United States Patent

Faulconer

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[54] MEANS AND METHODS OF JOINING CONDUCTORS

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[22] Filed: **Sept. 23, 1970**

[21] Appl. No.: **74,907**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 316, Jan. 2, 1970, abandoned, which is a continuation-in-part of Ser. No. 676,002, Sept. 28, 1967, abandoned, which is a continuation-in-part of Ser. No. 594,785, Nov. 16, 1966, abandoned.

[52] **U.S. Cl.** .....**174/88 R,** 29/628, 174/72 R, 174/135, 339/97 R, 339/98, 339/99 R, 339/198 R

[51] **Int. Cl.** **H02g 15/08**

[58] **Field of Search** .....174/88 R, 88 S, 84 R, 84 S, 174/72 R, 135; 29/628; 339/95 R, 97 R, 98, 99 R, 198 R

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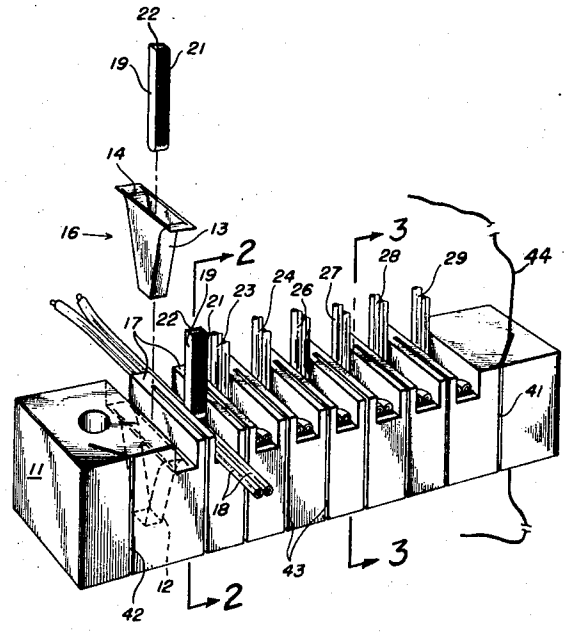
Attorney—George J. Netter and Kendrick, Subkow and Kriegel

[57] **ABSTRACT**

Method and apparatus for organizing and joining conductors of multi-conductor cables such as communication cables. An elongated multiple connector structure having a series of open-channels, the entrance ends of which are intersected by guide channels, each having a releasable holder at one end so that a bundle of wires may be separated, organized and held in the channels in bridging relation to connection sockets. Plugs are forced into the sockets and press bridging portions of the wires therein to strip the insulation and establish permanent electrical connections. Each socket is provided with a sharp edge to shear the excess portions of the wires as the plugs are forced into the sockets.

