities, designated generally by the numeral **221**, are provided for feeding a plurality of strips **222—222** of partially formed terminals **59—59**. The terminal forming and insertion apparatus **76** includes facilities for receiving the leading portion of each of the repetitively configured strips **222—222** of partially formed terminals **59—59** and for then shearing the leading portion therefrom. The leading portin of each of the strips **222—222**, which is formed into one of the terminals **59—59**, is supported around a defined periphery thereof.

a. Feeding Facilities

The feeding facilities **221** include two groups of four rolls (not shown) of the strips **222—222** supported in suitable bearings (not shown). Each of the strips **222—222** includes a plurality of partially formed terminals **59—59** interconnected by thin strips **223—223** of metallic material (see FIG. **15**).

Each of the strips **222—222** is pulled from an associated one of the rolls and advanced so that the terminals **59—59** formed from the strips may be fed in a generally vertical fashion, into engagement with the associated assembly of parts **56** and **57**. Each one of the strips **222—222** is advanced into and along an associated channel **224** in a trackway **226**. At the initiation of each cycle of operation, each one of the channels **224—224** is aligned with an associated one of the grooves **61—61** of the top part **57** into which the terminals **59—59** are to be inserted (see FIG. **14**).

One end of the trackway **226** is received in an opening **227** of a reciprocally moveable (in a direction normal of the sheet of drawings) shearing assembly, designated generally by the numeral **228**. The trackway **226** is cantilevered and amount pivotally to permit the shearing assembly **228** to be moved reciprocally laterally of the strips **222—222** without bending the trackway. In this way the miniature, fragile strips **222—222** of partially formed terminals **59—59** may be constantly provided with support within associated ones of the channels **224—224** without becoming bound therein because of deformed paths of travel.

As is shown in FIG. **15**, the facilities **221** for advancing the strips **222—222** of the terminals **59—59** includes a pneumatically operated cylinder **229** having a rod **231** extending therefrom through a housing **232** and keyed into a housing **233**. The housing **232** and **233** partially enclose the trackway **226** with the housing **233** being connected thereto. However, the housing **232** is fixedly attached to the general framework **77** with the trackways **226—226** being slidably moveable therethrough.

As is shown in FIG. **15**, a pawl **234** having a toothed end **236** is mounted pivotally on a pin **237**. The pawl **234** is biased in a counterclockwise direction by a spring **238**.

Unlike the housing **233**, which is moveable with the trackway **226**, the housing **232** is fixed with respect thereto. Also, a pawl **239** having a toothed end **241** is mounted pivotally on a pin **242** mounted within the housing **232**. The pawl **239** is biased in a counterclockwise direction by a spring **243**.

The pawls 234 and 239 are positioned with respect to the trackway 226 so that the pawls span transversely across the four strips 222—222. Moreover, the toothed ends 236 and 241 are designed to seat between adjacent ones of the tangs of each of the partially formed terminals 59—59.

The operation of the cylinder 229 extends the rod 231 to cause the housing 233 and associated pawl to be moved to the left as viewed in FIG. 15. The movement which is adjustable, is designed to move the leading one of the partially formed terminals 59—59 into engagement with a face 244 of a front wall 246 of the anvil 210 of the bonding facilities 74.

The pawl 234 functions to urge the strips 222—222 to the left as viewed in FIG. 15. During the movement, the toothed end 241 of the pawl 239 merely rides over the tops of the tangs of the strips 222—222, the cylinder 229 is operated to cause retraction of the rod 231 and the housing 233. The spring 238 is overcome to permit pivotal movement of the pawl 234 in a clockwise direction. Meanwhile an pawl 239 acts in an antiretrograde manner to prevent movement of the strips 222—222 rearwardly of the insertion facilities to the right as viewed in FIG. 15.

b. Terminal Severing Facilities

The shearing assembly 228 is supported in a dovetailed opening 247 in a plate 248 (see FIG. 15). The plate 248 is mounted in a fixed engagement with the anvil 210 which also functions as a die block and which is mounted slidably to a frame 249. The opening 247 in the plate 248 is such that the shearing assembly 228 may be moved therein in a direction transverse of the strips 222—222 to sever the leading portions therefrom.

The shearing assembly 228 has an insert 251 (see FIGS. 16 and 17) received and held in an opening 252 therein. The insert 228 is formed to provide a plurality of openings, each of which is designed to receive an associated one of the strips 222—222 of the partially formed terminals.

