United States Patent [19]

Caveney et al.

[11] **3,778,750**

[45] **Dec. 11, 1973**

[54] **WIRE TERMINATION AND SPLICING SYSTEM**

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[73] Assignee: **Panduit Corp.**, Tinley Park, Ill.

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[21] Appl. No.: **225,089**

[52] **U.S. Cl.** ..... **339/97 R**, 339/125 R, 339/210 M, 317/122, 308/DIG. 7

[51] **Int. Cl.** **H01r 9/08**

[58] **Field of Search**.....339/95-99, 103 R, 126 RS, 339/128, 113, 198 R, 198 J, 206, 208, 210 R, 210 M; 29/203, 206; 308/DIG. 7, 238; 317/122; 179/98; 74/10.41

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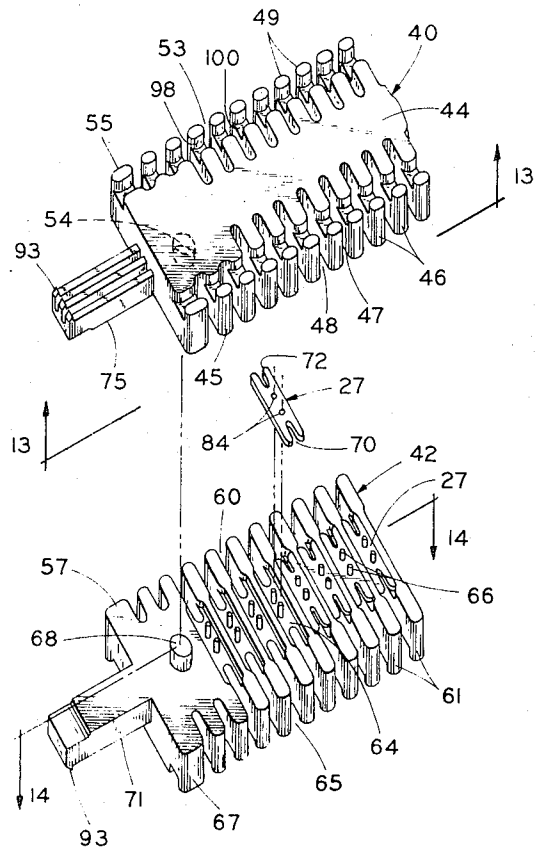
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Primary Examiner—Marvin A. Champion
Assistant Examiner—Lawrence J. Staab
Attorney—Evan D. Roberts

[57] **ABSTRACT**

A wire termination and splicing system including a frame having a pair of upstanding frame members upon which two series of elongated, two-sided, multi-contact, connectors are mounted for rotation between pairs of rotational mounts having detent action for successively positioning the sides of the connectors in convenient wire installation orientation; each connector including an insulative connector block having a plurality of wire-receiving slots therein and carrying a plurality of recessed insulation-stripping contacts in the slots, each slot having a wire restraining structure for temporarily holdihg a wire to be forced onto the associated contact and retaining structure for holding a wire on the associated contact; the connector block being provided with a color coding adjacent to the slots, reaction surfaces for cooperating with a wire installation tool, and a cap for assisting in holding installed wires therein; wire guiding channels are provided, associated with the frame for bringing wires from cables to the connectors and for guiding cross-connect wires between the two series of connectors.