17 Claims, 21 Drawing Figures



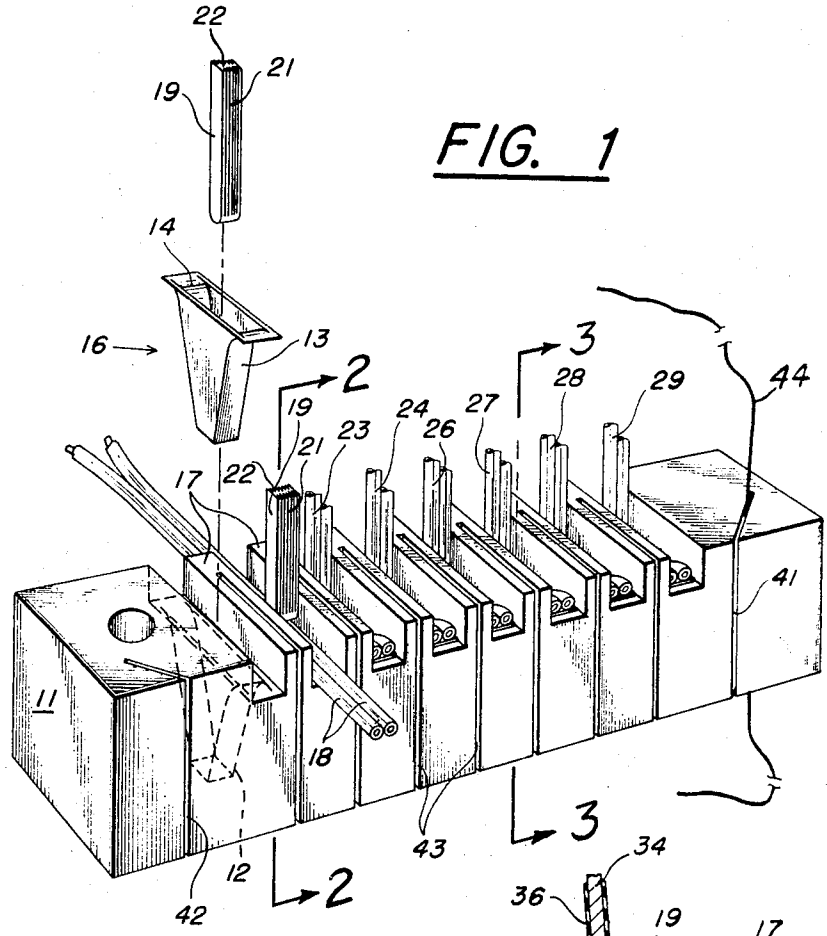


FIG. 1

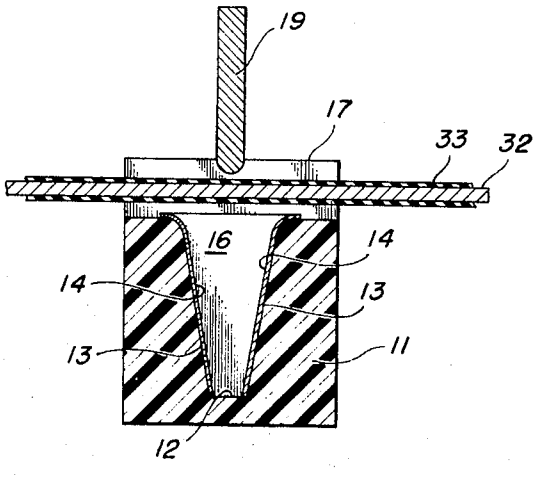


FIG. 2

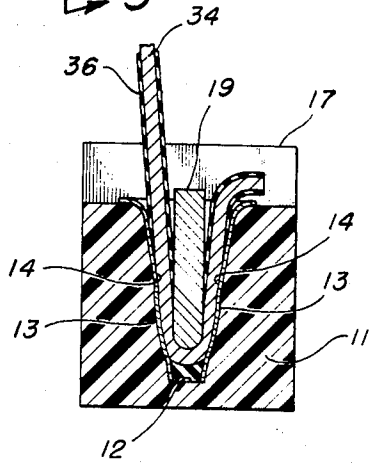


FIG. 3

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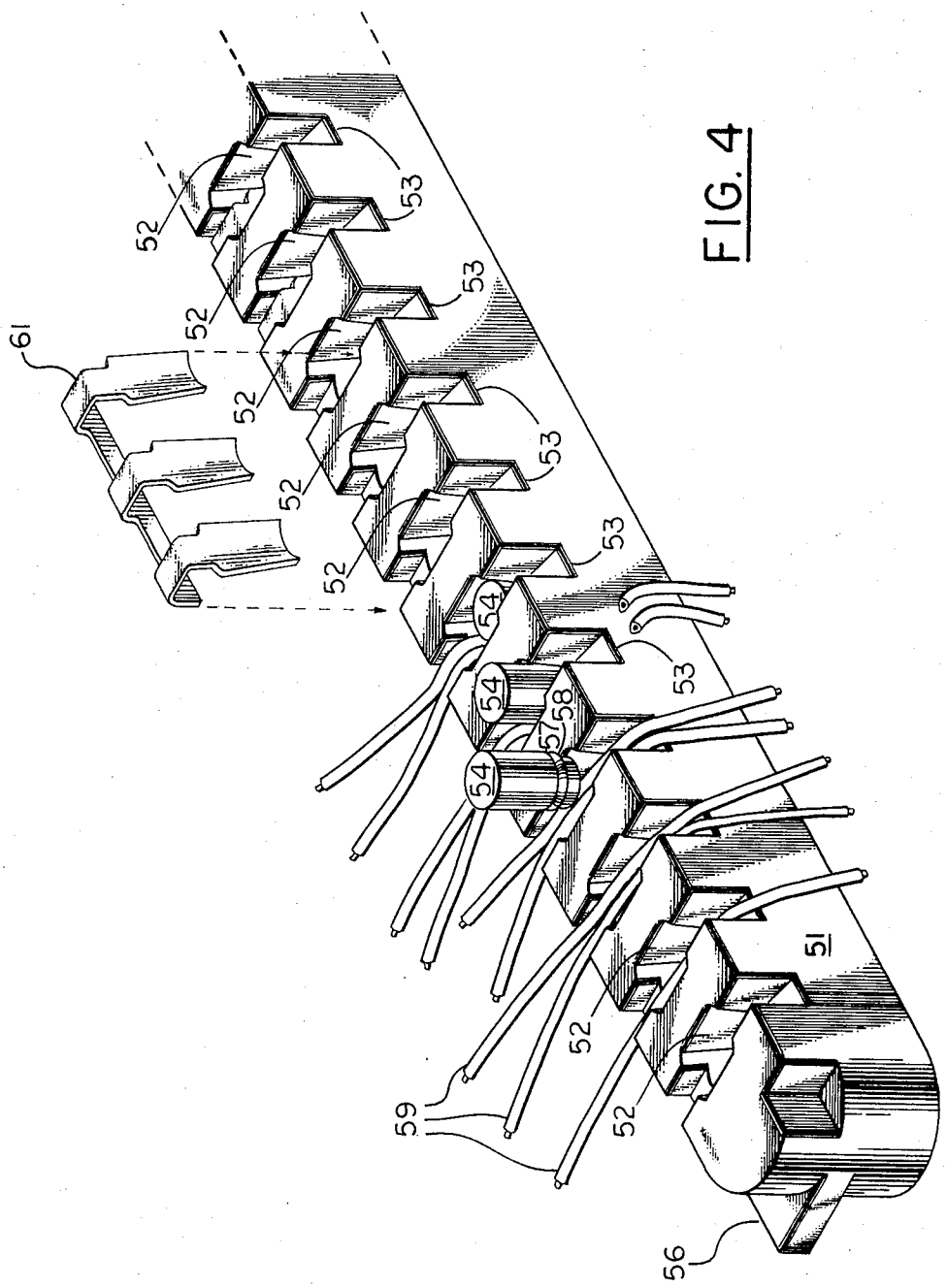

FIG. 4

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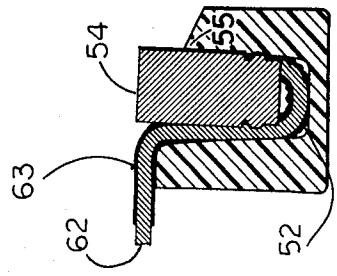

