United States Patent [19]

Hardesty

[11] **3,860,316**

[45] **Jan. 14, 1975**

[54] **ELECTRICAL CONNECTING DEVICES FOR TERMINATING CORDS AND METHODS OF ASSEMBLING THE DEVICES TO CORDS**

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

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[21] Appl. No.: **377,154**

[52] **U.S. Cl.** ..... **339/91 R,** 339/99 R, 339/103 M, 339/176 MF

[51] **Int. Cl.**..... **H01r 13/54**

[58] **Field of Search** .... 339/91, 97, 98, 99, 176 MF, 339/103, 107

[56] **References Cited**

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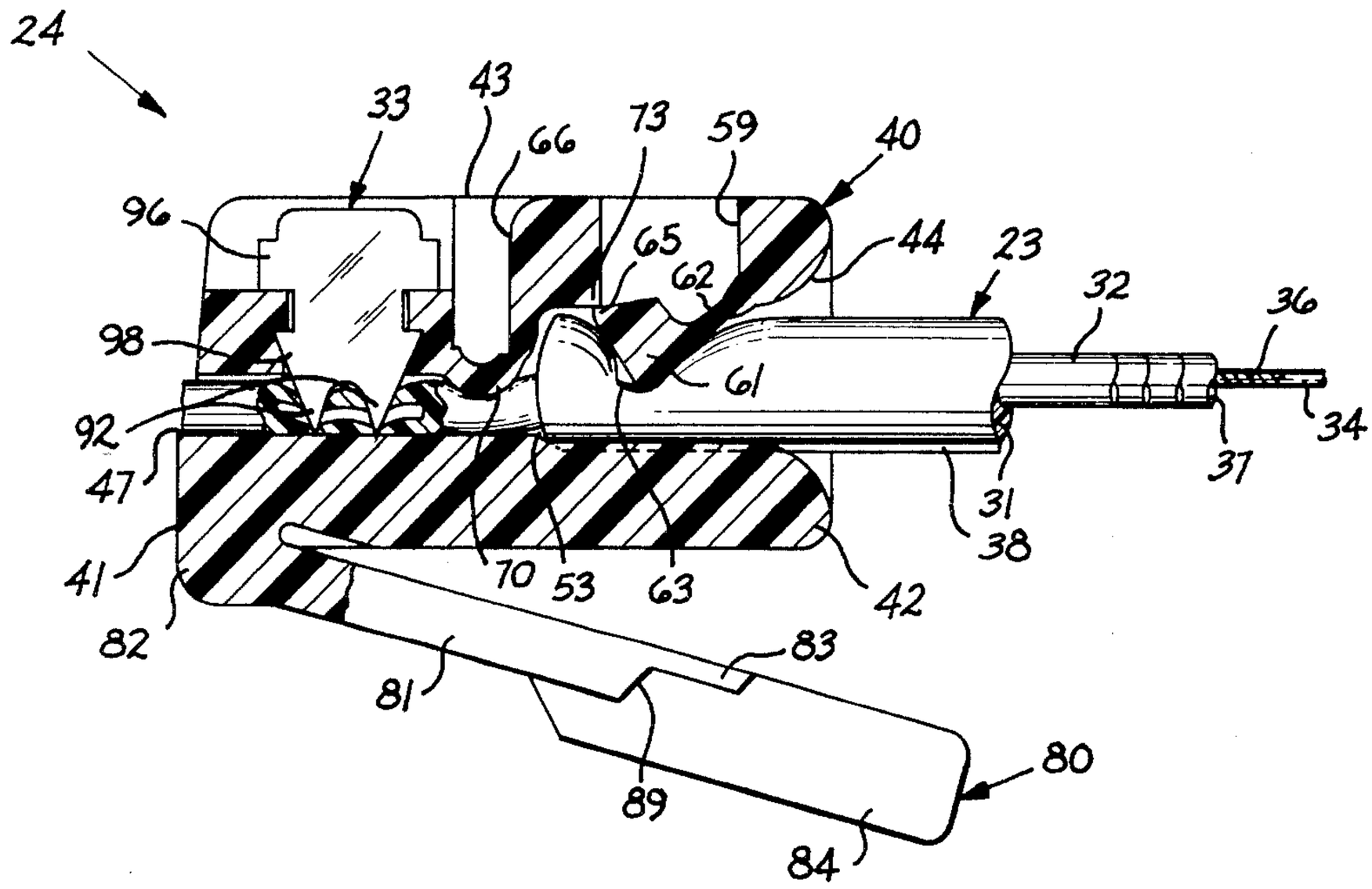
3,761,869	9/1973	Hardesty et al.	339/99 R

Primary Examiner—Roy D. Frazier
Assistant Examiner—Robert A. Hafer
Attorney, Agent, or Firm—E. W. Somers

[57] **ABSTRACT**

A one-piece plug for terminating a cord to connect electrically the cord to components in a telephone apparatus is constructed with features advantageous to the assembly of the cord with the plug. The plug has a dielectric housing molded with a cord-input aperture in the one end thereof. The jacket is removed from a leading portion to expose individually insulated conductors. Then an end portion of the cord is inserted into the cord-input aperture in the housing until individual conductors are received in conductor-receiving troughs and until the leading end of the jacket abuts a shoulder formed internally of the housing. Forces are applied to a jacket anchoring member formed integrally of the housing to partially disconnect it from the housing and move it into engagement with the jacket. Another portion formed integrally with the housing is reformed into a strain relief element in engagement with the conductors to provide strain relief for the conductors. Flat blade-like terminals are inserted into the dielectric housing to move internal contacting portions thereof through the insulation and into engagement with the conductors. External contacting portions of the terminals engage associated components of the telephone apparatus when the plug is inserted thereinto.