The insert 251 is formed with an opening 253 therethrough (see FIG. 17). The opening 253 is formed so as to provide a plurality of spaced fins 254—254 (see FIG. 16) extending into the opening from a top surface thereof (see again FIG. 17). The fins 254—254 each have a width essentially equal to the thickness of one of the strips 222—222 of the partially formed terminals 59—59.

As can be seen in FIG. 16, a shearing blade 256 is positioned in the opening 253 between each of the fins 254—254 and between end ones of the fins and the walls of the opening. The blades 256—256 are maintained spaced apart along the bottom portions thereof by spacer shims 257—257 interposed therebetween. The blades 256—256 are used to separate leading portions of the strips 222—222 to form successive groups of the terminals 59—59.

The spacer shims 257—256 each have a thickness essentially equal to the thickness of the associated aligned fins 254—254. Moreover, and as can best be seen in FIG. 17, the spacer shims 257—257 are dimensioned so that a top surface 258 thereof is coplanar with the bottom surface of each of the channels 224 of the associated trackway 226. In this way, the blades 256—256, the spacer shims 257—257 and the bottom surface of the fins 254—254 cooperate to provide spaced openings or slots 259—259 through which leading portions of the strips 222—222 are advanced. The lower edges of the strips 222—222 are in engagement with the surfaces 258—258 of the spacer shims 257—257.

Each of the shearing assemblies 228—228 associated with one of the assembly positions is mounted slidably to be moved reciprocally by an air cylinder 261 (see FIG. 14). The air cylinder 261 may be operated to move the shearing assembly 228 laterally of the strips 222—222 and thereby shear the leading portions at the interconnecting strips 223—223 from the respectively configured strips 222—222 to form the terminals.

The strips 222—222 of the terminals 59—59 are advanced through the slots 259—259 in the shearing assembly 228 into associated passageways 262—262 formed in the anvil or die block 210 and then into engagement with the wall 244 of the die block (see FIGS. 15 and 18). At this time, and as can be viewed in FIG. 14, each of the leading respectively configured portions of the terminals strips 222—222 is supported along the leading edge thereof and also along the adjoining flat faces of the terminals 59—59.

The relative positions of the shearing assembly 228 and the die block 210 in an aligned unoperated condition are best shown in FIG. 15. As can be seen, the passageways 259—259 in the shearing assembly 228 are aligned with the grooves 262—262 in the die block 210. These are also aligned with the channels 224—224 in the trackway 226.

At the conclusion of each cycle of operation, the actuation of the cylinder 261 moves the shearing assembly 228 with respect to the die block 210 (see FIG. 14) to accomplish a dual function. The blades 256—256 sever the portions 223—223 interconnecting the repetitively configured strips 222—222 to form terminals 59—59. Secondly, the movement of the shearing assembly 228 is sufficient to cover the passageways 359—259 formed in the die block 210 such that the newly formed ones of the terminals 59—59 received in each of the passageways 262—262 is now completely enclosed about the periphery thereof as defined hereinbefore. The aligned channels 224—224 and passage 259—259 are now misaligned with the groove 262—262 in the anvil or die block 210. The enclosed periphery includes the leading edge thereof, the two flat adjoining faces and then along the newly formed edges adjacent the remaining portions of the strips 222—222.

The newly formed ones of the terminals 59—59 are aligned with associated ones of the grooves 61—61 in the part 57 of the plug 52 now positioned on a top surface of the anvil 210 above the passageways 262—262. Moreover, a bottom edge of each one of the terminals 59—59 is aligned with a blade-like insertion ram 263 (see FIG. 15) mounted slidably in the associated passageway 262 in the die block 210.

c. Terminal Insertion Facilities

Each of the insertion rams 263—263 is attached to a connecting bar 264 which is spring-mounted in a slotted head 266. The head 266 is supported in engagement with one end 267 of a pivotally mounted lever 268 supported on a fulcrum 269 in a block 271. The lever 268 is caused to be turned by a cylinder 272 (see FIG. 4) clockwise as viewed in FIG. 15 to move the head 266 upwardly until the top surface thereof en-

gages the underside of the frame **249.** Continued movement of the head **266** causes the anvil **210** and the part **57** to be moved upwardly to engage the part with the cord end such that the conductors **53—53** of the stripped portion are received in the conductor-receiving troughs **58—58.**

It will be recalled (compare FIGS. 2E and 2F) that the jacket stripping is accomplished to facilitate the positioning of the conductors **53—53** in the troughs **58—58** in the part **57** when that part is moved upwardly into engagement with the cordage **51.** The severed jacket portion is moved axially to expose the individually insulated conductors **53—53** but remains in engagement with the ends of the conductors. This maintains the conductors **53—53** spaced apart at distance corresponding to that of the troughs **58—58.**

At this time, the bonding facilities **74** are operated to bond ultrasonically the part **56** to the part **57** thereby securing the cordage **51** and conductors **53—53** within the dielectric housing. Then facilities (not shown) are operated to lock the horn **209** in the bonding position, albeit with the bonding energy discontinued to permit terminal insertion without unduly stressing the horn and anvil.