9 Claims, 23 Drawing Figures



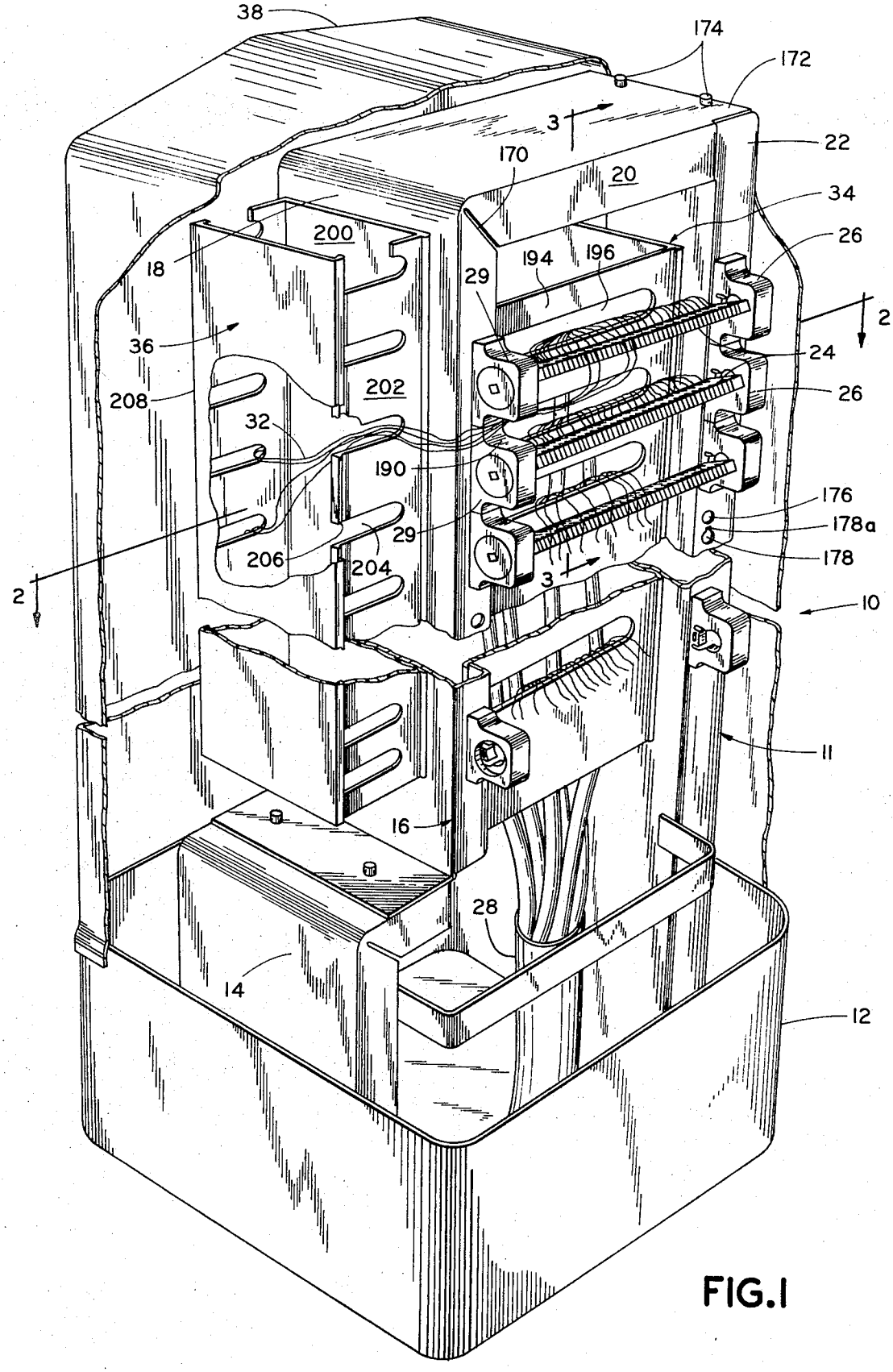

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FIG.1

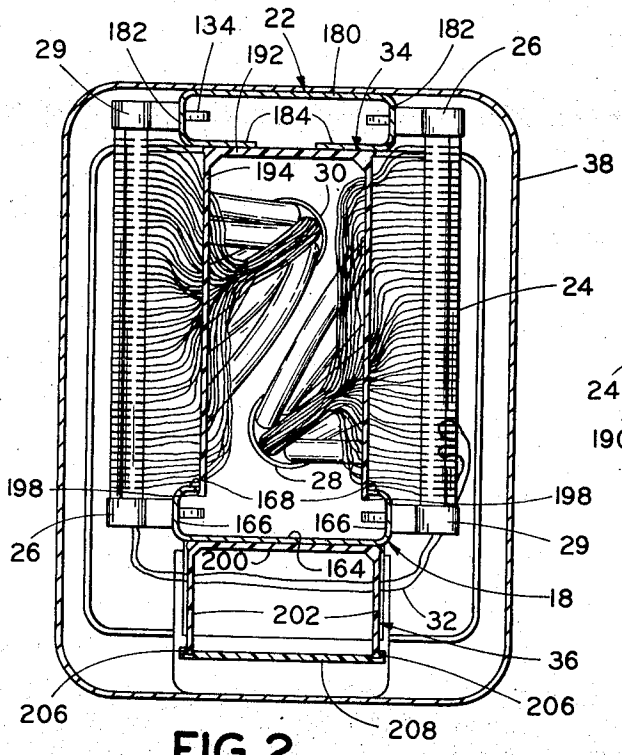


FIG.2

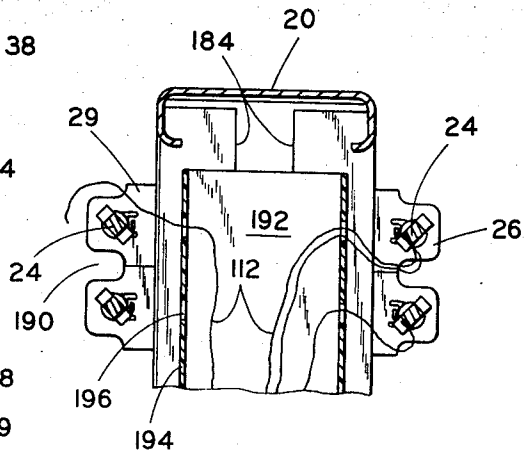


FIG.3

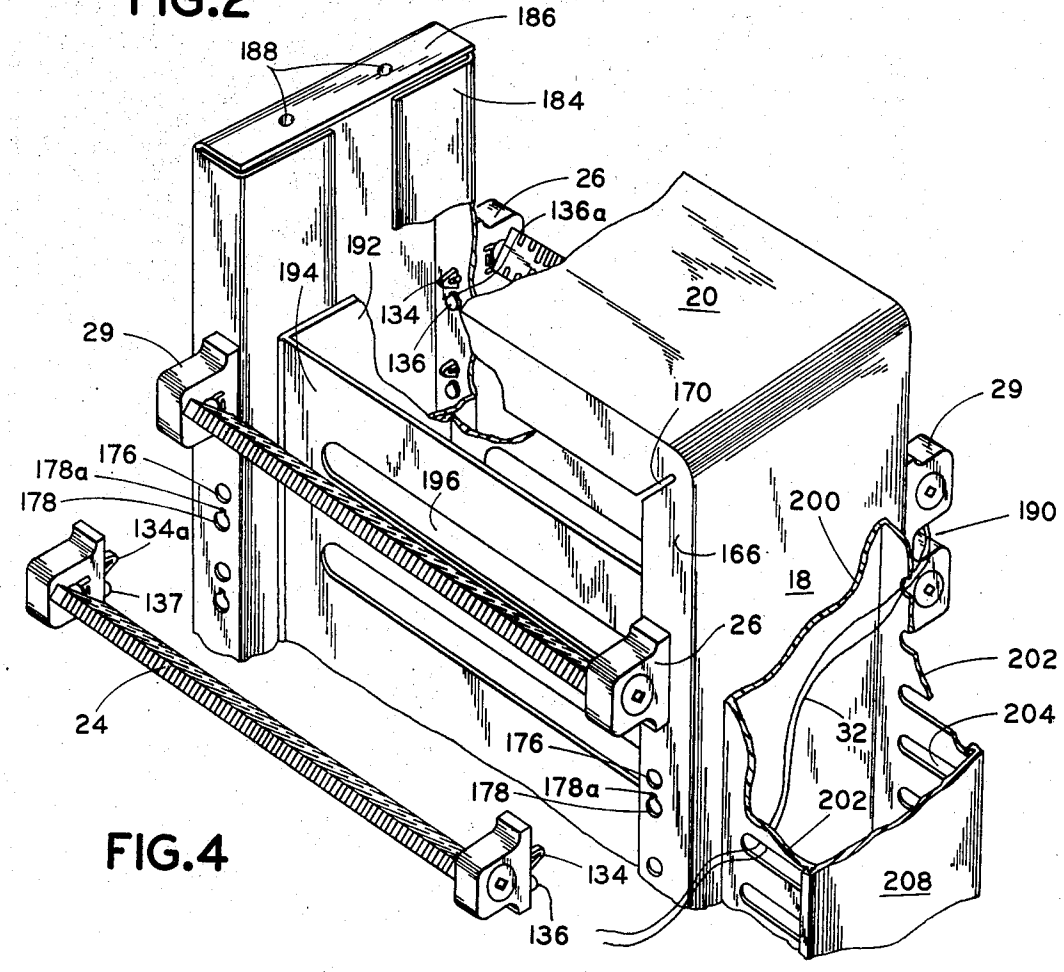


FIG.4