23 Claims, 12 Drawing Figures



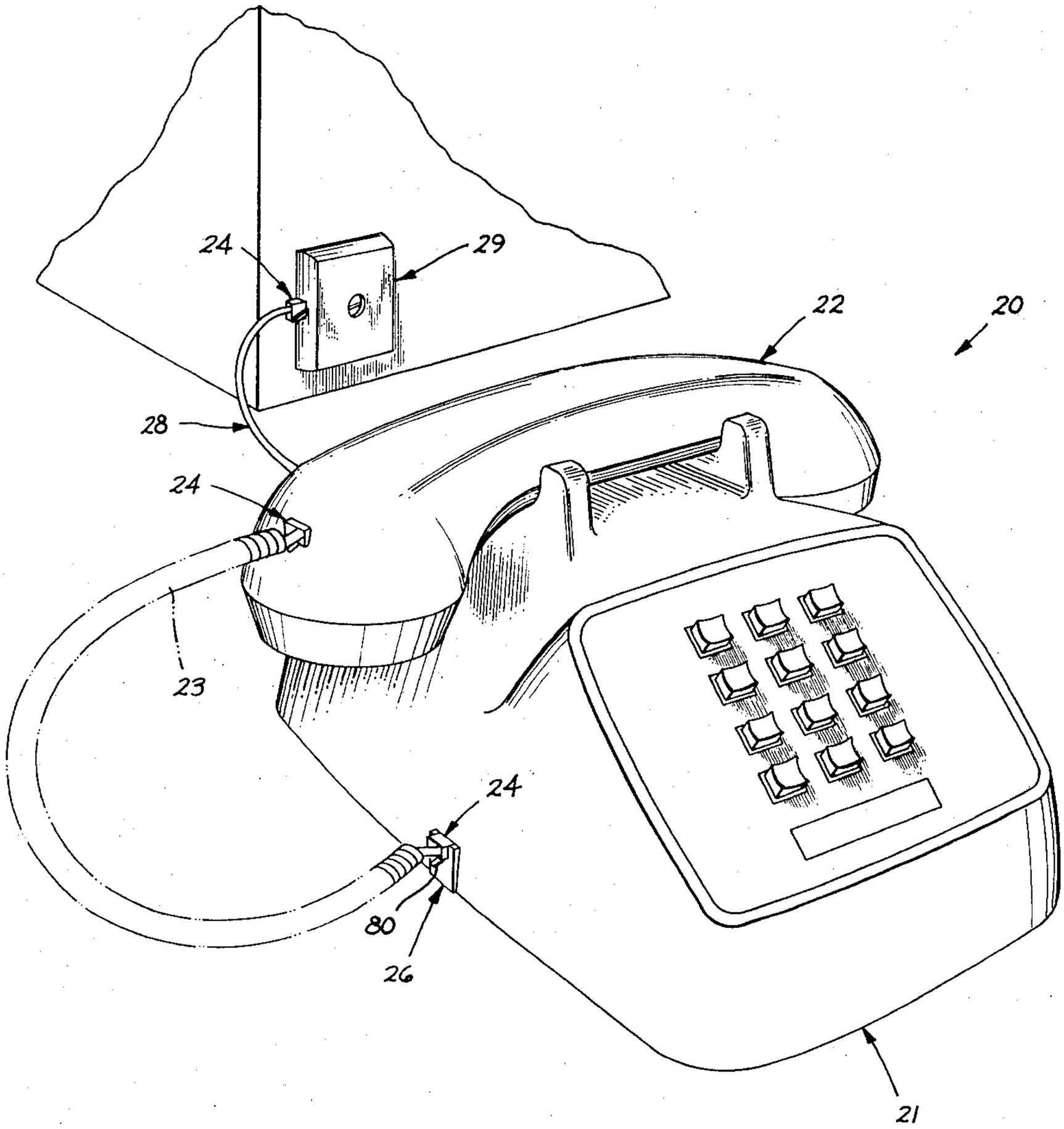


FIG. 1

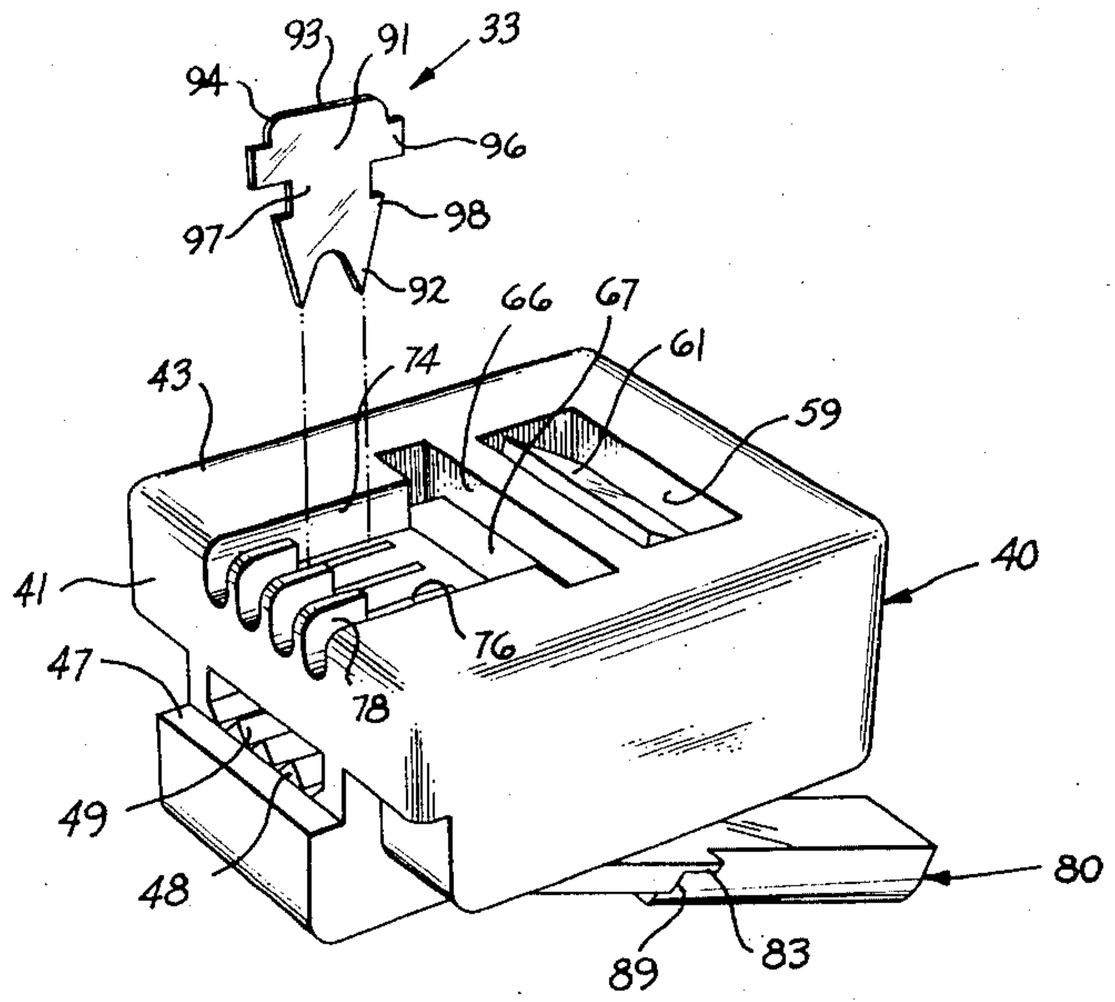

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FIG. 2

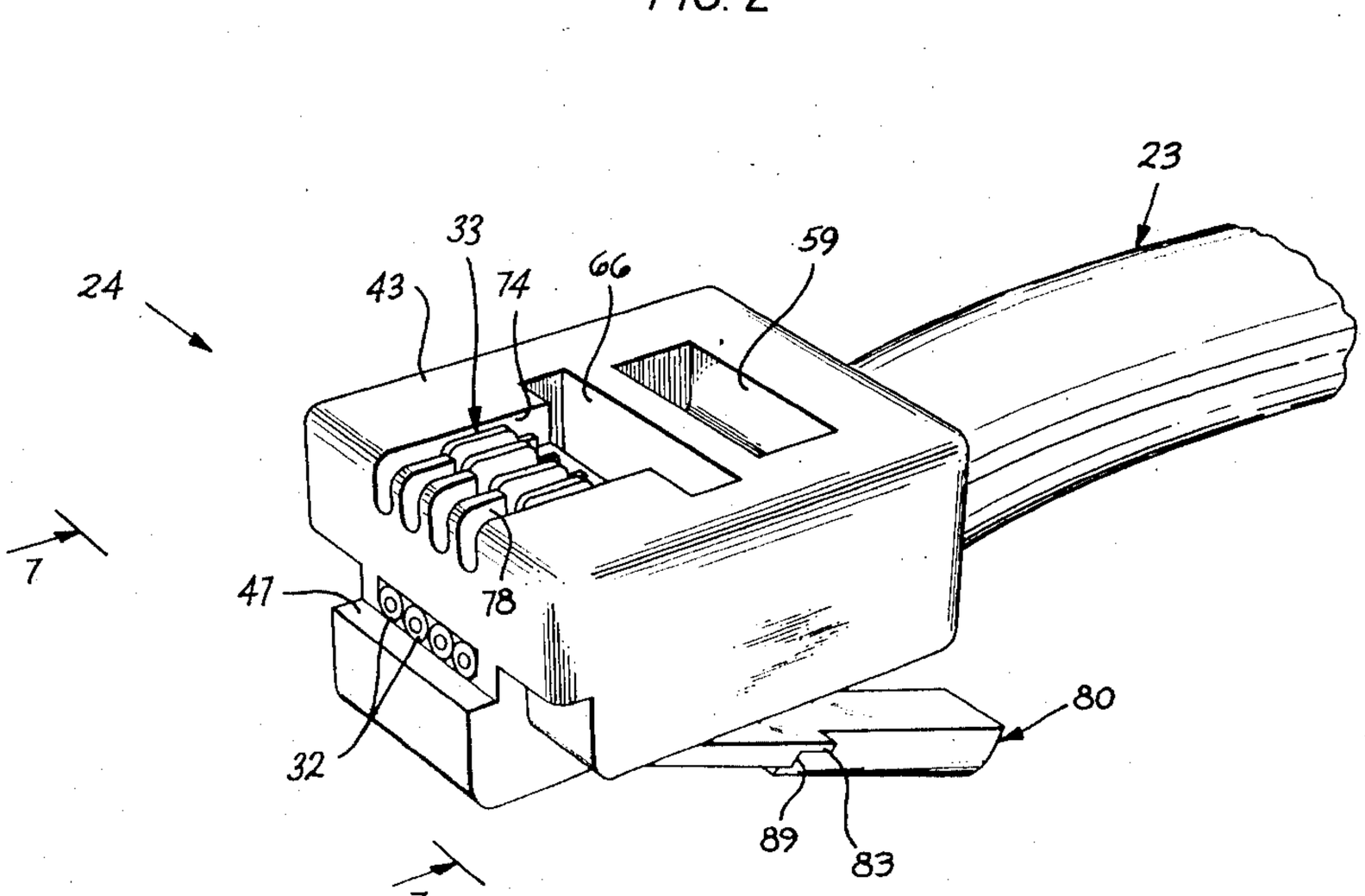
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FIG. 3