The pivotal movement of the lever **268** causes the follower **273** attached to a pivotally mounted plate **277** to be moved upwardly until it is in alignment with a plunger **275.** The plunger **274** is operated by a cylinder **276** (see FIG. **4**) and is moveable into engagement with the follower **273** to move pivotally the plate **277** about a pin **278.** This causes the rams **263—263** (see FIG. **18**) to move the terminals **59—59** along the passageways and into the terminal-receiving grooves **61—61** in the plug part **57** (see FIG. **19**).

The insertion rams **263—263** are dimensioned so as to fit snugly, but slidably, within the associated ones of the grooves **262—262.** In this way, there is no possibility of the insertion rams **263—263** overriding one of the miniature-type terminals **59—59** and causing a malfunction of the equipment or damage to the terminals.

As can best be seen in FIG. **15,** the topmost edge of each of the insertion rams **263—263** is deliberately slightly below the bottom edges of the strips **222—222.** Or, relative to the shearing assembly **228,** the topmost edge of each of the rams **263—263** is slightly below the surface **258** of the spacer plates **257—257** in the insert **251.** In this way, there is no possibility that the topmost edges of the rams will protrude above the bottoms of the trackways **226—226** and surfaces **258—258** of the spacer plates **257—257** to interfere with the indexing of the strips **222—222.**

d. Conductor Severance

The apparatus **70** also includes provisions for severing excess lengths of conductors extending beyond the plug **52.** It will be recalled that the part **56** is formed with a cutoff ledge **62** (see FIG. **11**).

Referring now to FIGS. **20** and **21,** it can be seen that an adjustable bolt **281** is turned threadably into a lower end of a slidably mounted bar **282** biased downwardly by a spring **283** into engagement with a top surface **284** of an abutment **286.** One of the bars **282—282** is mounted slidably on each side of the insertion rams **263—263.** The spring **283** engages the underside of an overhang of the anvil **210** of the bonded facilities **74.** The bolt **281** is supported in engagement with a ledge **287** formed at the juncture of the insertion rams **263—263** and the bars **264—264** (see FIG. **14**).

As can be seen in FIG. **20,** the part **57** is supported on the anvil **210** such that the front end thereof engages a toothed end **288** of a pivotally mounted pawl **289.** The pawl **289** is urged in a counterclockwise direction as seen in FIG. **20** by a spring **291** supported in a block **292.** In this position, the toothed end **288** shields the conductors **53—53** from a shearing blade **293** attached to the bars **282—282** and in sliding engagement with a side face of the anvil overhang. A spacer lug **294** maintains the blade **293** spaced from the anvil **210** and in alignment with the ledge **62** of the part **57.**

In operation, as the insertion rams **263—263** are moved upwardly initially by the lever **268** and still further by the pawl **275** of the plate **277,** the bolt **281** and bars **282—282** are correspondingly raised and overcome the action of the spring **283.** The movement of the bars **282—282** also causes the blade **293** to be moved upwardly past the toothed end **288** urging the pawl **289** in a clockwise direction as viewed in FIG. **21,** overcoming the action of the spring **291.** The blade **293** is exposed and bottoms in engagement with the ledge **62,** thereby severing the conductors **53—53** which extend beyond the ledge. It should be observed that this conductor severance operation is a result of the movement of the insertion rams **263—263** and hence of the ledge **287.**

Scrap Removal

Provisions are also made for ejecting the removed portion of the jacket **54** and severed conductors **53—53** from the workholder **72.** As can best be seen in FIG. **12,** the apparatus **70** also includes three spaced fingers **301—301** depending from a common support **302** which is connected to a vertically extending member **303** (see FIG. **4**). The vertically extending member **303** is connected to a shaft **304** having a collar **306** pinned to a trunnion **307** connected to a piston rod **308** of a pnuematically operated cylinder **309.** When the cylinder **309** is operated, the collar **306** and shaft **304** are caused to be turned to move pivotally the member **303.** This causes the fingers **301—301** to sweep past the portion of the cordage **51** which extends past the ledge end of the plugs **52** (see FIGS. **2I** and **13E,** fingers **301** being in phantom).