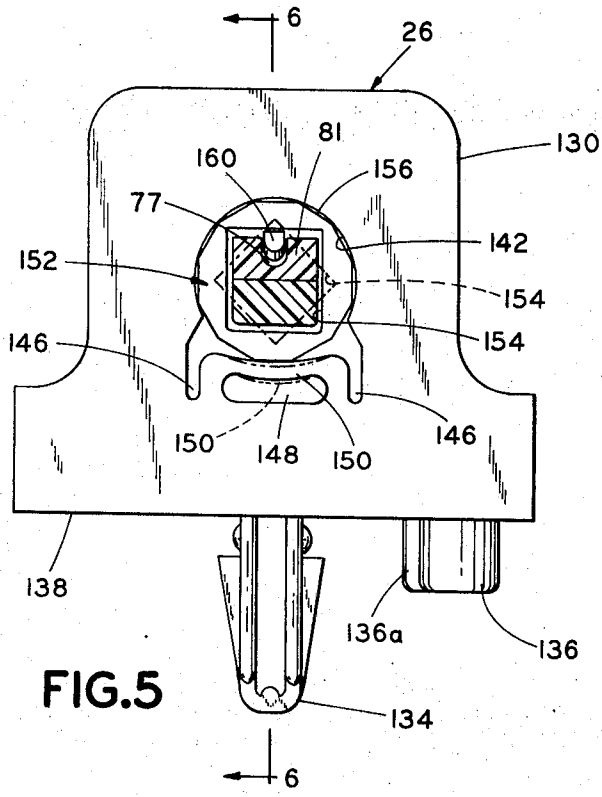


FIG.5

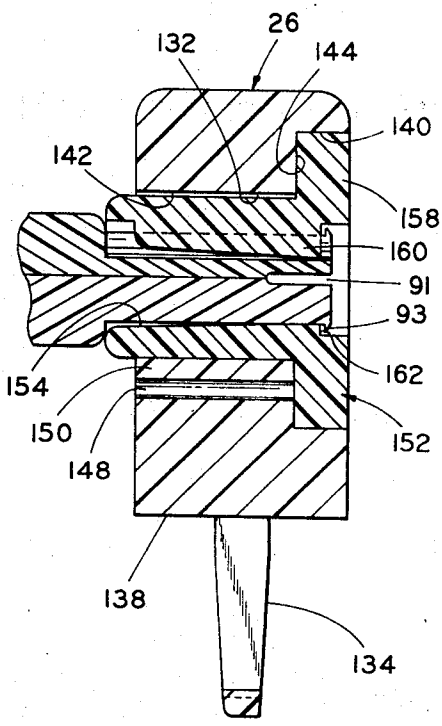


FIG.6

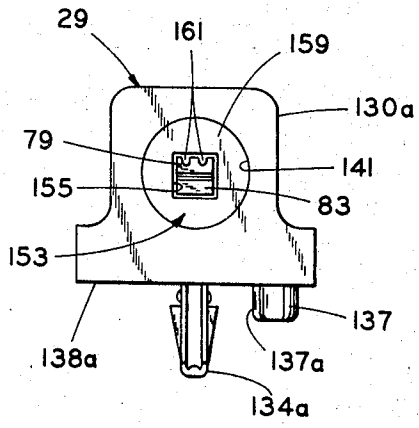


FIG.5a

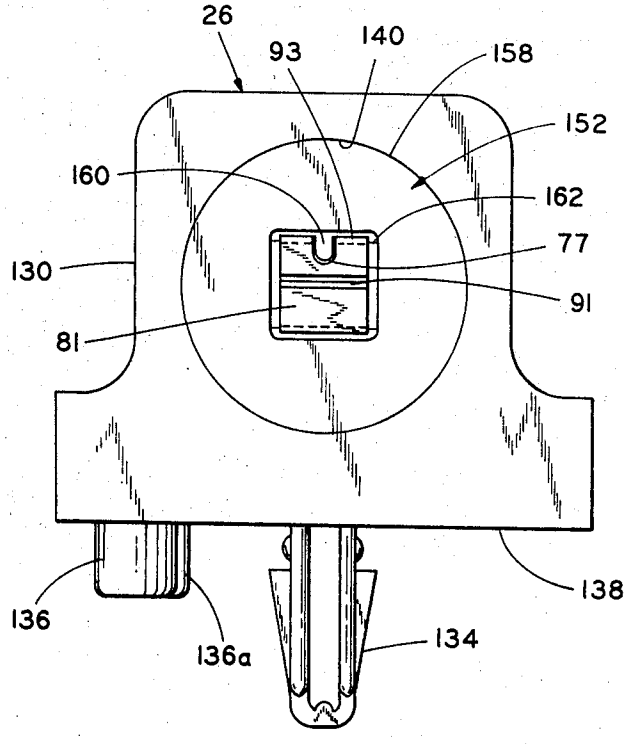


FIG.7

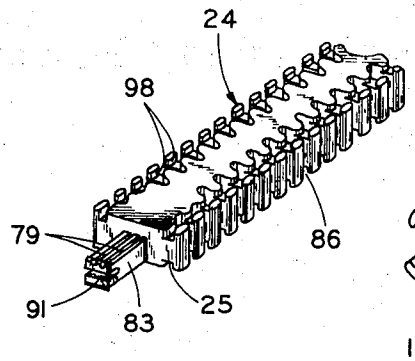
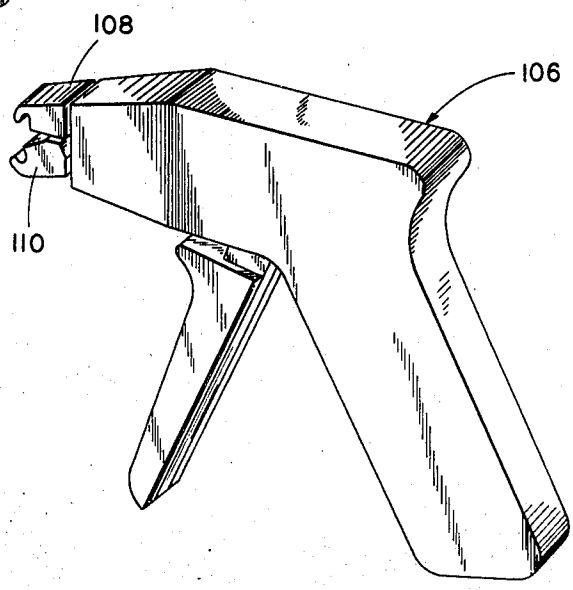