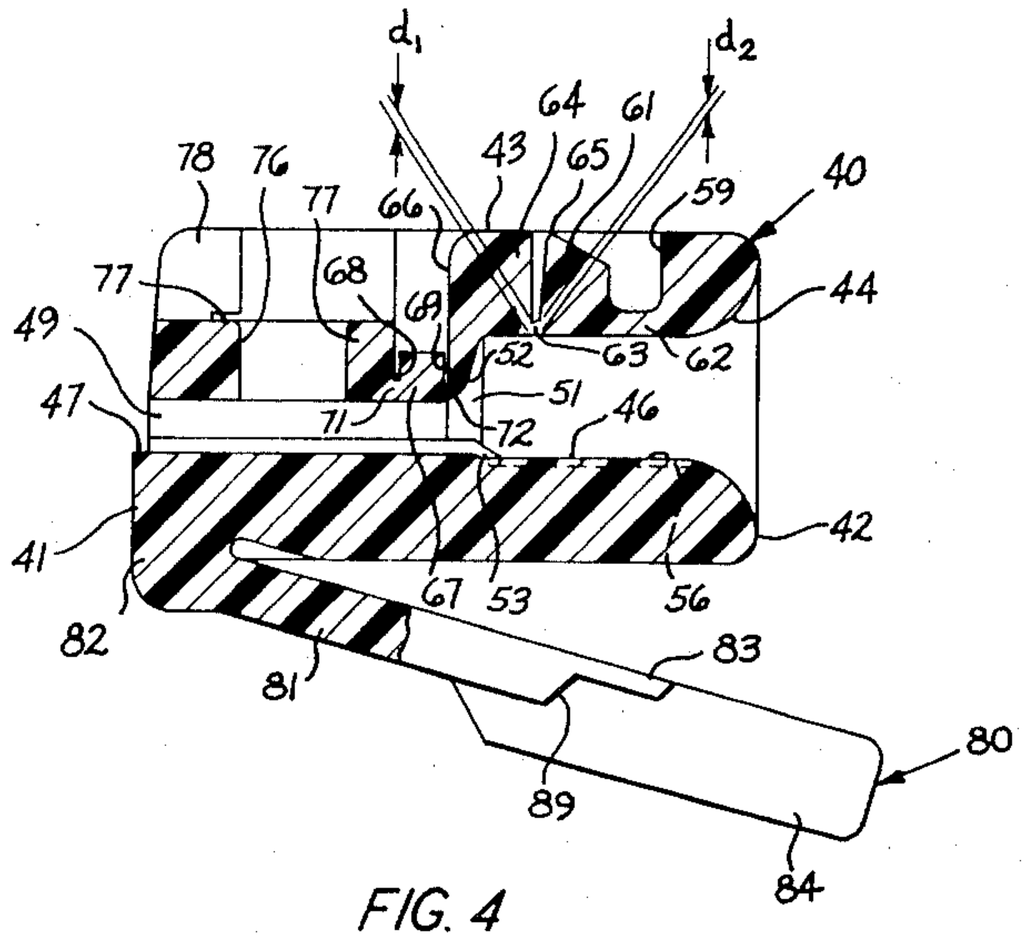

FIG. 4

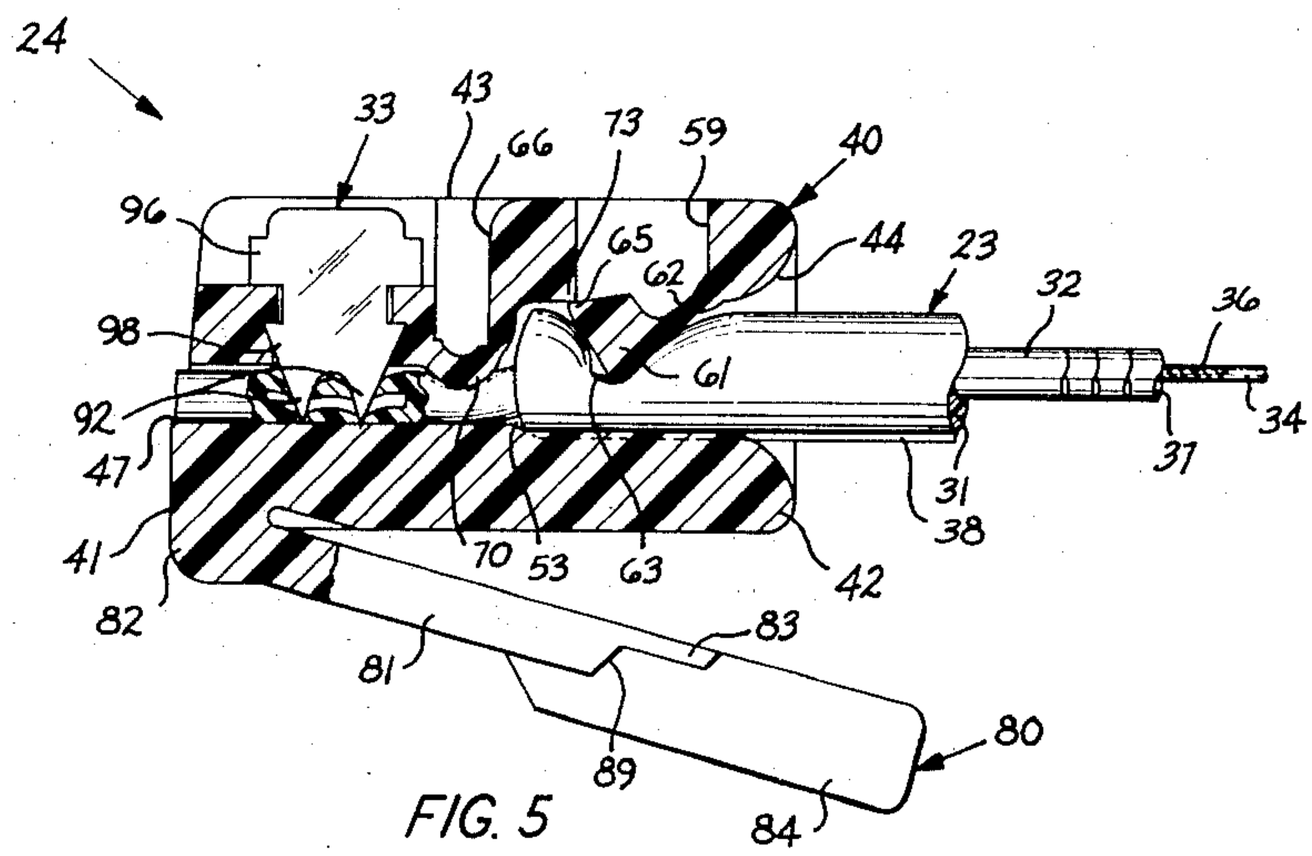

FIG. 5

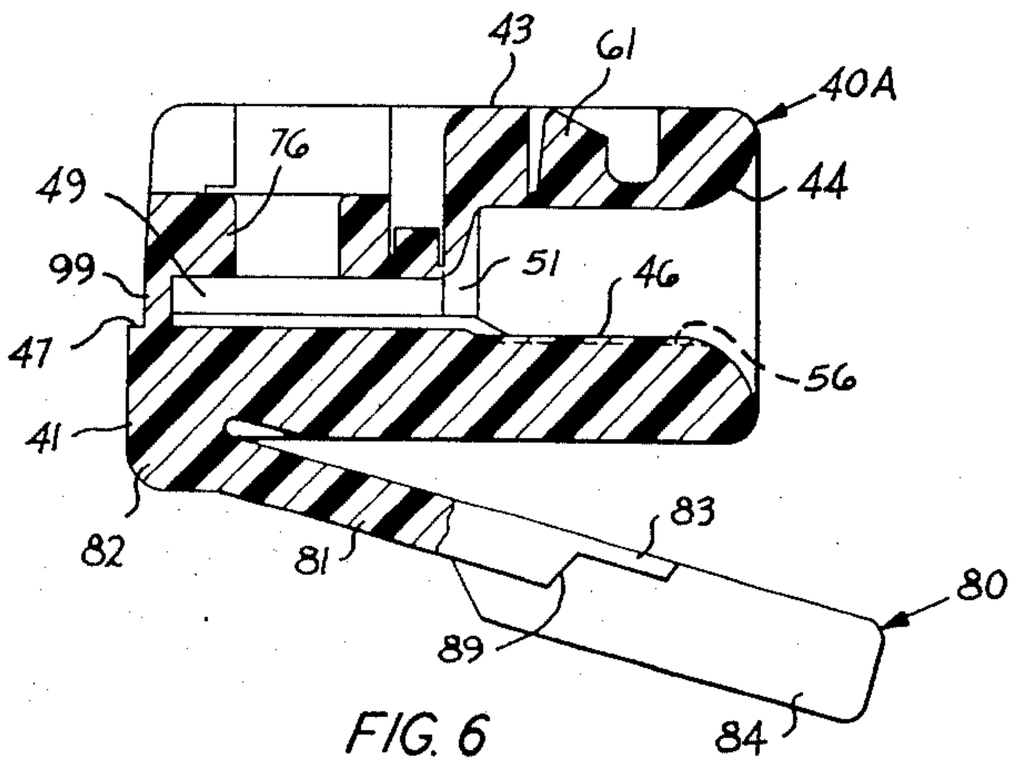

FIG. 6

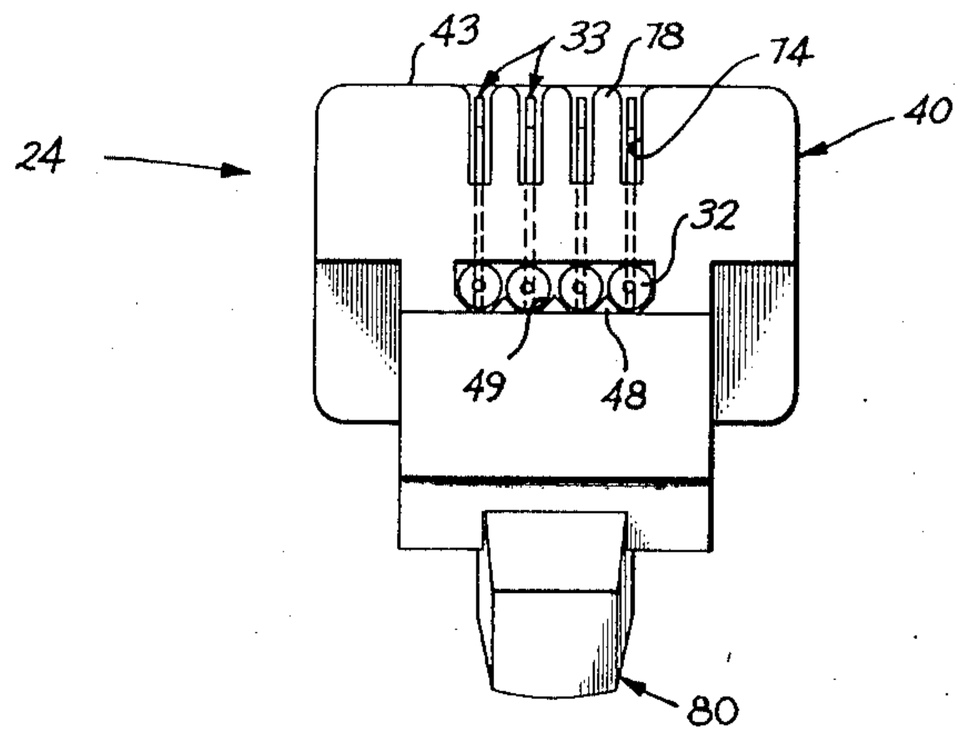

FIG. 7

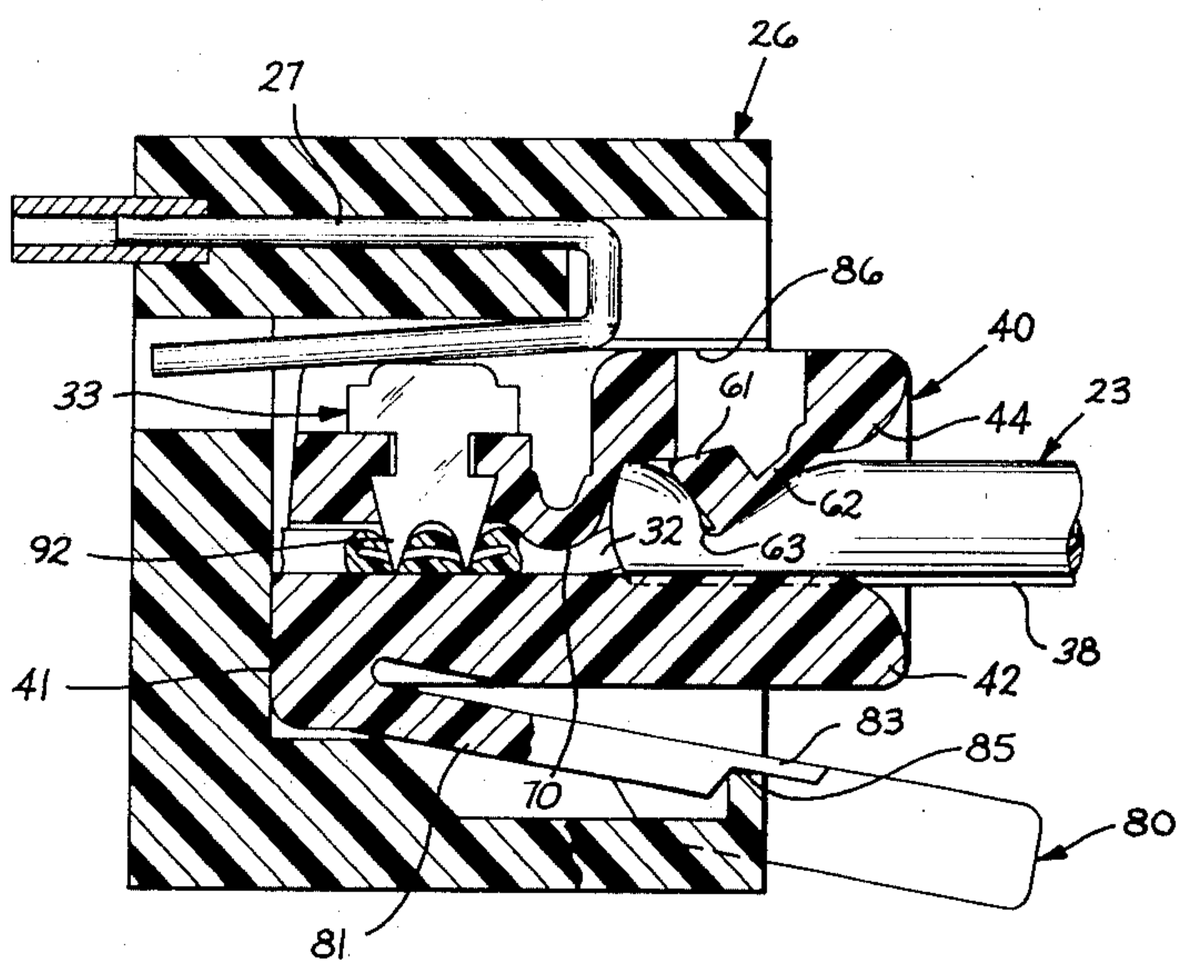

FIG. 10

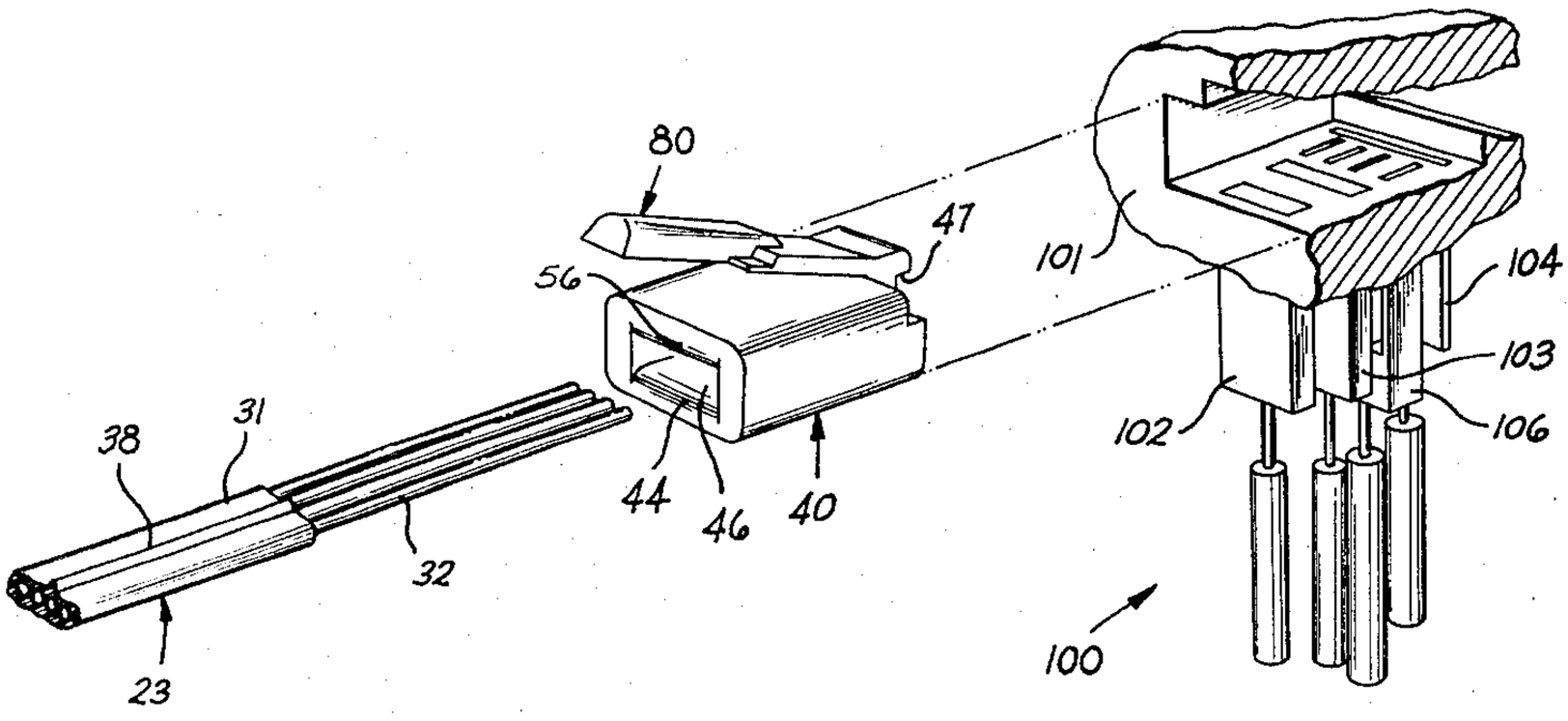

FIG. 12

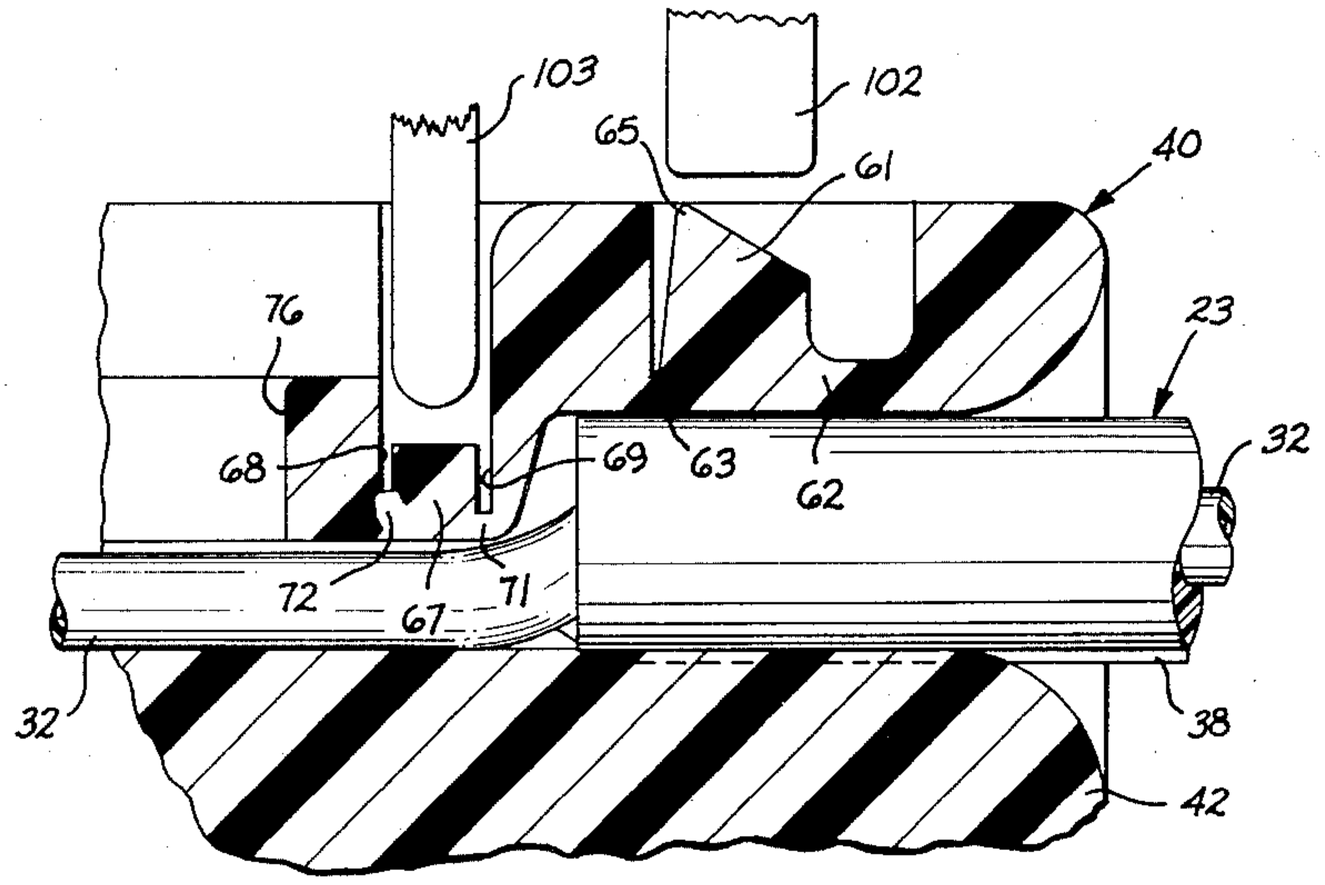

FIG. 8

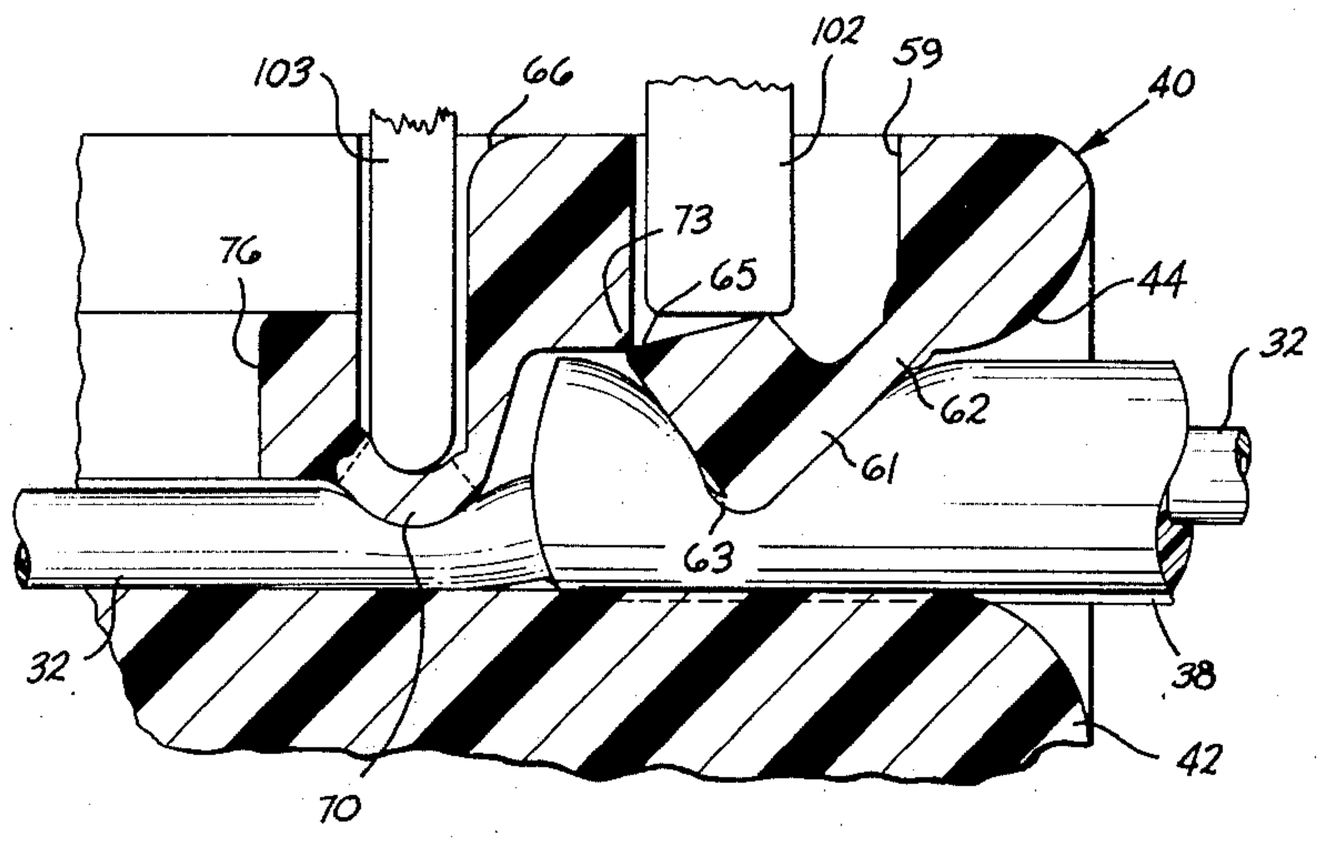

FIG. 9

FIG. 11

ELECTRICAL CONNECTING DEVICES FOR TERMINATING CORDS AND METHODS OF ASSEMBLING THE DEVICES TO CORDS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical connecting devices for terminating cords and methods of assembling the devices to cords, and more particularly, to devices for making electrical connections between a cord comprising flexible conductors and terminals wherein conductive terminals are combined with one-piece dielectric members to form plugs and methods of assembling the cord and the devices.