FIG. 9

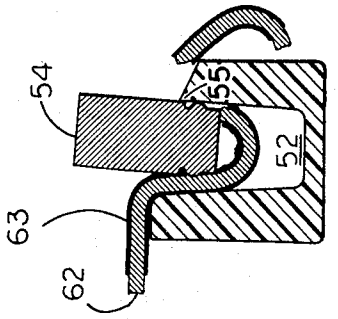

FIG. 8

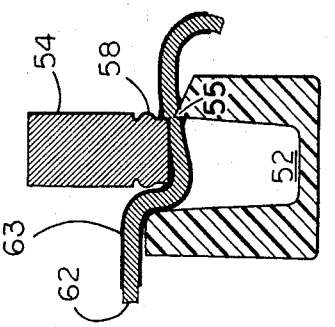

FIG. 7

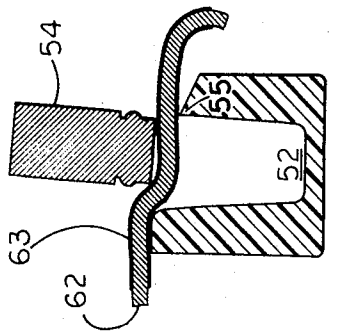

FIG. 6

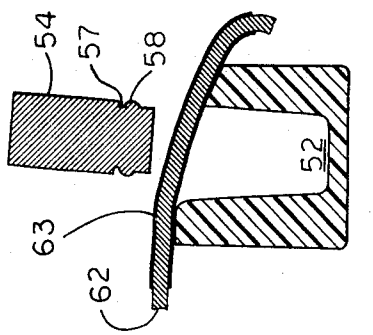

FIG. 5

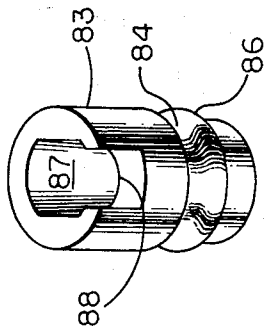

FIG. 14

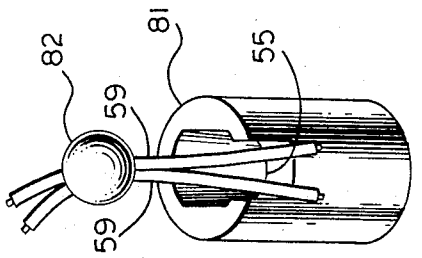

FIG. 13

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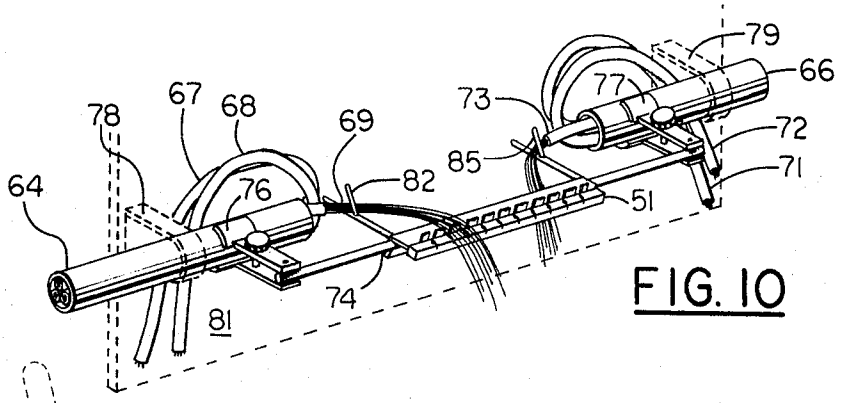

FIG. 10

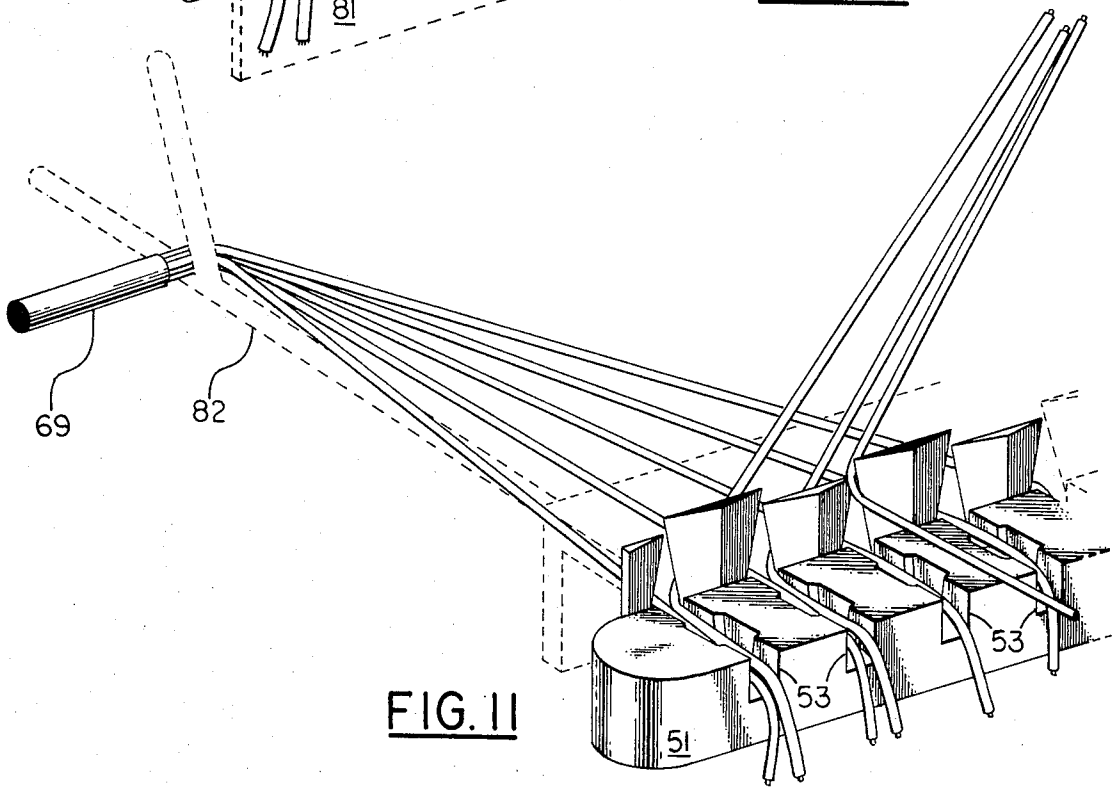

FIG. 11

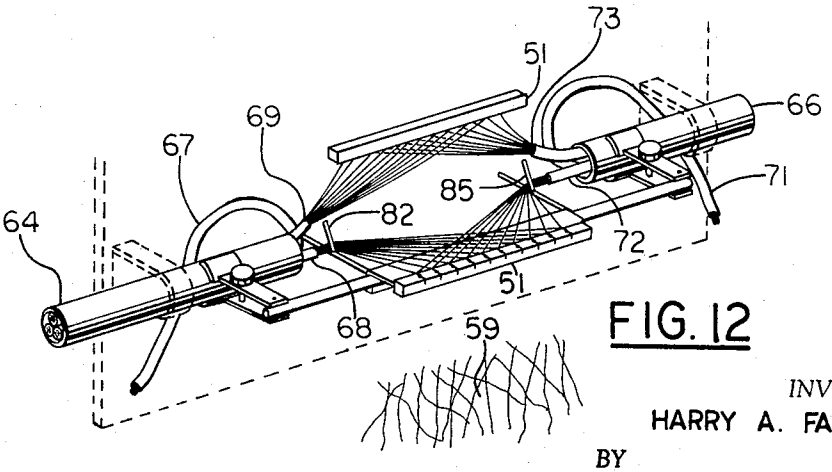

FIG. 12

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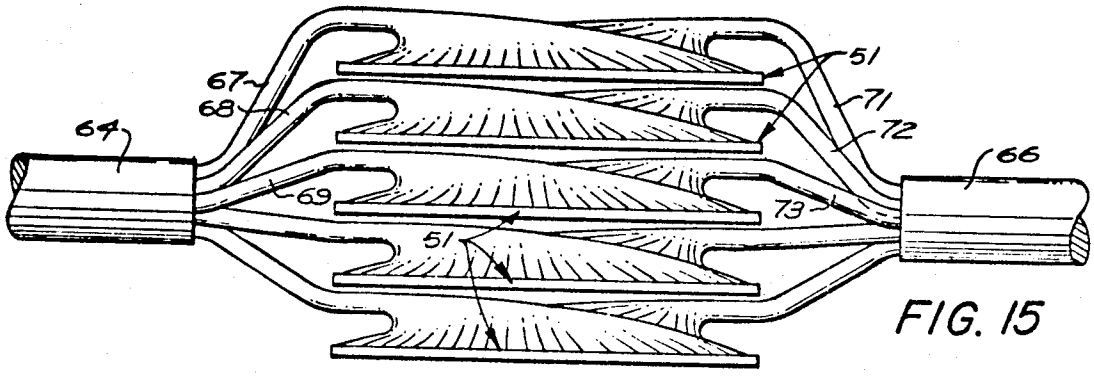