FIG.8



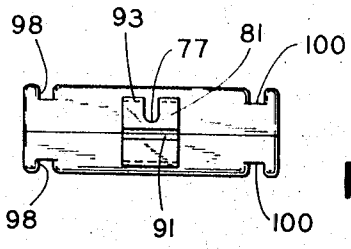


FIG.11

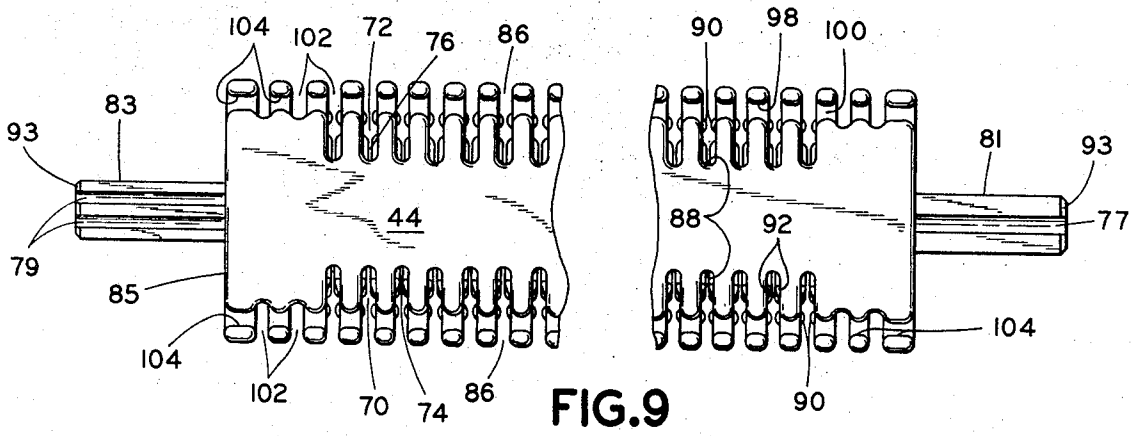


FIG.9

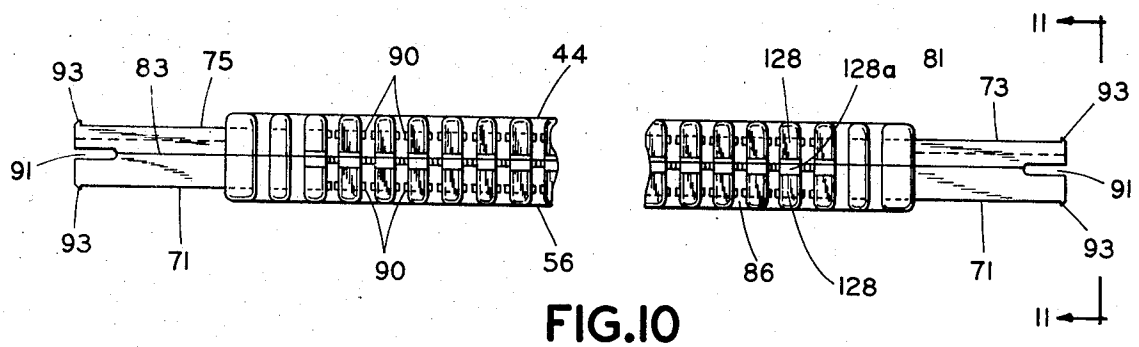


FIG.10

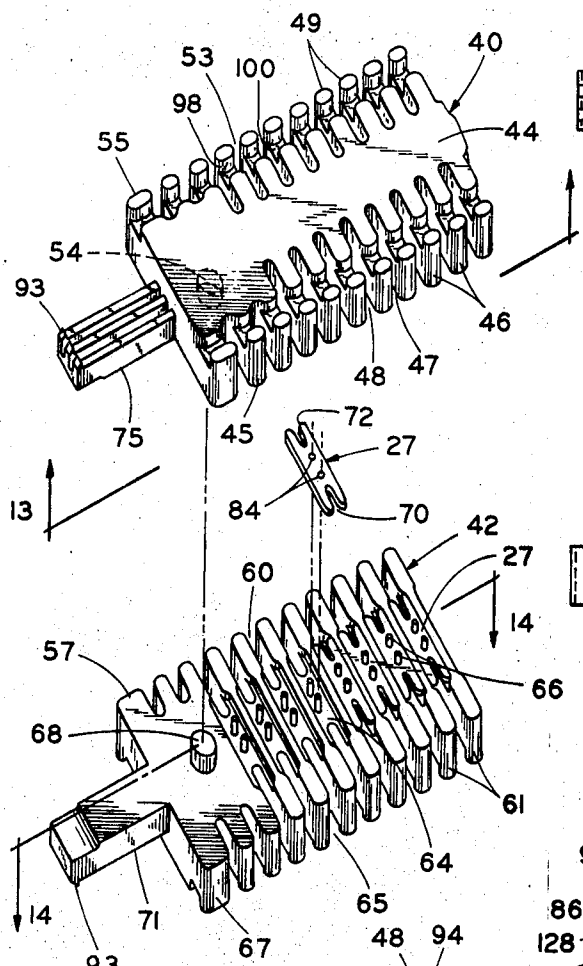


FIG.12

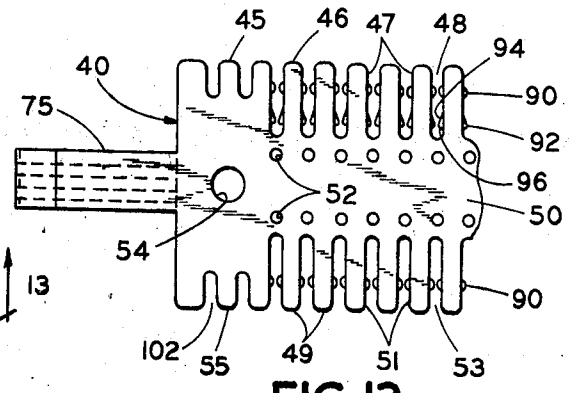


FIG.13

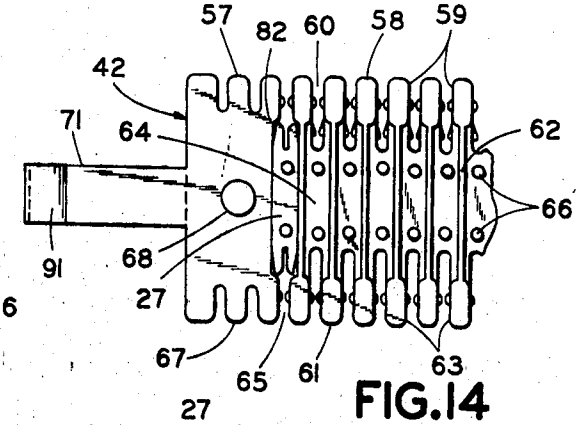


FIG.14

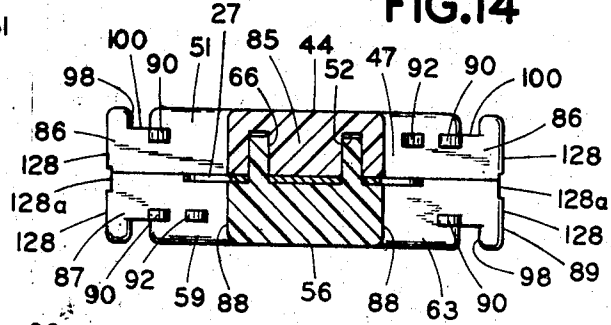


FIG.15

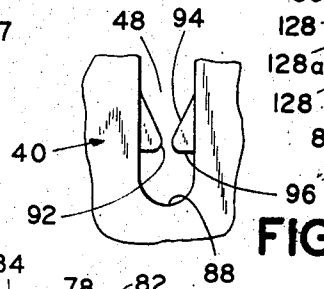


FIG.13a

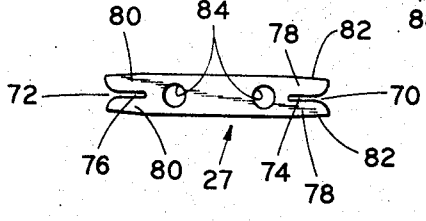


FIG.12a

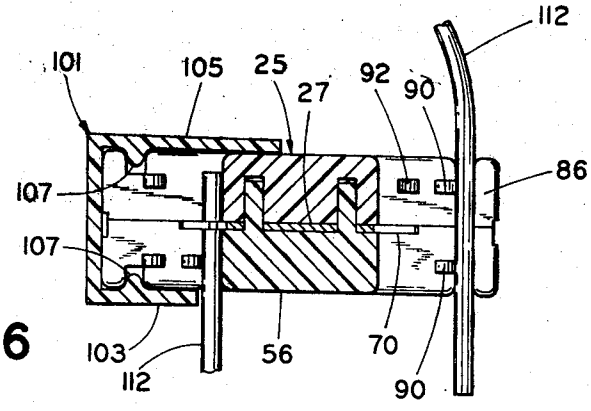


FIG.16

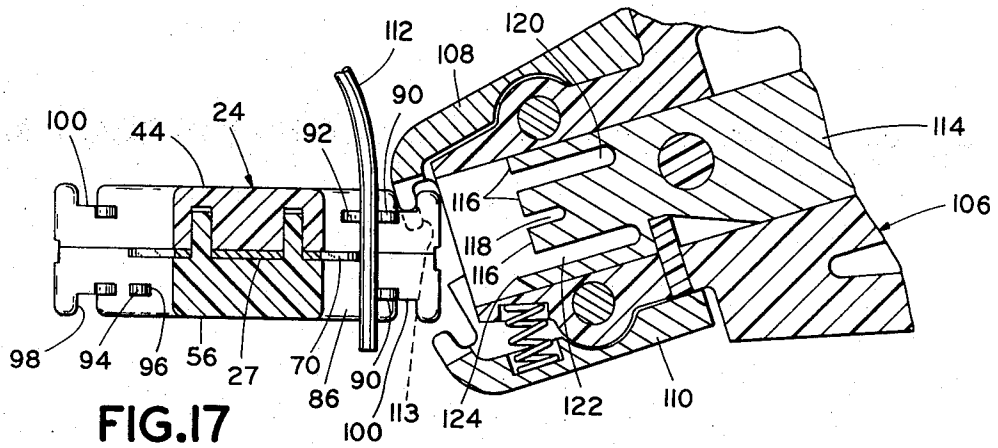


FIG.17

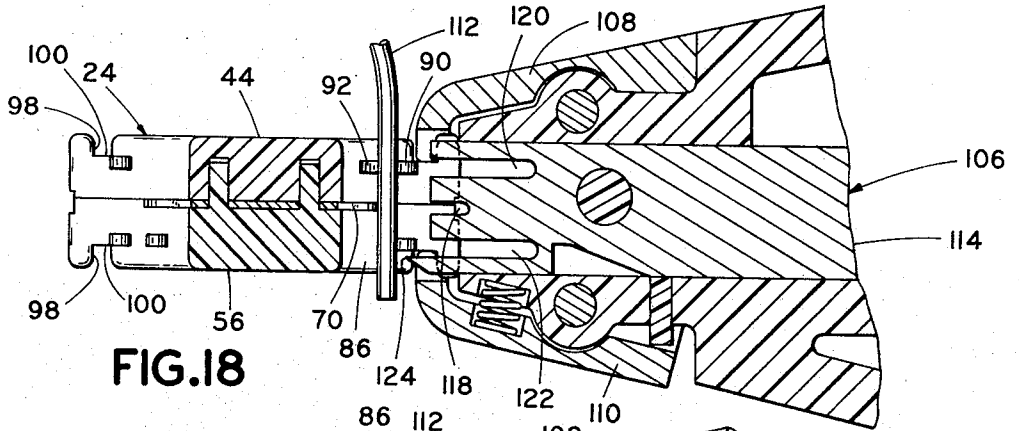


FIG.18

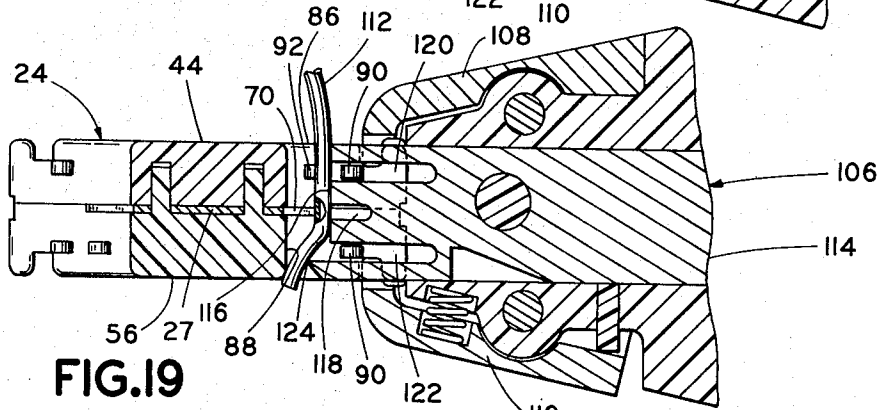


FIG.19

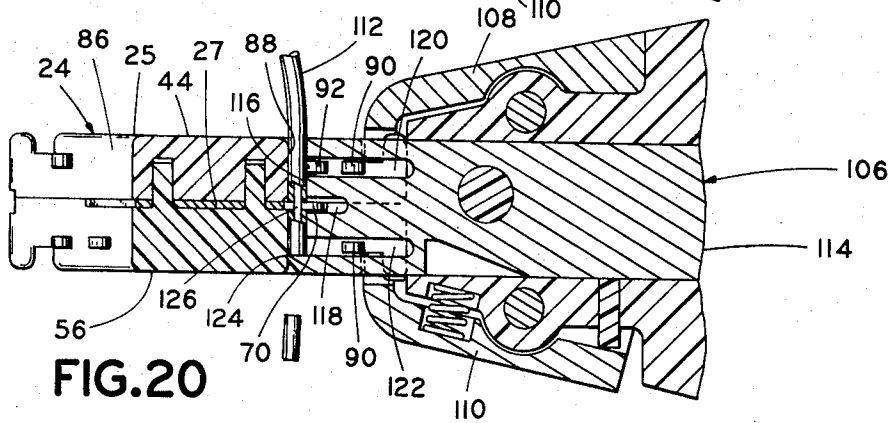


FIG.20

WIRE TERMINATION AND SPLICING SYSTEM

BACKGROUND OF THE INVENTION

The present invention is directed to a wire termination and splicing system. More particularly it is directed to a system for terminating multiple insulated wires by utilizing insulation-stripping contacts in a novel connector and connector mounting system.

The connectors and the wire terminating assembly disclosed and claimed herein find many applications in the electrical industry; however, they are particularly useful in the telephone industry and within that industry find application in cross-connect wiring systems and wire-splicing devices.

Insulation-stripping contacts are themselves well-known in the electrical art and have long been used extensively in the telephone industry for forming end-to-end splices of cable segments and for forming connections between feeder cables from a central telephone office and distribution cables leading to various telephone units within a building. The typical cross-connect wiring system consists of two banks of terminal blocks or connector blocks mounted in a cabinet. One bank of terminal blocks is permanently connected to the wires of a feeder cable