2. Description of the Prior Art

In the telephone industry, increasing use is being made of modular plug type connectors on straight and retractile handset and line cords which are used between the base and a handset of a telephone and between the base and a wall terminal block. In the presently used plugs, a terminal is applied to each of a plurality of insulated conductors contained within a jacketed length of a retractile cordage. These terminals are mounted within a dielectric structure which is attached securely to the associated cordage. The dielectric portions of the plugs, which are mounted on both ends of a length of cordage, cooperate with receptacles in the handset and in the base of the telephone to properly align the terminals of the plug with mating terminals within the components of the telephone.

One presently used plug is disclosed in U.S. Pat. No. 3,699,498 issued on Oct. 17, 1972 in the names of E. C. Hardesty, C. L. Krumreich, A. E. Mulbarger, Jr. and S. W. Walden. In this disclosure, conductors are confined in conductor-receiving troughs formed in a dielectric base by a cover bonded to the base. Flat terminals are then inserted into individual grooves in the base in a side-by-side arrangement with contact portions thereof extending into engagement with the conductors. When the plug is inserted into a jack of a telephone handset, portions of the terminals in the jack engage portions of associated terminals in the plug.

Provisions in the just-identified plug for contacting the external component may be changed to that described in a continuation-in-part application Ser. No. 232,803 filed on Mar. 8, 1972 in the names of E. C. Hardesty, C. L. Krumreich, A. E. Mulbarger, Jr. and S. W. Walden. There, the external contact portions of the terminals of the plug consist of an edge exposed to the exterior of the dielectric enclosure.

Of course, the terminals in the plugs are aligned with the contact elements in the jack in the telephone handset. The cord conductors in the just described system are aligned with the terminals.

The recent trend to the use of plug-in type connectors in telephone handsets as exemplified by that shown in U.S. Pat. No. 3,617,982 has been accompanied by the use of flat telephone cords. The use of flat cords leads toward increased manufacturing economies provided that the plug is designed with regard for a flat cord system.

As an alternative to the bonding together of the portions of the dielectric housing in using the plug, it would be desirable to have a one-piece plug, into which a telephone cord end may be inserted and secured and subsequently engaged by flat terminals moved into terminal-receiving openings in the plug. Such a plug would also yield manufacturing economies.

SUMMARY OF THE INVENTION

This invention provides electrical connecting devices for terminating cords. A dielectric portion of the device can be fabricated in one-piece by using conventional molding techniques. The device may be assembled to a line cord or to a retractile cord either before or after the cord is heat treated to achieve retractile properties.

An electrical connecting device which embodies the principles of this invention is molded to include a one-piece or unipartite dielectric housing which includes a cavity that opens to at least one end of the housing for receiving an end section of a telephone cord. Unipartite or one-piece as used to describe the housing is intended to define the housing as not divided or divisible into parts. Moreover, the housing is molded so that no securing, including bonding, nor moving of hinged or otherwise moveable parts is necessary to form the cavity. The surfaces of the housing as molded define the cavity and substantially enclose the end portion of the cord. The plug is molded with a plurality of terminal-receiving openings communicating with the cavity and with the exterior of the connector. The housing is formed with at least one portion moveable at least partially into the cavity for engaging portions of the cord to secure the cord within the housing to prevent unintended movement of portions of the cord. Terminals positioned within associated ones of the terminal-receiving openings each includes a first contact portion extending into the cavity for making electrical engagement with the associated conductor in the cavity and a second contact portion positioned within the associated terminal-receiving opening for making electrical contact external to the connector.

A method embodying the principles of this invention for assembling connecting devices to cords for connecting electrically individual conductors which comprise the cord to associated components external to the device includes holding the housing and exposing individual insulated conductors of a predetermined length of a leading portion of the cord by removing the jacket therefrom. Then the leading portion of the cord is inserted into a cord-input aperture of the device and advanced to position the exposed conductors in conductor-receiving troughs. Forces are applied to portions formed integrally with the dielectric housing to move the portions to engage the jacket and the conductors to secure the cord within the device and provide strain relief for the jacket and the individual conductors. Terminals are inserted into openings in the device such that first contact portions extend into the troughs and pierce the insulation to establish an electrical connection with the conductors and to expose second contact portions of the terminals for engagement with external components.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features of the present invention will be readily understood from the following detailed description of specific embodiments thereof when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view showing plugs which embody the principles of this invention inserted into a handset and base portion of a telephone set and into a wall terminal;

FIG. 2 is a perspective view of one of the plugs prior to assembly of a cord and terminals therewith for purposes of clarity and further showing an internally movable jacket strain relief member of the plug prior to movement thereof;

FIG. 3 is a perspective view of the plug shown in FIG. 2 with terminals inserted into the plug and with the jacket strain relief member having been moved into engagement with the cord which has been inserted into the plug;

FIG. 4 is an elevational view of a housing of the plug partially in section prior to the assembly of the cord and terminals therewith;

FIG. 5 is an elevational view partially in section showing the jacket strain relief member of the plug after having been moved into engagement with the jacket of the cord to provide strain relief for the cord and a portion of the housing having been reformed into a strain relief member in engagement with the conductors and also showing the terminals inserted;

FIG. 6 is an elevational view showing an alternate embodiment in which one end of the plug housing is closed;

FIG. 7 is a front end view of the plug shown in FIG. 3 and taken along lines 7—7 thereof;

FIGS. 8 and 9 are enlarged detail views in elevation showing the use of tools to move the jacket strain relief member and to form the conductor strain relief member and with the tools and plug in an inverted position from that normally used for this operation;

FIG. 10 is an elevational view partially in section and showing the plug inserted into a jack in a telephone set;

FIG. 11 is an enlarged detail view of a portion of latching facilities of the plug in engagement with surfaces of a jack in the telephone set; and

FIG. 12 is a perspective view of an apparatus which may be used to carry out the steps of the methods of this invention.

DETAILED DESCRIPTION

1. Overall

Referring now to FIG. 1, there is shown a telephone, designated generally by the numeral 20, which includes a base portion, designated generally by the numeral 21, and a handset portion, designated generally by the numeral 22. A retractile cord, designated generally by the numeral 23, interconnects the base portion 21 and the handset portion 22.

Each end of the retractile cord 13 is provided with a plug, designated generally by the numeral 24, designed to be inserted into a jack 26. One of the plugs 24—24 is inserted into one of the jacks 26—26 assembled to the handset end and the other plug of the retractile cord 23 inserted into a jack in the base of the telephone 20. The plug 24 has facilities for establishing electrical connections between the cord 23 and internal contacting components 27—27 of the telephone 20 (see FIG. 10). Ones of the plugs 24—24 are also assembled to each end of a line cord, designated generally by the numeral 28 (see FIG. 1), for connecting the line cord to jacks 26—26 in the telephone base and in a wall terminal block 29.

Referring now to FIG. 5, a more detailed view of the structure of the retractile cord 23 can be seen. The retractile cord 23 includes a jacket 31 covering a plurality of insulated conductors 32—32. A free end portion of each of the conductors 32—32 is designed to be connected to an associated one of a plurality of terminals, designated generally by the numerals 33—33. Each of the conductors 32—32 is constructed of a nylon core 34 having a tinsel ribbon 36 wrapped helically thereabout. The tinsel ribbon 36 has a nylon insulation covering 37 extruded thereabout with a ridge 38 formed longitudinally thereof. The outside nominal diameter of the individual insulated conductors 32—32 is approximately 0.037 inch.

Miniature plugs constructed in accordance with the present inventions permit the expeditious connection of cord ends to the completed dielectric portion of the plugs rather than to a dielectric subassembly which must then be assembled to at least one other subassembly. This avoids having to maintain the cord 23 in a predetermined position in the subassembly while assembling the dielectric portion of the plug.

2. Dielectric Portion

The detailed construction of a plug 24 is shown in FIGS. 2, 4 and 7. A rigid, dielectric unpartite housing, designated generally by the numeral 40, is designed to be easily molded by using conventional injection molding techniques. The rigid, dielectric housing 40 has a free end 41, a cord-input end 42, and a terminal-receiving side 43 (see FIG. 4).

It may be observed from FIGS. 4 and 5 that the housing 40 is formed with a cord input aperture 44 which circumscribes substantially the portion of the jacket 31 of the cord 23 extending therethrough. As may be appreciated from the drawing, the housing 40 is constructed in one-piece with the cord input aperture 44 formed entirely therewithin. The aperture 44 has a flared entrance which prevents sharp bends in the cord 23 about an otherwise sharp edge during use of the telephone 10 by the subscriber. This advantageously increases the life of the cord 23. The flared entrance also facilitates insertion of a leading end of the cord 23.

The cord input aperture 44 opens to a cavity 46 (see FIG. 4) which partially terminates in a ledge 47 at the free end 41 of the base of the housing 40. The cavity 46 substantially encloses the entire end section of the cord which is inserted into the aperture 44 and is completely formed as molded. No further securing together of parts such as by bonding or moving of hinged parts with subsequent bonding together is required to form the cavity 46.

The formation of a one-piece housing 40 with the surfaces defining the cavity 46 substantially enclosing the entire end portion of the cord 23 facilitates holding the cord while other operations are performed by automated equipment. In prior art connectors, the cord 23 is generally positioned in a portion of a conductor-access opening formed in a base and then a lid bonded to the base. This, of course, will not suffice to hold the cord 23 in the base during assembly without additional steps and equipment. Moreover, problems have been experienced in consistently obtaining reliable bonds between the cover and the base.

As can best be seen in FIGS. 2 and 7, the cavity 46 is formed with a plurality of longitudinally extending partitions 48—48 which are molded with the dielectric housing 40. The partitions 48—48 are in the form of toothed ridges with a plurality of conductor-receiving troughs 49—49 formed therebetween on 0.040 inch centers and opening to the free end 41. The conductor-receiving troughs 49—49 are designed to receive associated ones of the conductors 32—32 (see FIG. 7).

Each of the troughs **49—49** is dimensioned so that the conductor **32** therein cannot move laterally. This is necessary to insure that during the insertion of the terminals **33—33,** the terminals remain aligned with the conductors **32—32** to make electrical engagement therewith.