The sweep motion of the fingers **301—301** has a dual function. It applies forces to the jacket to remove the jacket from the confines of the stripping head **153** and it also ejects excess conductor lengths which have been severed during the insertion of the terminal blades **59—59.**

After the removal of the scrap, it should be observed that the flange **166** is still held in a rearward position by the latch **159.** However, when the workholder **72** is returned to the cord-transfer position, the flange **166** is released to recondition the workholder to strip the next successive cord. This is accomplished when the stud **117** engages the release end **162** of the latch **159** as the workholder **72** is returned. This engagement pivots the latch **159,** and the spring **167** returns the stripping head **153** to the left as shown in FIG. **6** until the gauging button **164** engages the stop **163** in preparation for the receipt of another cordage end.

An alternate embodiment for removing the scrap is shown in FIG. **13F.** The apparatus shown in FIGS. **13A–13E** is modified to include an additional cord

clamp 311 having a V-shaped opening 312 for further holding the cordage end. Since the clamp 311 must extend as far from the rod 157 as the leg 156, an opening is provided therein to permit the latch 159 to extend therethrough when the hub 165 is moved upwardly as viewed in FIG. 8.

In the alternate embodiment, the sweep fingers 301—301 are replaced by a pair of clamping fingers 313—313 extending from a hinge 314. The fingers 313—313 are positioned initially so that when the length "L" of jacket 54 is severed from the remainder of the jacket and moved axially of the end of the cordage 51, it is received between the fingers. Then, after the excess conductor lengths are severed by the shearing blade 293, the hinge 314 is moved to the right as viewed in FIG. 13F and the fingers 313—313 are cam-closed on the severed jacket and to remove the jacket from the workholder 72.

Operation

The operator inserts each end of the cordage 51 in the associated one of the transfer devices 71—71 and depresses simultaneously START palmbuttons 399—399 to initiate the operation of an electrical control circuit designated generally by the numeral 400 (see FIG. 22). The transfer of the cordage 51 from the transfer devices 71—71 to the workholder 72—72 causes the opposed coating blades 154—154 in each of the workholders to cut into the jacket. The palmbuttons 399—399 must be maintained depressed until the transfer device 71 transfers the cord end to the workholder 72. Then, when the workholder 72 is rotated through a quarter turn to position the cord end in the plug-assembly position, a length L of the jacket 54 is partially removed from a leading end of the cordage 51. After a cycle has begun, it continues until an emergency stop button (not shown) is depressed, a malfunction occurs, or until the cord ends have plugs 52—52 assembled thereto and an operator initiates another cycle.

Prior to the operation of a main air interlock valve, all of the elements of a pneumatic control system, designated generally by the numeral 500 (see FIG. 23) must be in predetermined positions. If any of the elements are not in an initial position, the air interlock valve is not activated.

It should be recognized that the apparatus 70 is a sequential apparatus and that no action is initiated until the preceding step has been completed. The sequence of operations may be controlled by the control circuit such as that shown in FIG. 22 and designated 400. The control circuit 400 includes a timing mechanism, designated generally by the numeral 401, which is provided with a motor 402. The motor 402 operates a camming system (not shown) whereby a plurality of contacts of the timing mechanism are cam-controlled, thereby energizing a plurality of solenoids to control the apparatus 70.

Assuming that the apparatus 70 has completed at least one cycle of operation, the following operational description is illustrative of the sequential operation of the various controlling air cylinders for the apparatus. Referring to FIGS. 22 and 23, all air cylinders are assumed to be in a rest position. Thereafter, the rotational movement of the motor 402 results in the cam closing of a contact 403 (see FIG. 22) of the timing mechanism whereby a solenoid 404 is energized. As the solenoid 404 is energized, an air valve 504 (see FIG. 23) is opened to supply pneumatic pressure to the transfer device air motor 104. This causes the transfer device 71 to transfer the cordage end 51 from the cord-input position to the cord-transfer position and into the workholder 72. The cord end is held in the leg 156 and optionally in the leg 311 and a portion is moved into engagement with the blades 154—154 in the stripping head 153.