and the other bank of terminal blocks is permanently connected to the wires of a distribution cable. Selected terminals on the one bank of terminal blocks are then connected by cross-connect wires respectively to selected terminals on the other bank of terminal blocks. While the connections to the feeder and distribution cables are seldom changed, the connections to the cross-connect wires are often changed as individual phones are installed and removed.

The most common terminal blocks in use in such systems at the present time are bulky blocks of insulating material having 50 contacts made of heavy gauge metal for connecting 25 pairs of telephone wires. Each contact contains two or more pairs of insulation crushing jaws extending from an electrically common conducting body and outwardly from the insulating block in unsupported fashion.

Termination of a wire is made by manually placing the insulated wire between a pair of the insulation crushing jaws and forcing it down into a narrow slot between the jaws displacing the insulation and establishing electrical contact between the bared wire and the particular contact in question. The forcing action is normally accomplished by a screwdriver-like hand tool pushing the insulated wire downwardly toward the insulating block, the force of the tool being transmitted through the contact to the insulating block. Either the tool or the insulating block normally carries a metal cutting edge for severing the waste wire after the connection is made.

Other connections are then made in a similar manner to one jaw pair on each contact. Selected ones of the remaining jaw pairs are then connected to contacts on other terminal blocks by cross-connect wires. The typical prior art terminal block suitable for the interconnection of 25 pairs of telephone wires is a rather bulky device having dimensions of approximately 3 × 12 Such devices when used in large telephone cable terminating cabinets, either inside or outside a building, occupy a significant amount of space and the space required continues to grow with additional telephone installations in a given area.

SUMMARY OF THE INVENTION

By contrast to the prior art the termination system of the present invention provides a miniaturized connector capable of interconnecting 25 pairs of wires onto a connector block measuring approximately 1 × 6 resulting in a much more compact wire termination system. A novel mounting means and frame for multiple connector blocks allows each connector block to be rotated for easy access by the installer and further assists the installation of wires by providing a wire separation system for separating individual bundles of 50 wires after they leave the main cable and extend toward the connector itself.

Furthermore, the connector of the present invention provides ease of installation of the wires by providing a series of slots into which the wires can be manually placed prior to the installation onto insulation-stripping contacts buried within and protected by the connector. The slots are so designed that the wires are retained in the slots in proper position for installation by a suitable compatible reaction type tool such as that described in copending application Ser. No. 225,267, filed of even date herewith, entitled Wire Installation Tool and assigned to the assignee of the present invention.

It is an object of the present invention to provide an improved wire termination and splicing system.

It is a further object of the present invention to provide an improved insulation-stripping connector for the electrical termination and splicing of wires.

Still a further object of the present invention is to provide an improved insulation-stripping connector which is compatible for use with a reaction type installation tool.