It may be observed from FIG. **2** that the bottoms of the troughs **49—49** are substantially coplanar with the top surface of the ledge **47** at the free end **41.** This facilitates the use of the ledge **47** at the free end **41** as an anvil for conductor cut-off during assembly of the plug **24** to the cord **23.**

As can best be seen in FIG. **4,** the portion of the cavity **46** adjacent the cord-input end **42** communicates with the main portions of the conductor-receiving troughs **49—49** through a tapered transition section **51** having a shoulder **52.** The partitions **48—48** are constructed to extend along a sloping face **53** of the tapered transition section **51.**

After the jacket **31** of the cord **23** is stripped therefrom to expose a predetermined length of each of the insulated conductors **32—32,** the cord is inserted into the input aperture **44** until the conductors **32—32** are moved along associated ones of the conductor-receiving troughs **49—49** extending down the sloping face **53.** The portions of the partitions extending down the sloping face **53** assist in guiding the conductors **32—32** into the main portions of the troughs **49—49.** As the conductors **32—32** are moved up the face **53,** the jacketed portion of the cord **23** is being moved into the cavity **46.** When the cord **23** has been advanced such that the conductors **32—32** are received in the troughs **49—49,** the leading end of the jacket **31** is in engagement with the shoulder **52** (see FIG. **5**).

Also, as can be seen in FIG. **4,** the walls of the cavity **46** are formed to include a groove **56** longitudinally thereof. The groove **56** is designed to mate with the ridge **38** formed externally of the jacket to insure that the cord **23** is inserted properly into the plug **24.**

The housing **40** is also constructed with facilities for providing strain relief for the jacket and for the individual conductors **32—32.** This is one of the key features of the invention in that it permits the use of a one-piece molded plug rather than two parts assembled to the cord **23.** As can best be seen in FIG. **4,** the housing **40** is constructed with an opening **59** having a jacket-anchoring member **61** connected to a rear section of the plug through a plastic hinge **62.** Referring now to FIG. **2,** it is seen that the member **61** extends for only a portion of the width of the housing **40.** Moreover, the member **61** is connected at a forward end thereof by a very thin tapered web of dielectric material **63.**

The configuration of the connecting web **63** is very important. As can best be seen in FIG. **4,** the web **63** is constructed such that the dimension "d_1," adjacent a forward wall **64** is substantially less than the dimension "d_2" adjacent the main body of the member **61.** This has two functions. It insures that the web **63** is broken along the shearing plane along the dimension d_1. The shearing plane is a vertical plane adjacent the wall **64** along the thinnest portion of the web **63.** Secondly, the web **63** forms a rounded trailing edge (see FIG. **5**) of the hinged member **61** to be formed and wrapped in a clockwise direction, as viewed in FIG. **5,** of the cord **23.** In this way, there are no sharp burrs or edges to tear the material comprising the jacket **31.** Rather, the trailing end of the web **63** curls around, as seen in FIG. **5,** with the contour of the cord **23.**

The wrap-around effect of the web **63** permits the development of a more effective resistance of the cord **23** to forces imparted to the cord during customer use. If the member **61** were simply hinged initially without the web **63** and moved pivotally to engage the cord **23,** the member would bite into the jacket **31.** Then, during use, forces imparted to the cord **23** could cause a cutting of the jacket **31.** However, the use of the web **63** which connects the member **61** initially to the portion **64** and then is severed, forms a blunt portion which engages the jacket **31** and avoids cutting into the jacket. This permits greater forces to be applied to the cord **23** without damaging the jacket **31.**

The unitary dielectric housing **40** is also formed with facilities to provide strain relief for the conductors **32-32.** An opening **66** extends transversely across a portion of the housing **40** (see FIG. **2**). As can be seen in FIG. **4,** a conductor-anchoring member in the form of a restraining bar **67** of dielectric material spans the opening **66.** A portion of the conductor restraining bar **67** is spaced from the main portion of the housing **40** by slots **68** and **69** (see FIGS. **4** and **8**). The restraining bar **67** is integral with the walls of the opening **66** through connecting portions **71** and **72.** As can be seen in FIG. **2,** the ends of the restraining bar **67** of dielectric material are spaced from the end walls of the opening **66.**

In this way, an operator may cause a specially adapted tool **103** (see FIG. **8**) to reform the restraining bar **67** within the opening **66** to provide a generally wedge-shaped strain relief element **70** (see FIGS. **5** and **9**) in engagement with ones of the individual conductors **32—32.** Forces are applied to the restraining bar **67** to shear the bar along irregular planes. The resultant strain relief element **70** is of a generally trapezoidal cross-section with the larger dimension base in engagement with the conductors **32—32.** The sloping walls of the element **70** engage with the walls of the opening **66** to lock the element in engagement with the conductors **32—32.**

While the embodiment shown in FIGS. **4** and **8,** shows the pressure bar **67** separated from the housing **40** by he slots **68** and **69,** it should be understood that other structural arrangements will suffice. For example, one of the slots **68** or **69,** desirably the slot **69,** may be extended to communicate with the cavity **46.** Also, the restraining bar **67** may be molded so that forces applied thereto cause the bar to be moved linearly or pivotally to engage the conductors **32—32.**

The use of the one-piece or unipartite dielectric housing **40** affords certain advantages. It permits an operator to simply insert a jacketed cord **23.** Heretofore, separate or hinged portions (see application Ser. No. 311,575 filed Dec. 4, 1972 in the name of E. C. Hardesty) are mated together to secure the cord jacket and the conductors **32—32** within the assembled dielectric body. Finally, the terminals **33—33** are inserted into the assembled dielectric body.

In using a connecting device embodying the principles of this invention, there is no required bonding of mating portions with accompanying problems of alignment and reliability of the bond.

Moreover, the housing **40** has provisions molded therewith for securing the cord **23** to the plug and for alleviating strain relief on the cord jacket **28** and the

conductors **32—32** during customer use. The jacket-anchoring member **61** and the conductor restraining bar **67** not only secure the plug **24** to the cord **23** but also provide strain relief for the jacket and the conductors, respectively.

After the cord **23** has been inserted into the aperture **44** and operator may apply forces to the member **61** to break the connection **63** and move the resulting tooth portion thereof into engagement with the cord jacket **31.** As this is done, an upper portion **65** of the hinged member **61** catches under a ledge **73** (see FIGS. **5** and **9**) which has been formed upon breaking the web **63.** The strain relief for the individual conductors **32—32** is provided by reforming the dielectric restraining bar **67** downwardly within the opening **66** into the strain relief element **70** which engages with the individual conductors **32—32.**

In this way, the terminals **33—33** function only to make electrical contact with the conductors **32—32** and are not required to retain the conductors and resist the forces imparted to the conductors or the cord during customer use. The forces on the conductors **32—32** occur notwithstanding the anchoring of the jacket **31** with the member **61.** While the pressure on the jacket **31** may prevent the insulation **37** of the conductors **32—32** from moving relative to the jacket, the pressure is not sufficient to prevent the nylon core **34** and ribbon **36** from moving relative to the insulation thereof during customer use. This occurs because the relatively hard nylon insulation **37** forms what may be thought of as a tubulation over the core **34** and nylon **36** wrapped about the core. Forces applied to the cord **23** by the subscriber tends to cause the core **34** and ribbon to move slideably within the insulation **37.** This movement, if unchecked, could cause the tinsel ribbon to be sheared off the core **34** at the engagement thereof with portions of the terminals **33—33.**

The molding of the housing **40** with the ability to be able to precisely confine the conductors **32—32** in the troughs **49—49** is especially important. Prohibition against movement is necessary in order to cause the terminals **33—33** to penetrate the nylon-insulated conductors **32—32.** The terminals **33—33** must be inserted with sufficiently high forces imparted thereto to penetrate the insulation. If the conductors **32—32** were free to move laterally of the plug, the terminals **33—33** may very well slice into the insulation on either side of the conductive elements and fail to establish engagement therewith.

As can best be seen in FIG. **2,** the housing **40** is formed with a well **74** having a plurality of spaced parallel terminal-receiving openings **76—76** opening thereto. The openings **76—76** are in the form of slots and are aligned on a one-to-one basis with associated ones of the conductor-receiving troughs **49—49.** Each of the terminal-receiving slots **76—76** is parallel to and communicates with an associated one of the conductor-receiving troughs **49—49.** Each of the slots **76—76** is of a length slightly less than the out-to-out distance of that portion of the terminal **33** which is to be received therein. The shortening of the slots **76—76** from the overall length of the well **74** forms abutments **77—77** (see FIG. **4,** for example).

The dielectric housing **40** is also formed with a plurality of fins **78—78** (see FIGS. **2, 3** and **7**). The fins **78—78** are upstanding from a bottom surface **79** of the well **74** to which the terminal-receiving slots **76—76** open and are spaced apart approximately 0.035 inch. Also, the fins **78—78** are aligned between adjacent associated ones of the terminal-receiving slots **76—76.** In this way, the external contacting components **27—27** of the jack **26** are received between the associated fins **78—78** and guided into engagement with portions of the terminals **33—33.**

Formed integrally with the dielectric housing **40** is a resilient locking tab, designated generally by the numeral **80.** The locking tab is approximately 0.040 inch thick, 0.200 inch wide, and 0.500 inch long. The locking tab **80** is molded so that its longitudinal axis is oriented at an angle approximately 15° with respect to the plane of the terminal-inserting side **43.** The locking tab **80** is molded with a generally flat portion **81** connected by a plastic hinge **82** to the free end of the housing. The portion **81** is stepped to form wings **83—83** adjacent a subscriber-contact portion **84.**

The combined height of the thickness of the locking tab **80** and resiliency of the locking tab permits the insertion of the plug **24** into the jack **26** between opposing surfaces **85** and **86** (see FIG. **10**). The tab **80** can be deflected inwardly of the dielectric housing **40** to become substantially coplanar with the under-surface of the housing **40** and be moved slideably in engagement with the surface **85** which forms an entrance ledge (see FIG. **10**).

After being released, the locking tab **80** will essentially resume its original molded shape and orientation because of its natural resilience. Proper resilience to provide desired flexing properties can be incorporated into the locking tab **80** when it is molded from polycarbonate or other appropriate materials with the aforementioned dimensions. Return of the tab **80** to its originally molded shape causes the free end of the tab to be urged downwardly into seating engagement with surfaces of the jack **26** (see FIGS. **10** and **11**) in the handset **22** and base **21.** A wall **87** and the ledge surface **85** cooperate to form an edge **88** which engages the locking tab **80.** This locks the plug **24** to the jack **26** in the handset **22** and insures integrity of the connection during customer use.