FIG. 15

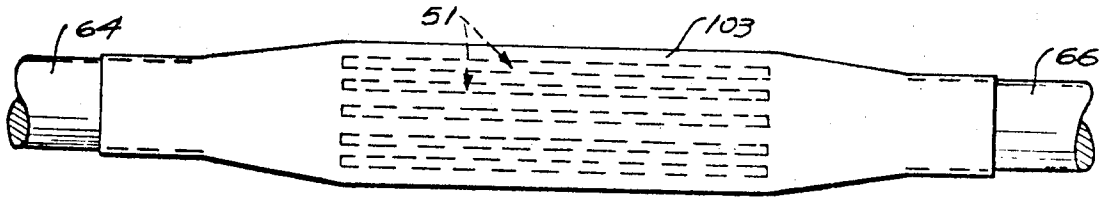

FIG. 16

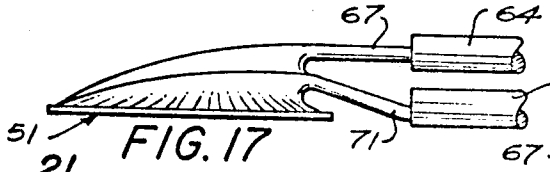

FIG. 17

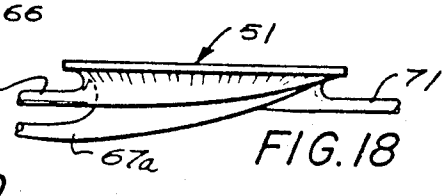

FIG. 18

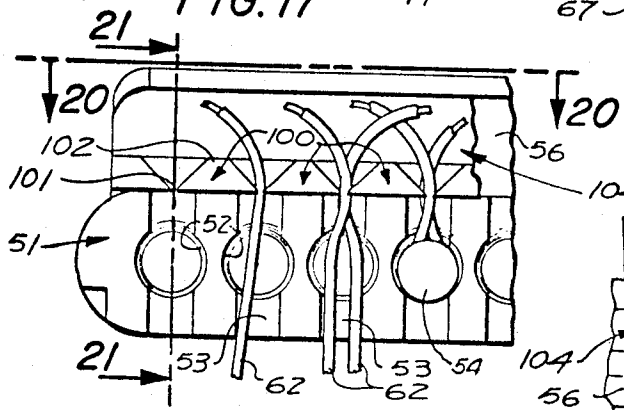

FIG. 19

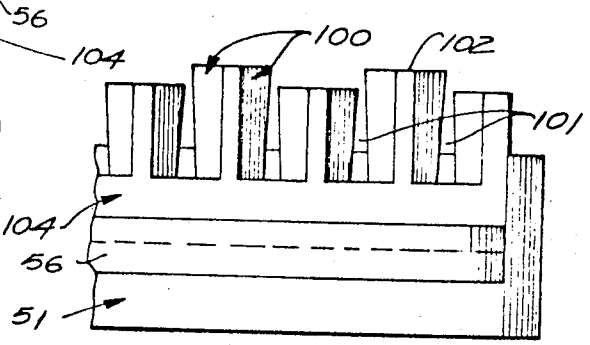

FIG. 20

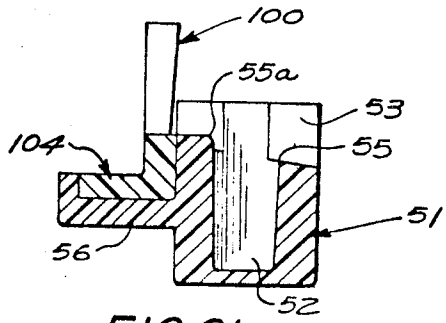

FIG. 21

MEANS AND METHODS OF JOINING CONDUCTORS

RELATED APPLICATIONS No.

This application is a continuation-in-part of my copending application Ser. No. 316, filed Jan. 2, 1970 for "Means and Methods of Joining Conductors" now abandoned; which application is a continuation-in-part of a previous application Ser. No . 676,002, filed Sept. 28, 1967 for "Splicing Method and Apparatus," now abandoned; which latter application is a continuation-in-part of a previous application, Ser. No. 594,785, filed Nov. 16, 1966, for "Splicing Method and Apparatus," now abandoned, but which was copending therewith.

BACKGROUND OF THE INVENTION

The joining of high pair count cables, such as used in the communication field, has involved the selection of mating pairs of wires, then joining these wires individually. Such connections have involved stripping of the insulation from the wires, then twisting the bare wires together, sometimes with the addition of solder to the twisted portion, or, more recently, the use of mechanical crimping devices, sometimes utilizing a sleeve which is slipped over the wires and their insulation, then crimped to pierce the insulation.

Each of the prior art methods is limited to joining individual pairs of wires, totally unorganized with respect to the cable as a whole. It is not uncommon to join communication cables having 2,400 pairs of wires, requiring 4,800 connections at each splice. Furthermore, cables of this size are 700 feet or less in length. Thus, the number of splices, the time consumed and resulting cost in soldering and covering each connection virtually eliminates this method. The crimping method is somewhat faster, but has the serious disadvantage, previously mentioned, of resulting in a totally unorganized splice, which is further aggravated by the greater bulk contributed by the crimp connectors.

A still further disadvantage exists, particularly in joining high pair count cables requiring hundreds of connections, in that prior art methods are conducive to human error as to the proper sorting and selection of wires and pairs of wires to be joined, and errors so made are not readily detectable until subsequent testing of completed cables. This being too late for corrective measures, pairs affected by such errors must be abandoned, resulting in the costly waste referred to in the industry as "dead copper," of which thousands of miles exist.

Considering the individual connectors whether used in the field of communication, or in other fields such as the joining of conductors used to transmit electrical power, the time required to effect a connection and the dependability of the connection leaves much to be desired. Considering the joining of high pair count cables, prior art methods are conductive to human error. No means is provided by known prior art methods for timely detection or correction of such erroneous connections, which are common and costly. Considering a completed splice in a multiple conductor cable, prior art methods make no provision for the permanent and orderly organization of the wires, which shortcoming is increasingly serious in view of the vast proliferation of installations where cables with large numbers of conductors must be interconnected.