These and other objects of the present invention will be more clearly understood and appreciated from the following detailed description of the invention together with the drawings in which:

FIG. 1 is a perspective view of a wire termination system embodying the present invention;

FIG. 2 is a sectional view of the wire termination system illustrated in FIG. 1 taken along line 2—2 thereof;

FIG. 3 is a sectional view of the wire termination system illustrated in FIG. 1 taken along the line 3—3 thereof;

FIG. 4 is a perspective view partially exploded of a portion of the wire termination system of the present invention;

FIG. 5 is a front elevational view of a preferred embodiment of a rotational mount for use in the wire terminating system of the present invention, a right-hand mount being illustrated;

FIG. 5A is a view like FIG. 5 illustrating a left-hand mount;

FIG. 6 is a sectional view of the mount of FIG. 5 taken along line 6—6 thereof;

FIG. 7 is a rear elevational view of the mount of FIG. 5;

FIG. 8 is a perspective view of a partial connector block in accordance with the present invention illustrating its relationship to a reaction type wire insertion tool;

FIG. 9 is a plan view, partially broken away, of a preferred embodiment of a connector in accordance with the present invention;

FIG. 10 is a side elevational view, partially broken away, of the connector of FIG. 9;

FIG. 11 is an end view taken from line 11—11 of FIG. 10;

FIG. 12 is an exploded view of a connector in accordance with the present invention;

FIG. 12A is a plan view of a contact forming a part of the connector block of FIG. 12;

FIG. 13 is a plan view of the upper segment of the connector block of FIG. 12 taken along line 13—13 thereof;

FIG. 13A is a fragmentary view of a portion of the connector block segment of FIG. 13;

FIG. 14 is a plan view of the lower segment of the connector block of FIG. 12 taken along line 14—14 thereof;

FIG. 15 is a sectional view of the connector of the present invention taken along line 15—15 of FIG. 10;

FIG. 16 is a sectional view of a connector in accordance with the present invention having a wire in position for manual insertion on one side and an installed wire on the opposite side;

FIG. 17 is a cross-sectional view of the connector of FIG. 16 having the wire manually positioned and illustrating the relationship of the installation tool;

FIG. 18 is a view similar to FIG. 17 having the installation tool in place to engage the wire;

FIG. 19 is a view similar to FIG. 18 illustrating the relationship of the wire, the connector and the tool during an intermediate step of the installation; and

FIG. 20 is a view similar to FIG. 19 illustrating the fully installed wire and the relationship of the tool to the connector and to the wire.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1–4, a preferred embodiment of the wiring system of the present invention is illustrated in the form of a pedestal wiring cabinet 10 including a frame 11 having an outer rectangular base 12 to which is connected at one end thereof an inner base 14, the outer base 12 being normally affixed to the earth by suitable means known in the art and not illustrated. The opposite end of the outer base 12 has secured thereto a fixed frame member 22 which extends vertically therefrom. The inner base 14 and the frame member 22 support a removable L-shaped frame member 16 which includes a vertical leg 18 that extends upwardly from the base 14 and horizontal leg 20 supported at the outer end on the frame member 22.

Two series of connectors 24 are rotatably mounted by mounts 26 and 29 respectively on the opposite sides of and extending between the removable frame member 16 and the fixed frame member 22, each connector 24 carrying two sets of contacts thereon. One set of contacts in the first series of connectors 24 is connected to the wires of a feeder cable 28 (FIG. 2) and one set of contacts in the second series of connectors is connected to the wires of a distribution cable 30. The other set of contacts on each of the rotatably mounted two-sided connectors 24 is utilized on a selective basis to extend cross-connect wires 32 from the feeder side to the distribution side of the frame. The cabinet 10 is further provided with a bundle separation channel 34 for separating individual bundles of 50 wires of the respective feeder and distribution cables to present the wires in position for attachment to the respective connectors 24. A wire guiding duct 36 is also provided on the outside of the removable frame member 16 for guiding the cross-connect wires 32 from one side of the frame 11 to the other in an orderly fashion. The entire assembly is provided with an outer cover 38 which protects the other portions of the wiring system from the elements.

The operation and interaction of the various elements in this system will be better understood after the following detailed description of each of the above noted components.

Referring now specifically to FIGS. 8–16, a preferred embodiment of the novel connector 24 of the present invention is illustrated. The connector 24 is made up of a connector block 25 manufactured from a suitable thermoplastic resin, and preferably a nonflammable or self-extinguishing and insulating thermoplastic resin; disposed within the connector block 25 is a plurality of thin flat contact strips 27. The connector block 25, in its preferred embodiment, is an elongated body of insulating material made from two connector block segments 40 and 42 (FIG. 12) which will, for purposes of explanation, be referred to hereinafter as first and second connector block segments, respectively. The first connector block segment 40 comprises an elongated body portion formed from a block rectangular in cross section and having a side surface 44 illustrated at the top in FIG. 12. The opposite longitudinally disposed edge surfaces of the segment 40 carry a plurality of laterally aligned indentations 48 and 53, respectively, forming a plurality of flexible fingers 46 and 49, respectively, terminating in outer surfaces 45 and 55, respectively, that are generally disposed in planes defining outer edge surfaces for the connector block segment 40. The fingers 46 are uniformly spaced from each other and are generally of uniform thickness and have laterally extending and generally parallel walls 47 that are disposed normal to the longitudinal axis of the connector block segment 40. The fingers 49 are also uniformly spaced from each other, are of generally uniform thickness, and have walls 51 disposed generally parallel to each other and normal to the longitudinal axis of the connector block segment 40. As illustrated, each of the fingers 46 is in lateral alignment with one of the fingers 49, and the indentations 48 defined between the fingers 46 are each in general lateral alignment with one of the indentations 53 formed between the fingers 49. In other words, the indentations 48 and 53 are arranged in laterally aligned pairs, and the indentations have a width in the direction of the longitudinal axis of the connector block segment 40 that is approximately equal to the thickness of the fingers 46 and 49 in that direction, the fingers 46 and 49 being also laterally aligned in pairs along the length of the connector block segment 40. The first connector block segment 40 also includes a contact retaining surface 50 which, in the illustrated embodiment, is planar, and intersects the surfaces 45 and 55 at their opposite ends from the side surface 44. The contact retaining surface 50 includes in its central area two rows of openings 52, each adapted to receive a pin as will be described hereinafter. One opening 52 from each of the two rows is located in lateral alignment with each aligned pair of indentations 48 and 53. The first connector block segment 40 is also provided with a post receiving opening 54 located at one end of the connector block segment 40. Each of the openings 52 and 54 extends perpendicularly into the central portion of the connector block segment 40 from the contact retaining surface 50 and toward the side surface 44.