The locking tab **80** is designed to permit the plug **24** to be released from the handset **22** when subjected to at least a predetermined force rather than to break the plug or rupture the cord **23.** In order to accomplish this, the tab **80** is constructed with shallow angled shoulders **89—89** (see FIGS. **2** and **3**) which form the wings **83—83.** When the plug **24** has been inserted into the jack **26,** the shoulders **89—89** engage the edge **88.** The shoulders **89—89** ride up along the edge **88** when forces of a predetermined magnitude are imparted to the cord **23.** Continued application of the forces cause withdrawal of the plug **24** from the jack **26.**

3. Terminals

As can best be seen in FIG. **2,** each one of the terminals **33—33** is made from an electrically conductive resilient material such as Phosphor bronze. The terminal **33** has a flat conductive portion **91** with at least one contact or insulation-piercing tang **92** protruding therefrom. The tangs **92—92** provide electrical connection between the conductive portion of the conductor **32—32** and the associated ones of the terminals **33—33.**

Each of the blade-like terminals **33—33** also has an edge surface **93** having curved crowns **94—94** of predetermined radii. The crown **94** nearest the free end **41**

of the housing **40** functions to complete the connection between the associated conductor **32** and an associated external-contacting component **27** illustrated in FIG. **10,** and positioned in the telephone jack **26.**

Provisions are also made for seating properly the terminals **33—33** within the associated terminal-receiving slots **76—76.** Each of the terminals **33—33** is formed with shoulders **96—96** having necked-down portions **97—97** that terminate in barbs **98—98.** As was indicated hereinbefore, the overall length of the terminal **33** out-to-out of the barbs **98—98** is greater than that of the length of the terminal-receiving slot **76.** When the terminal **33** is inserted into the associated terminal-receiving slot **76,** the barbs **98—98** penetrate the dielectric material which defines the slot to anchor the terminal (see FIG. **5**).

The extent to which the terminal **33** is inserted into the associated slot **76** is determined by the operation of an apparatus, designated generally by the numeral **100** (see FIG. **12**) used to insert the terminals. Generally, the apparatus **100** is controlled to insert the terminals **33—33** within the associated ones of the terminal-receiving slots **76—76** such that the shoulders **96—96** are spaced above the abutments **77—77.**

The extent to which the terminal **33** is inserted into the associated terminal-receiving slot **76** is controlled to also insure that adequate electrical engagement is effected between the terminal tangs **92—92** and the conductors **32—32.** If the depth of insertion is lacking, the tangs **92—92** may not engage one or both aligned portions of the helical tinsel ribbon **36.** On the other hand if the depth of insertion is too great, the shoulders **98—98** could rupture the abutments **77—77.** It is important that the tangs **92—92** engage the top or closest portion of the tinsel ribbon **36,** be moved through the core **34,** and into engagement with the bottom portion of the helically wrapped tinsel ribbon.

While the terminals **33—33** have been shown in a flat blade-like configuration, it should be obvious that they could be in the form of pins (not shown). Of course, the terminal-receiving openings **76—76** would then be molded to accommodate the pins (not shown) rather than the blade-like terminals **33—33.**

ALTERNATE EMBODIMENT OF DIELECTRIC PORTION

There have been instances of contaminants and corrosive atmospheres penetrating the plug **74.** This could cause problems in maintaining electrical continuity and reduction in the effectiveness of the electrical engagement between the terminals **33—33** and the cord **23.**

In order to prevent such occurrences, the housing **40** of the plug may be modified to that designated **40A** and shown in FIG. **6.** The housing **40A** is identical to the housing **40** except that the free end **41** has a wall **99** closing off the conductor-receiving troughs **49—49.** This prevents any contaminants or unwanted atmospheric corrosives from entering the plug **24** at least from the one end thereof adjacent the terminals **33—33.** This creates an essentially hemetic seal.

In using the plug **24** having a modified housing **40A,** the cord **23** must be stripped of the jacket **31** with some precision to expose only a predetermined length of the conductors **32-32.** Then, when the cord **23** is inserted into the cavity **46** and the free end of the jacket **31** abuts the shoulder **52,** the ends of the conductors **32-32** will be spaced slightly from the wall **99.**

SECOND ALTERNATE EMBODIMENT OF DIELECTRIC PORTION

It will be recalled that the embodiment first described herein discloses that the cord **23** have the jacket **31** removed from a leading portion thereof to expose the individual insulated conductors **32—32.** The individual conductors **32—32** are received in the conductor-receiving troughs **49—49.**

The principles of this invention may be used to construct a housing **40** which may accommodate an end portion of a flat cord **23** without the necessity of removing the jacket from an end portion thereof. The cavity **46** is molded without the conductor-receiving troughs **49—49** and such that a leading end portion of the cord **23** is inserted into the cavity. The cavity **46** is constructed to communicate with the terminal-receiving slots **76—76** and may or may not open to the free end **41** of the housing **40** (see FIG. **6**).

In using this embodiment, the end portion of the cord **23** is inserted into the cavity **46.** Then the terminals **33—33** are driven into the slots **76-76** into engagement with the conductive elements of the cord **23.** Since the cord **23** is flat, and assuming that the cord is inserted properly into the cavity **46,** the conductive elements of the cord are aligned properly with the terminals **33—33.**

METHOD OF ASSEMBLING PLUG WITH CORD

The construction of the plug **24** is especially adapted to be used with flat cordage. Moreover, the plug **24** is easily adapted to automated high speed manufacturing. In describing the assembly of the plug **24** and the cord **23,** reference will be made to FIGS. **4** and **5** which depict the steps of the method. Reference will also be made to FIG. **12** which illustrates the apparatus **100.** The apparatus **100** is exemplary of apparatus which may be used to carry out the steps of the method.

One of the plugs **24—24** is positioned in a work holder **101.** Then a leading end of the jacketed cord **23** has a portion of the jacket **31** stripped therefrom. The leading end of the cord **23** is inserted into the flared entrance **44** and into the cavity **46** with the conductors riding up along the sloped portion **53** until the conductors **32—32** are received in associated ones of the conductor-receiving troughs **49—49.** At that time, the leading edge of the jacketed portion **31** engages the shoulder **52.** Also, then, the conductors **32—32** extend onto and perhaps slightly past the ledge **47.**

An advantage of constructing a one-piece dielectric housing **40** derives from the alignment feature of the cord **23** with the housing. In using prior plugs, it was necessary to align the conductors **32—32** with appropriate conductor-receiving facilities within the plug and to maintain that alignment during the insertion of the terminals **33—33.** This is unnecessary in using the plug **24** embodying the features of this invention since the insertion of the cord **23** within the plug automatically maintains the cord therewithin and aligns the individual conductors **32—32** with the associated ones of the troughs **49—49.**

There is still another significant advantage realized from the use of the one-piece plug **24.** The dimensions of the separate dielectric portions in a two-piece plug may vary within tolerances as between different molding tools. This may cause problems of alignment as between successive matings of successive pairs of parts

and further may cause problems of alignment of the terminals **33—33** and associated conductors **32—32** in assembly equipment when using parts from different molds. With the one-piece plug **24,** the terminal-receiving slots **76—76** are inherently aligned with the conductor-receiving troughs **49—49.**

Because the cord **23** is flat and because of the assembly process, the conductors **32—32** are spaced in a prearranged order in the troughs **49—49.** Once the cord **23** is inserted into the housing **40** in the correct orientation, then it is unnecessary for an operator to identify the conductors **32—32** prior to the electrical connection with ones of the terminals **33—33.** The order in the cord **13** is maintained in the plug **24** to correspond to the order of engagement with the external contact elements **27—27.**

However, to insure the correct orientation of the cord **23** with respect to the plug **24,** the cord must be inserted into the plug in such a fashion to insure that the order of the conductors **32—32** is correct. Since the cavity **46** is formed with the groove **56,** the cord **23** should be inserted such that the ridge **38** on the cord jacket **31** is received in the groove. If the cord **23** were inserted in an inverted position, the conductors **32—32** would not be oriented properly with the terminals **33—33** and hence with the external contacting components **27—27.** Also, the subsequent engagement of the member **61** with the cord **23** would span the ridge and not be fully seated across the jacket enclosing the four conductors **32—32.** This would result in a less efficient anchoring of the jacket **31.**

The operator then causes a tool **102** to be moved into engagement with the member **61** to break the thin web **63.** The now-hinged member **61** is moved counterclockwise, as viewed in FIG. **5,** until the toothed portion **65** thereof catches and locks under the newly formed ledge **73.** As can be seen in FIGS. **5** and **9** the thin web **63** is such that the free end thereof curls around to form a blunt portion which engages the cord jacket **31.**

Next, the operator causes the tool **103** to engage the conductor-restraining bar **67** within the opening **66** (see FIG. **8**) and apply compressive forces thereto. The conductor bar **67** is reformed and broken off along the lines shown dotted in FIG. **9** into the tapered or wedge-shaped dielectric element **70** (see FIG. **9**) and moved into engagement with the conductors **32—32.** The element **70** spans the conductors **32—32** with the bottom portion thereof tending to assume the partial peripheral shape along the tops of the conductors **32—32.** Moreover, the element **70** is locked in the position shown in FIG. **9.** The element **70** therefore locks the conductors in the troughs **49-49** to provide strain relief for the conductors while the toothed portion of the hinged member **61,** i.e., the web **63,** provides strain relief for the jacket **31.**

The tool **103** used to reform the body **67** spans the entire opening **66.** This is unlike the tool **102** which is used to move the member **61.** In this way, downward movement of the tool **103** does not cause the restraining bar **67** to be moved pivotally about one of the connecting portions **71** and **72.** Rather, as shown in FIG. **9,** the restraining bar **67** is moved downwardly beginning at the bottom of the slots **68** and **69** and mushrooms outwardly. This in effect forms the strain relief element **70** having a generally trapezoidal cross-section which is locked at the bottom of the opening **66** in tight engagement with the conductors **32—32.**

Then the free end portions of the conductor **32—32** are trimmed off with a cutting device **104** using the ledge **47** as a bearing surface. The extension of the leading ends of the conductors **32—32** onto the ledge **47** avoids having to strip exactly the leading ends of the conductors.

In the alternative embodiment shown in FIG. **6** with the troughs **49—49** not opening to the ledge **47,** the conductors **32—32** are presized to approach the ends of the troughs. The cut-off must be such that the conductors extend beyond the most forward one of the tangs **92—92.** The construction of the plug **24** with a closed front end minimizes moisture absorption and exposure of the terminals **33—33** to a corrosive atmosphere. This creates an effective hemetic seal.

In order to complete the assembly of the plug **24** to an end of the cord **23,** four of the terminals **33—33** are inserted into the plug. The blade-like terminals **33—33** are inserted by rams **106—106** from the terminal-receiving face **43** of the plug **24** into associated ones of the terminal-receiving slots **76—76** until the rams bottom out. The shoulders **96-96** thereof are spaced above the abutments **77—77** (see FIG. **5**). At that time, the contact tangs **92—92** extend into the associated trough **49—49.** The tangs **92—92** penetrate the insulation of the conductors **32—32** confined in the troughs **49-49** and establish electrical contact with both the upper and lower wraps, as viewed in FIG. **5,** of the tinsel ribbon **36.** Also, the barbs **93—98** are caused to become embedded in the portion of the dielectric housing **40** which defines the terminal-receiving slot **76—76.** This anchors the terminal **33—33** against movement or inadvertent removal from the housing **40.**

An apparatus for completing the formation of and inserting the terminals **33—33** into housing **40** is disclosed and claimed in application Ser. No. 346,556 filed on Mar. 30, 1973 in the names of W. B. Brown (deceased) and F. D. Gavin.