SUMMARY OF THE INVENTION

The present invention provides a solution to the problem of effecting a permanent and orderly organization of the wires and groups of wires in the splicing of high pair count and other multiple conductor cables, and provides a fast efficient means of effecting dependable connection between two or more wires, whether in the communications field or wherever wires are joined for transmission of electrical signals or electrical power, and is summarized in the following objects:

First, to provide a means and method of joining insulated conductors which is particularly applicable to the joining of communication cables which may contain hundreds of wires

to be mated; more particularly, the means and method involves the use of elongated connector structures having means for holding a large number of wires for inspection and relocation of improperly placed wires, whereupon permanent connections may be made, and wherein the wires and groups of wires are retained in organized arrays.

Second, to provide a means and method, as indicated in the preceding object, wherein excess lengths of the wires are automatically severed, as the wires are joined, without mechanically or electrically weakening the connection.

Third, to provide a means and method of joining wires wherein one or more wires are placed in bridging relation across the entrance end of a socket and forced by a plug into the socket while simultaneously stripping the wire to make electrical connection as well as severing the excess wire.

Fourth, to provide a means and method of joining insulated wires which may comprise independent units to effect a single connection between mating wires and may be dimensioned for the joining of small wires such as used in the communication field or for the joining of large wires such as used in the power transmitting field.

Fifth, to provide a means and method of joining insulated wires, as indicated in the preceding objects, wherein a body of insulating material having one or more sockets is used to receive the wires and a conductor plug strips the wires to complete connection therewith; and, wherein the sockets may receive or be lined with conductive material to increase the area of electrical contact or to provide means for electrical connection between sockets.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is an enlarged perspective view of an embodiment of a multiple wire connector included in the present invention.

FIG. **2** is a cross sectional view thereof, taken from **2—2** of FIG. **1**.

FIG. **3** is a cross sectional view thereof, taken from **3—3** of FIG. **1**.

FIG. **4** is an enlarged fragmentary perspective view of another embodiment of a multiple wire connector included in the present invention.

FIGS. **5–9** represent a cross sectional view of one of the cavities of FIG. **4**, showing the splicing operation in sequence.

FIG. **10** is an enlarged perspective view, showing a modified form of a single connector unit.

FIG. **11** is an enlarged perspective view, showing a modified form of connector plug which also forms a secondary connector.

FIG. **12** is a schematic perspective view, illustrating a step in the joining of a pair of multiple conductor, multiple bundle cables.

FIG. **13** is an enlarged fragmentary perspective view, showing a modified form of a connector wherein releasable wire retaining means hold the wires in place during assembly and inspection.

FIG. **14** is a schematic perspective view, similar to FIG. **12**, showing a further step in the joining of a pair of multiple conductor, multiple bundle cables.

FIG. **15** is a diagrammatical front view, illustrating a further step in the joining of a pair of multiple conductor, multiple bundle cables.

FIG. **16** is a diagrammatical view, showing a completed connection between a pair of multiple conductor, multiple bundle cables.

FIG. **17** is a diagrammatical view, showing the manner of connection to a pair of cables located side-by-side.

FIG. **18** is a diagrammatical view, showing a manner of connection between three cables.

FIG. **19** is an enlarged fragmentary top view of a further modification of the multiple wire connector.

FIG. **20** is a fragmentary front view as seen from **20—20** of FIG. **19**.

FIG. **21** is a transverse view thereof, taken through **21—21** of FIG. **19**.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, a terminal insulating block **11** has a plurality of tapered cavities or sockets **12**. Each tapered cavity **12** has a pair of opposite converging walls **13** which are lined with a conductive strip **14**. The conductive strip **14** may merely line two converging sides of the cavity, or be in the form of a rectangular cross sectioned tapered socket or funnel, as indicated by **16**, and line all four sides of the cavities **12**.

Extensions **17** of insulative terminal block **11** form convenient guides and dividers between each cavity for the placement of a pair of conductors **18** in the open channel or trough formed therebetween. Conductive inserts **19** are dimensioned for a snug fit within cavities **12** and have a plurality of splines on opposite faces **21** and **22**. Conductor pairs **23**, **24**, **26**, **27**, **28** and **29** are shown after the splicing operation has been completed. Conductor pair **18**, with a corresponding insert **19**, is shown just prior to the completion of an electrical splice.

A plurality of slots **43** are provided in each extension **17** along with angled slots **41** and **42** in each end of insulating block **11**. These slots facilitate the bending of the entire terminal block after the splicing operation is completed. Angled slots **41** and **42** can be utilized for tying the terminal strip in arcuate configuration surrounding a bundle of conductors or cable. A string **44** is shown positioned within angled slot **41** for cooperation with angled slot **42** after the terminal block is bent.

Referring to FIG. **2**, a cross section along lines **2—2** is shown with insert **19** in a position just prior to a splice being made in spatial relationship with a conductor **32** having an insulative sleeve **33** thereon. The conductor **32** is placed over tapered cavity **12** having conductive strips **14** lining a pair of converging walls **13** in insulative terminal block **11**. One extension **17** is shown rising above conductor **32**.

Referring to FIG. **3**, a cross sectional view taken along line **3—3** of FIG. **1** is shown which is essentially the same as FIG. **2** with the exception that the splicing operation has been completed. Here, an individual conductor **34**, with an insulative sleeve **36**, is shown within tapered cavity **12** of insulative terminal block **11**. Insert **19** has driven conductor **34** into the tapered cavity **12** and in electrical contact with conductive strips **14** which line converging walls **13** of tapered recess **12**. As can be seen the conductive block, together with the conductive strips **14**, have been displaced at **37** from the pressure of insert **19** thereon. Insulative sleeve **36** has been destroyed in the lower regions of the tapered recess **12**, causing an electrical contact between conductor **34** and conductive insert **19**.

Referring to FIG. **4**, a modification of the terminal block splice of FIG. **1** is shown utilizing a relatively rigid insulative terminal block **51**, having a plurality of tapered cavities **52**. Each of the tapered cavities **52** has a forward shearing edge (not shown) terminating the top front edge of each cavity **52**. Each cavity has an associated lead recess **53** for sorting and dressing a plurality of leads for the future insertion of inserts **54**. It is also to be noted that each cavity **52** comprising a wire connection location is associated with a separate open-faced channel **52'** formed by upstanding portions of **51**. A back ledge **56** forms a convenient mounting extension for mounting the insulative strip in proximity to a pair of multiconductor cables, for example, being spliced.