Meanwhile, parts 56 and 57 have been fed by gravity from the hoppers 171 and 172 (see FIG. 4). Each of the supply hoppers 171 and 172 is equipped with a photoelectric control unit (not shown) which senses when the level of the parts is low. When this occurs, a control unit (not shown) causes vibratory forces to be applied to the hoppers 171 and 172 to renew the level of the parts 56 and 57 in the tracks 174 and 176, respectively.

Shortly thereafter, a switch 406 is cammed closed to enerize a solenoid 407 whereby a valve 507 is opened to supply pneumatic pressure to the air cylinder 201 (see FIG. 10) to clamp the leading one of the parts 57 in engagement with the transfer device 192. Simultaneously, the switch 403 is cammed open to return the transfer device 71 in a counterclockwise direction as viewed in FIG. 7 to its cord-input position.

Then, while the switch 406 remains closed, continued operation of the motor 402 rotates the camming system 401, whereby switches 411 and 416 are closed. This causes the energization of solenoids 412 and 417, respectively, which caused pneumatic pressure to be applied through valves 512 and 517, operate cylinders 181 and 207 to operate the upper and the lower plug-part transfer devices 179 and 192 which have received gravity-fed plug parts. The operation of the transfer devices 179 and 192 moves the plug parts 56 and 57 into vertical alignment with the bonding facilities 74.

The upper transfer device 179 is also operated to elevate the plug part 56 until it can be attached and vacuumly held by the horn 209. While the switches 406, 411, and 416 remain cammed closed, the motor 402 causes a switch 421 to be cam-closed. This energizes a solenoid 422 which opens an air valve 522 to operate the cylinder 187 to elevate the part 56.

The lower transfer device 192 moves the lower part 57 vertically over the anvil 210 at which time the switch 407 is opened to deactivate the cylinder 201 which releases the part 57 to permit it to be supported by the anvil. The continued operation of the motor 402 opens switches 411 and 416 to cause the air valves 512 and 517 to cause the plug transfer devices 179 and 192 to be returned to the rightmost position shown in FIG. 10. Also, the switch 421 is opened to cause the transfer device 179 to be lowered to its normal plug part accept position shown in FIG. 10.

The timing mechanism 401 is designed so that the return of the plug-part transfer device 179 and 192 causes the workholders 72—72 to be moved rotatably (in opposite rotational directions) to position the cordage ends between each of the associated aligned plug parts 56 and 57. When the cordage ends assume these positions, the apparatus is caused to strip the predetermined length L of jacket 54 from each one of the cord ends to expose the four conductors 53—53 therein.

Following the retraction of the part transfer devices 179 and 192, the continued operation of the motor 402 causes the camming mechanism 401 to close the contact 426. The closing of the contact 426 energizes

a solenoid 427 which opens an air valve 527 to cause pneumatic pressure to be applied to the air cylinder 137 to extend the piston rod and cause the workholder 72 associated with assembly position No. I to be rotated counterclockwise as viewed in FIG. 8 into the plug assembly position (see FIG. 2D). With the contact 426 cammed closed, the motor 402 then cams closes a switch 431 to energize a solenoid 432 and thereby causes an air valve 532 to apply pneumatic pressure to the cylinder 216 to move the arms 218—218 in engagement with the flange 166 to move the predetermined length L of jacket 54 along the cordage 51 (see FIG. 2E).

The separation of the jacket and the indexing and forming of the terminals 59—59 is followed by the anvil 210 being elevated to engage the part 57 with the stripped end of the cordage 51 (see FIG. 2F) to position the conductors 53—53 in the associated ones of the conductor-receiving troughs 58—58 therein. Also, the horn 209 is caused to be lowered to engage portions of the part 56 with portions of the part 57 and to bond ultrasonically the parts together. When the welds are completed, the locking mechanisms (not shown) are actuated to lock the bonding heads in position to facilitate the application of forces thereto during the insertion of the terminal blades 59—59 and the cutoff of the excess lengths of the conductors 53—53.

In order to accomplish this sequence of steps, the continued operation of the motor 402 causes a switch 436 to be cammed closed, thereby energizing a solenoid 437 and opening an air valve 537 causing pneumatic pressure to be applied to the cylinder 272 to cause the lever 268 (FIG. 15) to be turned to move the anvil 210 vertically upward. At the conclusion of this movement, the part 57 is engaged with the stripped cord end (FIG. 2F). While the switch 437 remains closed, the motor 402 causes a switch 441 to be cammed closed to energize as associated solenoid 442. This opens an air valve 542 to cause pneumatic pressure to be supplied to a cylinder to cause the horn 209 to be moved downwardly to engage the vacuumly held part 56 with the stripped cordage 51 and with the part 57 supported on the anvil. The bonding facilities 74 are then operated to weld ultrasonically the part 56 to the part 57. Facilities (not shown) are then caused to be operated to lock the bonding heads 209—209 in the welding position.