Of course, apparatus other than the apparatus **100** may be used to practice the methods of this invention. For example the assembly of the plug **24** to the cord **23** could be accomplished by using a turntable, (not shown) with facilities for inserting the cord, stripping the cord, etc. arranged about the periphery of the turntable. Successive cords **23—23** and associated plugs **24—24** are moved with the turntable (not shown) through the work stations.

It is to be understood that the above described arrangements are simply illustrative of the invention. Other arrangements may be devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. An electrical connector for terminating a cord having a plurality of insulated conductors and for making electrical contact external to the connector, which comprises:

an unipartite dielectric housing, with internal surfaces thereof defining a cavity that opens to at least one end of the housing for receiving an end portion of the cord, the surfaces of the housing as formed and defining the cavity substantially enclosing the entire end portion of the cord, with at least one portion of the surfaces defining the cavity being movable relative to the remainder of the surfaces

defining the cavity at least partially into the cavity for engaging portions of the cord to secure the cord within the housing and to prevent unintended lateral and longitudinal movement thereof the housing also including a plurality of terminal-receiving openings communicating with the cavity and the exterior of the connector; and

a plurality of electrically conductive terminals positioned within associated ones of the terminal-receiving openings each of which includes:

a first contact portion extending into the cavity for piercing the insulation of and making electrical engagement with an associated conductor of the cord; and

a second contact portion positioned within the associated terminal-receiving opening for making electrical contact external to the connector.

2. An electrical connector for terminating a cord having a plurality of insulated conductors and for making electrical contact external to the connector, which comprises:

an unipartite dielectric housing, which includes a free end and a cavity opening to a cord-input end for receiving an end portion of the cord, with internal surfaces of the housing as formed and defining the cavity substantially enclosing the entire end portion of the cord, with at least one portion of the surfaces defining the cavity being movable relative to the remainder of the surfaces defining the cavity at least partially into the cavity for engaging portions of the cord to secure the cord within the housing and to prevent unintended lateral and longitudinal movement thereof, the housing also including conductor-receiving troughs formed in at least a portion of the cavity and a plurality of terminal-receiving openings communicating with the troughs and the exterior of the connector; and

a plurality of electrically conductive terminals positioned within associated ones of the terminal-receiving openings each of which includes:

a first contact portion extending into the associated trough for piercing the insulation of and making electrical engagement with the associated conductor in the trough; and

a second contact portion positioned within the associated terminal-receiving opening for making electrical contact external to the connector.

3. The electrical connector of claim **2,** wherein the at least one moveable portion of the housing includes an anchoring member formed integrally with the housing along at least a portion of the periphery of the anchoring member such that compressive forces applied to the anchoring member reforms the anchoring member into a wedge-shaped element locked in engagement with the cord and the housing to provide strain relief for the cord during use thereof.

4. The electrical connector of claim **2,** wherein the conductor-receiving troughs open to the free end of the housing.

5. The electrical connector of claim **2,** wherein the conductor-receiving troughs terminate in a wall forming at least a portion of the free end of the housing to seal off the troughs from the free end of the housing.

6. The electrical connector of claim **2,** wherein a free end of the housing extends beyond the remaining portion of the housing to provide a bearing surface for cutting off exposed end portions of the conductors which extend beyond the free end of the housing.

7. The connector of claim **2,** wherein the terminals are blade-like and the terminal-receiving openings include a plurality of spaced slots opening to an external surface of the housing and communicating with associated ones of the troughs, each of the slots being of a size to permit the first contact portion of the associated one of the terminals to pass therethrough.

8. The connector of claim **7,** wherein the first contact portions of each terminal includes a plurality of contact tangs which extend through the associated one of the slots and into electrical engagement with the conductor in the associated trough.

9. The connector of claim **7,** wherein each of the terminals is formed with barbs extending therefrom and which are positioned within the associated one of the slots, an overall longitudinal dimension between extremities of the barbs being slightly greater than the longitudinal dimension of the slot which communicates with the associated trough to facilitate the barbs of the terminal becoming embedded in the walls of the slot when the terminals are inserted to anchor the terminals within the housing at a predetermined depth within the housing.

10. The electrical connector of claim **7,** wherein the housing is also formed with a plurality of spaced fins upstanding from the external surface to which the terminal-receiving slots open, each of the fins interposed between the longitudinal axes of two adjacent ones of the slots, the fins capable of guiding external contacting elements into engagement with second contact portions of associated ones of the terminals.

11. The connector of claim **2,** wherein the cord-input cavity has approximately the same cross section as the cord with the walls of the cavity diverging continuously from the inner portion to the cord-input end of the connector and forming a flared inlet to avoid sharp bends in the cord during use thereof and to facilitate insertion of the leading end of the cord.

12. The electrical connector of claim **2,** wherein the cord includes a jacket which encloses the individual conductors, the jacket being formed with a ridge longitudinally thereof, the cord-receiving cavity being formed with a groove parallel with the longitudinal axes of the troughs, the conductors of the cord inserted into the cavity being oriented properly with respect to associated ones of the troughs, the terminals and associated external contact elements only when the ridge is aligned with the groove.

13. The electrical connector of claim **2,** at least the free end of which is insertable into a cavity of a jack wherein the housing is formed with a resilient locking tab cantilevered from the free end of the housing, the electrical connector inserted into the cavity being in engagement with a surface defining partially the jack cavity which is adjacent the surface of the housing to which the second contact portions of the terminals are exposed, the locking tab being depressed toward the housing at the free end thereof to insert the electrical connector into the jack cavity, the tab moving pivotally away from the housing when forces are no longer applied to depress the free end thereof, the movement of the tab tending to return the tab to an initial position and causing a surface thereof to engage an edge formed transversely of the jack cavity by surfaces defining partially the jack cavity.

14. The electrical connector of claim 13, wherein the tab is undercut at a portion thereof which engages the edge of the jack cavity, the undercut formed by a sloping surface which engages the edge, the configuration of the locking tab and the cooperative engagement thereof with the jack edge and at least one of the surfaces defining the edge being such that when the cord of the electrical connector is subjected to unintended forces in excess of a predetermined magnitude, the sloping surface of the tab will ride up over the edge to permit the electrical connector to be withdrawn from the jack cavity.

15. The electrical connector of claim 3, wherein the anchoring member is a conductor-restraining member which is capable of being moved to engage individual conductors of the cord to secure the conductors within the housing and prevent unintended lateral and longitudinal movement thereof.

16. An electrical connector for terminating a cord having a plurality of insulated conductors and for making electrical contact external to the connector, which comprises:

an unipartite dielectric housing, which includes a free end and a cavity opening to a cord-input end for receiving an end portion of the cord, the surfaces of the housing defining the cavity substantially enclosing the entire end portion of the cord, the housing also including conductor-receiving troughs formed in at least a portion of the cavity and a plurality of terminal-receiving openings communicating with the troughs and the exterior of the connector, the housing being formed with, at least, one portion moveable at least partially into the cavity for engaging portions of the cord to secure the cord within the housing and to prevent unintended lateral and longitudinal movement thereof wherein the at least one moveable portion of the housing includes an anchoring member connected through a hinged portion at one end thereof and through a severable web at the other end thereof to the housing, such that application of forces to the anchoring member separates the web from the housing and then causes the anchoring member to be moved pivotally about the hinged portion to engage and anchor the cord; and

a plurality of electrically conductive terminals positioned within associated ones of the terminal-receiving openings each of which includes:

a first contact portion extending into the associated trough for piercing the insulation of and making electrical engagement with the associated conductor in the trough; and

a second contact portion positioned within the associated terminal-receiving opening for making electrical contact external to the connector.

17. The electrical connector of claim 16, wherein the web of the anchoring member is formed so that the web is separated from the housing adjacent the housing to form an elongated extension which is caused to assume a curved shape as the anchoring member is moved pivotally to cause a blunt curved portion of the extension to engage the cord thereby preventing damage to the cord as forces are applied thereto during use of the cord.

18. The electrical connector of claim 16, wherein the cord includes a jacket which encloses the individual insulated conductors, and the anchoring member capable of being moved into engagement with a jacketed portion of the cord to anchor the jacket against unintended lateral and longitudinal movement.

19. The electrical connector of claim 16 wherein the anchoring member is formed within an opening in the housing that communicates with the cavity and the pivotal movement of the anchoring member causes the anchoring member to lock under one of the walls defining the opening to secure the anchoring member in engagement with the cord.

20. The electrical connector of claim 18, wherein the jacket is removed from a portion of the cord which is adjacent the free end of the housing and the at least one moveable portion of the housing also includes a conductor-restraining member formed integrally with the housing along at least a portion of the periphery of the conductor-restraining member such that compressive forces applied to the conductor-restraining member reforms the restraining member into a wedge-shaped element locked in engagement with the housing and the conductors to provide strain relief for the conductors during use of the cord.

21. A device for terminating a cord having a plurality of insulated conductors, which comprises:

an unipartite dielectric housing,

the housing being provided with a cord-input cavity that opens to at least one end of the housing for receiving an end portion of the cord;

the surfaces of the housing defining the cavity substantially enclosing the entire end portion of the cord;

the housing also being provided with a plurality of terminal-receiving openings communicating with the cavity and the exterior of the device; and

the housing being formed with at least one portion of the surfaces defining the cavity being moveable relative to the remainder of the surfaces defining the cavity at least partially into the cavity for engaging portions of the cord to secure the cord within the housing and to prevent unintended lateral and longitudinal movement thereof.

22. A method of assembling a cord, which comprises individually insulated conductors enclosed in a jacket, to a device, which includes an unipartite housing constructed from a dielectric material having a cavity that opens to at least one end of the housing for receiving an end section of the cord, the surfaces of the housing defining the cavity substantially enclosing the entire end section of the cord, the housing also having conductor-receiving troughs formed in the cavity and terminal-receiving openings communicating with associated troughs, which includes the steps of:

holding the housing;

exposing the individual insulated conductors of a predetermined length of the one end section of the cord by removing the jacket therefrom;

inserting the one end section of the cord into the cavity;

causing relative motion between the device and the cord to advance the conductors into associated ones of the troughs;

applying forces to at least one portion of the unipartite housing to move the at least one portion at least partially into the cavity to engage and anchor the cord within the housing; and

inserting and seating terminals in the terminal-receiving openings such that first contact portions

thereof extend into the troughs and pierce the insulation of the associated conductors to establish an electrical connection with the conductors and to expose second contact portions thereof externally of the housing for engagement with external components.

23. The method of claim **22,** wherein the step of applying forces to at least one portion includes:

applying forces to one portion of the housing to disconnect one end of the one portion from the housing and to then move the portion pivotally to engage the one end thereof with the cord jacket; and

applying forces to another portion of the dielectric housing to reform the other portion to engage and lock the conductors within the housing to prevent unintended lateral and longitudinal movement of the conductors.

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