Insert **54** has an annular recess **57** and an annular extension **58** for effecting a parting of the insulation of electrical leads **59** within cavities **52**. In this embodiment, the cavities or sockets **52** each form a conical section for cooperation with cylindrical inserts **54**. If required, selected cavities may be electrically connected; for example, a shorting bar **61** is shown in proximity with three of the cavities **52** for electrically shorting all conductors within these cavities.

Referring to FIGS. **5–9**, a sequential progression of an insertion of insert **54** into a cavity **52** carrying with it electrical conductor **62** having an insulative sleeve **63** is shown. Again, insert **54** has an annular recess **57** and an annular extension **58**. Cavity **52** has a shearing edge **55** on one side thereof; however, the opposite edge is rounded to form a non-shearing edge **55*a***. As the insert **54** is forced into the cavity **52**, the insulated wire or conductor **62** is drawn and folded over the non-shearing edge **55*a***, while the shearing edge **55** cooperates with the insert **54** to shear the excess portion of the wire. As the insert **54** is forced further into the socket **52**, the lower edge of the insert adjacent the non-shearing edge cuts through the insulation and continues to draw the wire downwardly into the socket and the annular extension or rib **58** presses into the bare wire. By reason of the folded condition of the wire at **55*a*** and the pressure contact at **58**, excessive tension applied to the wire will cause the wire to fail at some point prior to the connector rather than at the connector itself.

Referring to FIG. **10**, here the connector is indicated as a generally cylindrical member **81**, having a single cavity or socket **52**. Also, a spherical insert **54*a*** is indicated. The spherical insert **54*a*** cooperates with the shearing edge **55** as previously described.

Referring now to FIG. **11**, there is illustrated a conductive insert **83**, which is, externally, similar to the insert **54** in having an annular recess **84** and rib **86** corresponding to the recess **57** and rib **58**. The insert **83** is sufficiently large to have a socket **87** corresponding to the socket **52**, and within which an insert **54** can be received in the manner illustrated in FIGS. **5–9**.

Referring to FIG. **12**, a pair of multi-conductor cables **64** and **66** are shown in the process of being spliced. Multi-conductor cable **64** has groups of conductors **67**, **68** and **69**. Similarly, multi-conductor cable **66** has groups of conductors **71**, **72** and **73**. An insulative terminal block **51** is shown mounted by mounting brackets **74**, **76** and **77** to multi-conductor cables **64** and **66**. Multi-conductor cables **64** and **66** are mounted as shown in phantom by straps **78** and **79** to a surface **80**.

Referring to FIG. **13**, one group of conductors **69** is shown being passed through a holding bar **82** with the conductors fanned out and individually received in the channels or recesses **53** in bridging relation to the sockets **52** together with similarly placed individual conductors from group **73** (FIG. **12**) ready for a completion of the connection.

Also shown in FIG. **13** at the entering side of the terminal block **51** is a row of upwardly extending wire retainers **100** forming downwardly diverging slots **101** aligned with the recesses **53**. Alternate retainers extend above the other retainers, as indicated by **102**, so that a wire may be laid across the end of a slot retainer and slipped sidewise into and forced into the entrance end of the slot.

Specifically, the upstanding retainers **100** and **102** serve, first, to guide the cable wires during initial emplacement in preselected connection locations, that is, within given channels or recesses **53**; and, second, to frictionally engage the mated wires after emplacement and maintain them with the predetermined channels while effecting connection. This retention, which is also aided by frictional contact of the wires with the walls defining the open channels **53**, although more than sufficient for holding mated wires within selected connection locations while other wires are being similarly located and connected, still permits ready removal of wires and emplacement in other connection locations in case of error.

Referring particularly to FIGS. **4**, **12** and **13**, the wires from, for example, group or bundle **69** are placed in the grooves or recesses **53** extending generally transversely of the block **51** and the sockets **52**. Also, at this time the wires are removably held, as indicated in FIG. **13**, within the channels or recesses **53**, by the confining action of retainers **100**. During or following placement of the wires, if any errors are noted, the wires are changed accordingly. After the wires from one group or bundle have been placed, the wires from another group or bundle, for example **73**, are placed in mating relation to the wires of the first bundle, extending transversely of **51** with each wire located at a predetermined wire connection location, and if any errors in placement occur, proper relocation is made.

Upon determination that the wires are correctly placed, the inserts **54** are forced in place. This may be done individually

or collectively by suitable inserting and pressing tools having magazines to carry and dispense the inserts. Such tools are not included in the present invention.

Exemplary of such tools is that described in copending United States patent application Ser. No. 761,097, entitled MAGAZINE-EQUIPPED SLUG-DRIVING TOOL, by Harry A. Faulconer and Douglas Arnold, filed Sept. 20, 1968.

Referring to FIG. **14**, conductor groups or bundles **69** and **73** of multi-conductor cables **64** and **66**, respectively, are shown joined together within an insulative terminal strip **51** and moved aside so that conductor groups or bundles such as **68** and **72** are shown as held by the guide bars **82** and **85**, respectively, and the wires placed in another insulative terminal strip **51**; the second terminal strip being shown completed ready for alignment adjacent to the first terminal strip. A plurality of individually sheared conductors **59** is shown illustrating the completion of the splice.

Referring to FIG. **15**, the completed terminal strips **51** tend to occupy an essentially parallel relationship with each other and the cables being joined, with the wires, indicated collectively, curving laterally and converging to their respective cable bundles. After connection between the cables is made, the terminal strips and wires are pressed together into a compact bundle generally colinear with the cables and wrapped with a suitable covering **103**, as indicated in FIG. **16**.

While usually the cables **64** and **66** are located in coaxial relation, this need not be the case for they may be in angular or offset relation, or may be side-by-side, as indicated in FIG. **17**. Still further, it may be desirable to provide lateral branches of cable bundles, as indicated by **67***a* in FIG. **18**. In this case, three wires are joined in each socket or selected sockets instead of a pair of wires.

Referring to FIGS. **19**, **20** and **21**, the construction illustrated is similar to the constructions shown in FIGS. **4** through **9** and FIG. **13**, and corresponding parts are indicated by the same reference numerals. In this construction, the ledge **56** supports a body **104** of angular cross section which supports the wire retainers **100**. It is desirable that the wire retainers be made of different plastic material than the terminal strip or body **51** for the reason the body **51** should be formed of relatively strong plastic in order to provide a dependable shearing edge **55**, even though each shearing edge is used only once. Also, the wire retainers may be formed of relatively soft or yieldable plastic which deforms to admit the wires or yield or combine both properties. It is further pointed out that the shearing edge is slightly lower than the back edge of the insert which permits the wire to be folded prior to shearing to ensure that the wire is drawn into the socket so as to effect a positive and permanent mechanical binding within cavity **52**.