In the next step of the method of operation which embodies the principles of this invention, the insertion rams 263—263 are raised to insert the previously formed blade-like terminals 59—59 held within the laterally confined passageways 262—262 in the die block. The terminals 59—59 are inserted in the grooves 61—61 in the part 57 such that the tangs thereof establish electrical contact with the conductors 53—53. The continued operation of the motor 402 cam-closes a switch 446 to energize a solenoid 447 to open an air valve 547. This causes the operation of the air cylinder 276 to move the rod 274 (see FIG. 15) to the left to move the insertion rams 263—263 upwardly. The terminals 59—59 are hence moved into and seated in the terminal-receiving grooves 61—61 in the plug part 57.

Subsequently, on the same upward motion of the bar 264–264 and rams 263—263, the blade 293 is extended and exposed and moved into engagement with the cutoff ledge 62 of the plug 52 to sever the excess lengths of the conductors 53—53 extending therepast.

Thereafter, a switch 451 is cammed closed to energize a solenoid 452 which opens an air valve 552. This causes pneumatic pressure to be applied to the cylinder 309 to sweep the fingers 301—301 past the cordage 51 carrying therewith the severed conductor ends and jacket. In the alternative, the cylinder 309 of the alternate embodiment shown in FIG. 13F may cause retraction of the hinge 314 to clamp the fingers 313—313 about the jacket. Its continued withdrawal causes the jacket to be removed together with excess conductor lengths.

The continued operation of the motor 402 causes the switches to be opened to lower the rams, raise the horn 209, lower the anvil 210, and withdraw the welder locks (not shown) and return the shearing assembly 228 to the right as viewed in FIG. 14. Also, the switches are opened to close the associated air valves and return the apparatus to the unoperated condition with the workholders 72—72 rotated to the cord-transfer position where the finished cords are released from the workholders by the camming of the follower 145 (see FIG. 8A).

At this time, the motor 402 continues to a final portion of its cycle of rotation to cause a cam closing of a switch 456. This energizes a solenoid 457 to operate an air valve 557 to cause pneumatic pressure to the cylinder 229. The rod 231 which is in an extended position from the previous cycle of operation is retracted until the pawl 239 is in engagement with the next successive ones of the partially formed terminals 59—59. Simultaneously, the operation of the motor 402 closes a switch 461 to energize a solenoid 462. This causes an air valve 562 to apply pneumatic pressure to the cylinder 261 to move the shearing assembly 228 to the right as viewed in FIG. 14. This movement aligns the slots 259—259 in the shearing assembly 228 with the passageways 262—262 in the anvil 210.

As the motor 402 continues to rotate, the circuit 400 causes the air valve 557 to control the cylinder 229 to extend the rod 231 to move the housing 233 and trackway 206 to index the strips 222—222 to the left as viewed in FIG. 15. This moves leading ones of the partially formed terminals 59—59 through the slots 239—239 in the shearing assembly 228 and into the now aligned, partially enclosed passageways 262—262 in the anvil 210. Also, the air valve 562 controls the cylinder 261 to move the shearing assembly 228 in a direction opposite to the prior movement to shear the leading ones of the terminals 59—59 from the strips 222—222. This movement completes the lateral enclosure of the passageways 262—262 in the anvil 210 in preparation for the terminal insertion in the next cycle of operation.

It is to be understood that the above-identified embodiments are simply illustrative of the invention and thay many other embodiments can be devised without departing from the scope and sprit of the invention.

What is claimed is:

1. A method of assembling one dielectric part with another dielectric part about an end portion of a jacketed cord such that blade-like terminals receivable in a plurality of terminal-receiving grooves in the one part establish electrical contact with conductors in the cord, which includes the steps of:

inserting an end portion of the cord into a workholder;

moving leading ones of pluralities of the dielectric parts along separate paths into vertical alignment with each other in an assembly position;

moving the workholder to position the cord conductors thereof in essentially vertical alignment with the grooves in the one part;

exposing the portions of the conductors in alignment with the grooves while maintaining the alignment;

moving the dielectric parts into engagement with each other and with the cord such that the conductors are received within the grooves;

bonding together the dielectric parts at a bonding position to form a dielectric housing; and

moving terminals into the grooves while the housing is in the bonding position to seat the terminals in the housing to complete the assembly and establish electrical contact with the aligned conductors.

2. A method of assembling a plug comprised of a base and a top, the top having a plurality of conductor-receiving troughs and a plurality of associated terminal-receiving grooves aligned and communicating with the troughs with an end portion of a multi-conductor cord such that blade-like terminals receivable in the grooves establish electrical contact with conductors in the cord, which includes the steps of:

advancing strips of partially formed terminals connected end to end to move a leading one thereof into insertion positions aligned with the grooves in the top;

confining a leading edge and two side surfaces of each leading one of the terminals;

shearing the leading one of the partially formed terminals from each of the strips to define and produce individual terminals each having a trailing edge; while

confining the leading ones of the terminals along the trailing edges thereof to support completely laterally the terminals and provide a laterally closed path of movement for the terminals;

inserting an end portion of the cord into a transfer device;

moving the transfer device to a cord transfer position whereat the end portion of the cord is transferred to a workholder;

applying clamping forces to the cord end to retain the cord end in the workholder;

moving leading ones of a supply of bases and tops along separate paths into vertical alignment with each other into a plug assembly position;

moving the workholder rotatably into the plug assembly position to align vertically the cord and conductors with the troughs in the top;

moving the base and the top into engagement with each other and with the cord such that the conductors are received in the troughs;

bonding the top to the base;

engaging a free edge of each leading one of the terminals and then moving the terminals along the paths into the aligned grooves and into electrical engagement with the associated conductors therein; and

returning the workholder to an initial position and removing the clamping forces to release the assembled cord and plug from the workholder.

3. The method of claim **2,** wherein the cord includes a plurality of individually insulated conductors enclosed by a jacket, which also includes:

separating, the jacket of an end portion of the cord from the adjacent portion of the jacket to expose the individually insulated conductors; and

severing, subsequent to the insertion of the terminals, excess lengths of the conductors protruding beyond the plug.

4. The method of claim **3,** wherein the separating of the jacket of an end portion of the cord from the remainder includes:

cutting circumferentially the jacket when the end portion of the cord is transferred to the workholder; and

moving subsequent to positioning the cord and conductors in vertical alignment with the base and top axially the jacket between the circumferential cut and the adjacent free end of the cord a distance less than the distance from the adjacent free end of the conductors to the circumferential cut;

the movement designed to retain the severed jacket in engagement with the ends of the conductors to maintain the conductors spaced apart to facilitate receipt thereof into the troughs.

5. An apparatus for assembling one dielectric part with another dielectric part about an end portion of a cord such that blade-like terminals receivable in a plurality of terminal-receiving grooves in the one part establish electrical contact with conductors in the cord, which includes;

a workholder for holding an end portion of a cord;

means for inserting an end portion of the cord into the workholder;

means for moving leading ones of pluralities of the dielectric parts along separate paths into vertical alignment with each other in an assembly position;

means for moving the workholder to position the conductor thereof in essentially vertical alignment with the grooves in the one part and for exposing portions of the conductors aligned with the grooves while maintaining the conductors aligned with the associated grooves;

means for moving the dielectric parts into engagement with each other and with the cord such that the conductors are maintained in alignment within the grooves;

means for bonding together the dielectric parts at a bonding position to form a dielectric housing; and

means operated while the bonding means engages the parts for moving terminals into the associated grooves to seat the terminals in the housing to complete the assembly and establish electrical contact with the aligned conductors.

6. An apparatus for assembling a plug comprised of a base and a top, the top having a plurality of terminal-receiving grooves aligned and communicating with a plurality of conductor-receiving troughs with an end portion of a multi-conductor cord such that blade-like terminals receivable in the grooves establish electrical contact with conductors in the cord, which includes:

means for advancing a plurality of strips of partially formed terminals connected end to end to move leading ones thereof into insertion positions aligned with grooves in the top;

means for confining a leading edge and two side surfaces of each leading one of the terminals;

means for shearing the leading ones of each of the partially formed terminals from the strips to define and produce individual terminals each having a

trailing edge and to confine the leading ones of the terminals along the trailing edges thereof to support completely laterally the terminals and provide a laterally closed path of movement for the terminals;

a workholder including a shearing blade for holding an end portion of the cord;

a transfer device receiving and end portion of the cord for inserting an end portion of the cord into the workholder, the transfer of the end portion of the end portion of the cord from the transfer device to the workholder causing the shearing blade to sever the jacket at a first distance from the free end of the cord to facilitate the subsequent removal of a portion of the jacket from the end portion of the cord;