The method of joining multiple conductor cables involves essentially the following steps or groups thereof:

The cables are arranged in fixed spaced relation with the bundles of wires extending a sufficient distance that they overlap. The terminal body supporting framework is secured with respect to the cables and a terminal body is clamped or otherwise secured in position so that wires from the bundles of both cables may be brought to and beyond the terminal body.

A single bundle from one of the cables is selected and the wires separated or fanned out so that they may be respectively placed in the retainer slots **101** and laid in the channels **53**, bridging the associated sockets **52** and thereby extending generally transversely of the terminal block **51**. As the wires are placed and on completion of placement, the wires are inspected and appropriate correction made if needed. Next, a mating bundle from the other cable is selected, the wires separated and mated with the first set of wires. Again inspection and appropriate correction is made if needed. If connection is to be made to a third cable, as shown in FIG. **18**, the steps are again repeated for that cable.

After determination that the wires are properly placed and mated, the inserts or plugs are forced in the corresponding sockets. As indicated, previously, a tool, not included in the present invention, is employed. Preferably, such tool includes a magazine for carrying a plurality of inserts or plugs and jaws which align the plugs with corresponding sockets either simultaneously or sequentially. Also, the tool may be either manually or power operated. As each plug is inserted, the excess length beyond the connection point is severed.

When each terminal body is completed, it is moved clear of the clamping means and a succeeding terminal body is secured in place and with wire placement and electrical connection of the mating wires accomplished in the manner described.

When all of the bundles of wires have been joined, the terminal bodies and the wires are pressed together into a composite or master bundle and wrapped. No insulation is needed between the terminal strips as they are formed of insulation material.

The present invention has its greatest utility in establishing electrical connection between select wires of two or more sets of wires or multi-wire cables where the number of wires or conductors in each set or cable ranges from, say, eight (FIG. **1**) to many times that number. That is, the technique of this invention is especially advantageous in providing for the arranging of a large number of sets of two or more wires per set at individual connection locations on a connector terminal where the wires are selected from multi-wire cables which can comprise individually literally hundreds of wires.

A still further important aspect of the subject invention is its applicability to the making of "in-service" connections. For example, two or more wires that are in use, and which it is desired to interconnect, can be located in, say, a channel **53** of a terminal block **51** and connected together in the manner described herein with service only being interrupted for that short period of time required to drive an insert **54** into the associated socket **52**. This substantially instantaneous connection ability, not requiring lengthy interruption of service is important particularly when working with communication circuits since it is a basic requirement there that when a line is to be taken out of service, users must be notified ahead of time. However, the time required to connect such in-service lines by the present invention is measured in the millisecond range and is, therefore, so short that no prior notification or other special measures have to be taken.

While the present invention is directed primarily to the connection of multiple conductor cables, it should be noted that the connector may be arranged in single units to effect a single joint between two or more wires. Still further, the connector may have only a few sockets which may be electrically connected and the wire or wires and their sockets may be of different size, to effect, for example, connection between wires of substantially different size.

It is customary to arrange the wires of communication cables in pairs which are distinctively colored; one color designating the "tip" or positive wire, the other designating the "ring" or negative wire. It has been conventional practice to separate or "split" a wire pair from one cable and join the wires to a pair of split wires from the other cable by means of two separate connectors.

Referring to FIGS. **13** and **20**, the provision of alternate retainers of greater height permits a pair of split wires to be handled simultaneously. That is, each pair is separated sufficiently to clear an extended retainer **102** with one color consistently to the left and the other to the right, then, while held in one hand, lowered to the shorter retainers flanking the extended retainer. A slight pull draws the wire pair against the sides of the extended retainer and a downward pull causes the wires to be drawn into corresponding slots **101**. This movement can be accomplished rapidly, thereby materially reducing the time require to effect the multiple connections between cables. Furthermore, the chance of error is minimal.

There is provided, therefore, in accordance with the practice of the present invention, a method and apparatus for interconnecting wires according to a predetermined connection scheme which optimizes the wire density. That is, the techniques of this invention permit rapid and simple connecting of large numbers of wires in a relatively small space and

where the final connection apparatus itself occupies a relatively small volume such that the additional space required for each connection is minimal.

What is claimed is:

1. An electrical connection of selected pairs of insulated wires, comprising:

a body member of non-conductive material having walls defining a plurality of sockets arranged side-by-side; each of said sockets receiving a portion of at least one of said insulated wires; said body member including wire guide means initially positioning at least one of said wires in bridging relation across and beyond the entrance end of one of said sockets;

a force transfer member engaging the bridging portion of each said wire and pressing said portion of said wire against one of said socket-defining walls and stripping a portion of the insulation from said wire;

means in each said socket shearing that portion of said wire extending beyond the entrance end of said socket as said force transfer member engages and presses said portion of said wires; and

conductive material in each said socket establishing electrical contact with said wire portion therein.

2. An electrical connecting means, as defined in claim 1, wherein:

the body member is flexible to permit shaping the body member in a circle to place the sockets in circumferential relation.

3. An electrical connecting means, as defined in claim 1, which further comprises:

electrical connecting means disposed in selected sockets and extending therebetween effecting electrical interconnection therebetween.

4. A splicing apparatus comprising:

an insulative terminal strip having a plurality of tapered cavities;

a plurality of conductors received by the cavities;

an insert snugly received by each cavity to secure a conductor therein; and

each of the cavities including a shearing edge on one side thereof whereby with the insertion of the corresponding insert, one end of each conductor in the cavity is sheared.

5. A splicing apparatus, as defined in claim 4, which further comprises:

at least one conductive bridge extending between selected cavities.

6. A splicing apparatus comprising:

an insulative terminal strip having a plurality of cavities;

a plurality of conductors received by the cavities;

an insert snugly received by each of the cavities, and electrically connected to the conductors therein;

means forming at least one slot adjacent each of the cavities for holding at least one conductor in bridging relation to the corresponding cavity prior to receiving the corresponding insert; and

shearing means at one side of each cavity for severing the excess length of each conductor.

7. A method of joining cables held in fixed relation to each other and having bundles of wires to be electrically connected and wherein there are provided a plurality of elongated multiple connector structures, each having a row of wire retention channels and an adjacent row of connector elements to effect permanent connections between the wires, the method characterized by:

placing a connector structure in position for receiving mating wires from corresponding bundles;

selecting a first bundle of wires from one of the cables, separating the wires, and then inserting the wires in retention channels;

inspecting the wires for error of placement while held by the retention channels and shifting wires to correct noted errors;

selecting a second bundle to wires from another cable, separating the wires, then inserting the wires of the second bundle in retention channels and in mating relation to wires from the first bundle;

inspecting the wires from the second bundle for error in placement while held by the retention channels and shifting wires to correct noted errors; and

securing and electrically connecting the mating wires while held by the retention channels.

8. A method, as defined in claim 7, which is further characterized by:

simultaneously, with completion of the electrical connection, severing the mating wires beyond their regions of electrical connection.

9. A method, as defined in claim 7, which is further characterized by:

repeating the steps of joining mating of corresponding bundles to connector structures;

arranging the completed connector structures in essentially parallel relation; and

pressing the connector structures radially causing the wires and connector structures to be compressed into a composite bundle.

10. A method of joining wires from a pair of wire bundles, characterized by:

releasably retaining the wires from one of the bundles in fixed separated relation to each other for inspection for error of placement, and rearranging the wires noted to be misplaced;

releasably retaining the wires from the other bundle in fixed separated relation to each other for electrical connection to corresponding previously retained wires and for inspection for error of placement, and rearranging the wires noted to be misplaced;

securing the mating wires to a common insulative support while simultaneously effecting electrical connection therebetween;

and shearing excess lengths of wires simultaneously with securing the mating wires.

11. In an electrical connection of one or more insulated electrical wires, the improvement comprising:

an insulative body member;

a plurality of walls on said body member defining a plurality of outwardly opening cavities, each of said cavities receiving an end portion of at least one of said insulated electrical wires lying thereacross;

said walls including insulation piercing means and wire severance means for respectively piercing the insulation on and severing the end portion of said at least one insulated electrical wire;

and a force transfer member fittingly received within each of said cavities forcing the end portion of said at least one insulated electrical wire into each cavity against said piercing means and against said severance means piercing the insulation on the said at least one wire and severing the terminal end portion thereof.

12. An electrical connecting means, comprising:

a body means having at least a pair of open channels, each of said channels receiving the end portion of an insulated wire;

an electrical conductor extending between the channels;

wire retaining means received within each channel engaging the wire therein;

insulation piercing means effecting an electrical connection between each wire and the electrical conductor;

wire severing means positioned to sever each wire at a point spaced from each insulation piercing means;

said insulation piercing means and said wire severing means including elements carried by the body means and the retaining means, the elements being movable toward each other on corresponding relative movement of the body means and retaining means to effect simultaneous, electrical connection between said wire and the electrical

conductor, and severance of the excess end portion of said wire.

13. An electrical connecting means, comprising:

an elongated body member having a series of juxtaposed channels, each having an open lateral side receiving the end portions of at least one insulated wire;

wire retaining means received in each channel;

wire insulation penetrating means penetrating the insulation on the wire in each channel to provide an electrical contact therewith;

and wire severing means cutting the excess portion of the wire at a location spaced from said wire insulation penetrating means;

said wire insulation penetrating means and said wire severing means including portions incorporated in the body member and the wire retaining means and essentially simultaneously effecting electrical contact with said wire and severing the excess portion of the wire, at least a portion of the wire penetrating means being conductive; and

conductive means extending between at least two of said channels and establishing electrical connection between said wires in said channels.

14. In an electrical connector, the improvement comprising:

an elongated body member;

a peripheral wall in said body member defining an outwardly opening socket receiving the end portion of an insulated electrical wire;

said peripheral wall of said socket including insulation piercing means and wire severance means which pierce the insulation on said wire and sever the end portion of said wire forced into said socket; and

a force transfer member engaging a portion of said electrical wire when said wire is extending across said socket to force a portion of the wire into said socket, pierce the insulation on the wire, and sever the terminal end portion of the wire.

15. In a method of electrically connecting several combinations of insulated wires, the improvement comprising:

a. laying the respective insulated wires of the several combinations transversely across an elongated body member adapted to receive and hold the respective wires of each of the combinations in separate wire-receiving locations containing wire severing means and disposed in spaced parallel relationship along said body member;

b. simultaneously pressing together in forced relationship said several combinations of insulated wires and separate insulation piercing and wire connecting means positioned contiguously with said wire-receiving locations of said elongated body member, and

c. in the same pressing operation of (b), simultaneously piercing insulation, connecting together each combination of wires of said several combinations, and severing each of said wires beyond the connection.

16. An electrical connector block for electrically connecting selected pairs of insulated wires from separate bundles of such wires, comprising:

an elongated base of non-conductive material; said base having an entrance side edge and a back side edge substantially parallel to said entrance side edge;

upstanding entrance wall means on said base adjacent said entrance side edge defining a plurality of generally parallel wire-entrance channels;

upstanding exit wall means on said base adjacent said back side edge defining a plurality of generally parallel wire-exit channels in substantial alignment with said wire-entrance channels;

means defining a plurality of sockets in said base, one socket being located between and substantially aligned with one of said wire-entrance channels and one of said wire-exit channels;

each of said socket-defining means comprising a substantially continuous inner peripheral wall; said inner peripheral wall including wire insulation piercing means and wire severing means; said wire severing means including a relatively sharp cutting edge spaced from said insulation piercing means; said wire insulation piercing means and said wire severing means being adapted to cooperate with a force transfer member to simultaneously pierce the insulation and sever the terminal end portion of a wire forced into each of said sockets; and

non-conductive material electrically insulating each adjacent pair of said sockets from one another.

17. An electrical connection of selected pairs of insulated electrical wires from separate bundles of such wires, comprising:

an elongated body member having an entrance side edge and a back side edge substantially parallel to and spaced from said entrance side edge;

inner peripheral wall means defining a plurality of spaced openings in said body member, said openings being aligned in a row between said entrance side edge and said back side edge and substantially parallel to said side edges;

a plurality of spaced, substantially parallel upstanding wall means adjacent said entrance side edge of said body member; said upstanding wall means defining a plurality of upwardly opening guide channels; each of said guide channels being substantially aligned with one of said openings;

a plurality of insulated electrical wires extending through said guide channels and into said openings; each of said insulated electrical wires having an intermediate portion extending through one of said guide channels, and an end portion extending into said opening aligned with said guide channel;

force transfer means pressingly engaging the end portion of each said insulated electrical wire and forcing said end portion into one of said openings;

insulation piercing means forming a component of said inner peripheral wall of each of said openings; said piercing means piercing the insulation on said end portions of said wires forced into said openings by said force transfer means;

wire severance means forming a component of said inner peripheral wall of each of said openings; said severance means severing the terminal end portions of said insulated wires forced into said openings by said force transfer means;

said wire severance means within the peripheral wall of each said opening being spaced from said insulation piercing means within the peripheral wall of each said opening; and

conductor means establishing electrical connection between selected pairs of said wires in said openings.

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