means for moving leading ones of a supply of bases and tops along separate paths into vertical alignment into a plug-assembly position;

means for moving the workholder into the plug-assembly position to position the conductors thereof in essentially vertical alignment with the troughs in the top;

means for moving the base and the top into engagement with each other and with the cord such that the conductors are received in the troughs;

means for bonding the top to the base to form a dielectric housing; and

means operated while the housing is in the plug-assembly position for engaging a free edge of each leading one of the terminals and then moving the terminals along the paths into the aligned grooves and into electrical engagement with the associated conductors therein to complete the assembly of the plug.

7. The apparatus of claim **6,** wherein the subsequent moving of the workholder into the plug-assembly position is rotational and further the workholder includes:

means for applying clamping forces to the cord end to retain the cord therein;

means operated subsequent to the insertion of the terminal blades for returning the workholder to an initial position; and

means rendered effective as the workholder is returned to the initial position for removing the cord clamping forces to release the cord from the workholder.

8. The apparatus of claim **6,** wherein the cord includes a plurality of individually insulated conductors enclosed by a jacket and, which also includes:

means for separating, subsequent to the positioning of the cord in vertical alignment with the base and cover, the severed jacket of the end portion of the cord from the adjacent portion of the jacket to expose the conductors;

means operated prior to inserting the terminals for locking the bonding means in engagement with the dielectric housing; and

means operated subsequent to the insertion of the terminals for severing excess lengths of conductors protruding beyond the housing.

9. The apparatus of claim **8,** wherein the means for separating the jacket includes:

means for moving axially the severed portion of the jacket a second distance less than the first distance whereby the severed jacket maintains the conductors spaced apart to facilitate receipt thereof in the troughs.

10. An apparatus for assembling mating dielectric parts to an end of a jacketed multi-conductor cord and for providing electrical access to each of the conductors, which comprises:

a transfer device for receiving an unfinished cord end;

ultrasonic means including an aligned horn and anvil for bonding together mating dielectric parts;

means for advancing in seriatim parts of mating dielectric parts into engagement with the horn and the anvil which in an unoperated condition are spaced apart;

a workholder mounted rotatably for receiving the cord end from the transfer device at a transfer position;

means for causing the transfer device to transfer the cord end to the workholder at a transfer position and for operating the advancing means to transfer each leading one of one of the mating parts to the anvil and the leading one of the other mating parts to the horn;

means operated subsequent to the advancing of the mating parts for turning the workholder into an assembly position to position the cord end in vertical alignment with the mating spaced aligned parts and for separating the jacket of an end portion of the cord from the adjacent portion of the jacket to expose the individually insulated conductors of the end portion of the cord;

means for moving the horn and the anvil to mate the parts in engagement with the end portion of the cord and to bond together the parts;

means for inserting terminals in grooves in the one part and into electrical engagement with the conductors therein;

means for severing excess lengths of the exposed conductors extending beyond the mated bonded parts;

means for returning the workholder to the transfer position; and

means operated upon the return of the workholder to the transfer position for releasing the cord end.

11. The apparatus of claim **10,** wherein the workholder also includes cord clamping means which upon rotation of the workholder into the assembly position is caused to clamp the cord end to facilitate removal of the jacket therefrom and which upon return of the workholder to the transfer position is caused to release the cord end.

12. The apparatus of claim **10,** which also includes means operated subsequent to the conductor exposure and the conductor severance for removing a portion of the jacket and excess conductor lengths from the apparatus.

13. The apparatus of claim **10,** wherein the anvil has a plurality of passageways aligned with the grooves in the one part to permit passage therethrough of the terminals into the one part, which also includes:

means operated subsequent to the return of the workholder to the cord-transfer position for advancing incrementally each of a plurality of strips of terminals to position leading ones thereof in the passageways in the anvil and for severing leading ones of each strip in preparation for insertion thereof during the next cycle of operation.

14. The apparatus of claim 11, wherein the one part also includes a plurality of conductor-receiving troughs aligned with associated ones of the grooves and the means for separating the jacket includes:

means for cutting circumferentially the jacket at a first distance from the free end of the cord; and

means for moving axially the severed portion of the jacket a second distance less than the first distance to expose the conductors and to maintain the conductors aligned with the troughs.

15. The apparatus of claim 14, which also includes means effective upon the return of the workholder to the transfer position for conditioning the jacket removing means for another cycle of operation.

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