The second connector block segment 42 is compatible in design with the first connector block segment 40 and includes an elongated body portion formed from a block rectangular in the cross section and having a side surface 56, see FIG. 15. The opposite longitudinally disposed edge surfaces of the segment 42 carry a plurality of laterally aligned indentations 60 and 65, respectively, forming a plurality of flexible fingers 58 and 61, respectively, terminating in surfaces 57 and 67 respectively, that are generally disposed in planes defining outer edge surfaces for the connector block segment 42. The fingers 58 are uniformly spaced from each other and are generally of uniform thickness and have laterally extending and generally parallel walls 59 that are disposed normal to the longitudinal axis of the connector block segment 42. Fingers 61 are also uniformly spaced from each other and are of generally uniform thickness and have walls 63 disposed generally parallel to each other and normal to the longitudinal axis of the connector block segment 42. As illustrated, each of the fingers 58 is in lateral alignment with one of the fingers 61, and the indentations 60 defined between the fingers 58 are each, in general, laterally aligned with one of the indentations 65 formed between the fingers 61. In other words, the indentations 60 and 65 are arranged in laterally aligned pairs; the indentations have a width in the direction of the longitudinal axis of the connector block segment 42 that is approximately equal to the thickness of the fingers 58 and 61 in that direction, the fingers 58 and 61 being also laterally aligned in pairs along the length of the connector block segment 42.

The various parts of the connector block segment 42 that correspond in shape and function to like parts in the connector block segment 40 have the same general overall dimensions and spacings, whereby assembly of the connector block segment 40 and 42 to form the connector block 25 can be accomplished, all as will be explained more fully hereinafter.

Referring specifically to FIG. 14, the second connector block segment also includes a contact receiving surface 62 which is generally planar and is adapted to mate with the contact retaining surface 50 of the first connector block segment 40. The contact retaining surface 62 includes a plurality of contact recesses 64. Each contact recess 64 has a bottom surface which is displaced from and parallel to the contact retaining surface 62. The depth of the contact recesses 64 is, in the illustrated embodiment, just sufficient to accept the thin flat metal contact strips 27. The contact recesses 64 also have a generally rectangular profile adapted to receive and hold such a contact. Two rows of alignment pins 66 extend at right angles from the bottom surface of the contact recesses 64. These alignment pins are of a proper diameter and are properly located to mate with the openings 52 in the first connector block segment 40. They serve a dual function, as will become apparent hereinafter, of acting as alignment and fastening surfaces for the connector block segments 40 and 42 as well as bearing surfaces to absorb force from the contacts during insertion of wires.

One heavier alignment pin or post 68 is disposed at one end of the second connector block segment 42 and extends perpendicularly to the contact retaining surface 62 to mate with the post receiving opening 54 in the first connector block segment 40. This post and opening combination 68, 54 serves primarily to assure that the segments 40 and 42 are assembled properly and are not turned end for end with respect to each other. It will, of course, be understood that various combinations of alignment pins 66 with mating openings 52 and alignment post 68 with mating opening 54 are possible and that the configuration locating all pins and posts on one connector segment and all openings on the other connector block segment is presented for illustrative purposes only.

Each connector block segment is provided at its opposite end surfaces with a mounting post or stud against extending longitudinally therefrom. In the illustrated embodiment, (FIGS. 9 & 10) the second connector block segment is provided with oppositely extending identical mounting post segments 71. The first connector block segment 40 on the other hand, has two different mounting post segments 73 and 75 at its opposite ends. The first segment 73 is provided with a key way 77 on its outer surface while the second segment 75 at the opposite end includes a pair of key ways 79 differing in position from the single key way 77. These key ways are for the purpose of assuring foolproof orientation of the connector block 25 in conjunction with the mounts 26 and 29 to be described hereinafter.

The contact strip 27 illustrated in perspective in FIG. 12 and in plan in FIG. 12A is an insulation-stripping contact strip which may be of any suitable conductive material such as phosphor bronze. In the illustrated embodiment, the contact strip 27 includes first and second stripping and gripping areas 70 and 72 in the form of narrow notches 74 and 76 defined by closely spaced arms 78 and 80. In plan view the contact strip 27 is generally an elongated rectangle and the thickness is of the order of 0.016 inch. The outer edges 82 of the arms 78 and 80 are tapered slightly inwardly toward the outer ends of the contact to provide a slight relief in the contact recesses 64 (FIG. 14) to accommodate outward movement of the arms 78 and 80 due to the force exerted by an inserted wire. The contact strip 27 is also provided with a pair of apertures 84 which in the illustrated embodiment are adapted to receive alignment pins 66 in the second connector block segment 42.

In assembling the connector block 25, the second connector block segment 42 which, in the illustrated embodiment, carries the alignment pins 66 and 68, respectively, is positioned with the pins vertically disposed and contact strips 27 are placed in each of the 50 contact recesses 64 with the alignment pins 66 passing through the apertures 84 in the contact strips 27. The alignment pins 66 thus act during assembly to properly position the contact strips 27 in the recesses 64. The first connector block segment 40 is then lowered onto the alignment pins 66 and the alignment post 68 which are respectively received into the openings 52 and the post receiving opening 54 of the first connector block segment 40. The connector block 25 is held in assembled position by means of adhesive applied to the mating surfaces or by other suitable means. Also the mounting post segments mate to form rectangular mounting studs or posts 81 and 83 respectively containing one and two key ways 77 and 79 and further each including a lateral flexure slot 91 and a pair of mounting ribs 93 for cooperation with the mounts 26 and 29. The assembled connector block is best illustrated in FIGS. 8–10 and 15. In the assembled form, the solid central portions of the two connector block segments are mated to form a central insulative core 85 of the

connector block which like its mating component halves is rectangular in cross section (FIG. 15). The side surfaces 44 and 56 of the respective connector block segments become the side surfaces of the finished connector block 25. The edge surfaces 55 and 57 of the respective segments combine and align to form the edge surface 87 of the connector block 25 and the edge surfaces 45 and 67 of the respective segments combine and align to form the edge surface 89 of the connector block 25, each of the edge surfaces 87 and 89 extending between and intersecting the side surfaces 44 and 56. Also, the indentations 48 and 65 combine to form a first plurality of wire-receiving slots 86 and the indentations 53 and 60 combine to form a second plurality of wire-receiving slots 86, each of the slots 86 being open-ended and laterally aligned in pairs. The shape of the slots 86 is best illustrated in FIG. 9 which indicates that the slots 86 are U-shaped in plan view and have a bottom wall 88 as the bight, and flexible side walls composed of the walls 47 and 63 in one series of slots 86 and flexible side walls composed of the walls 51 and 59 in the other series of slots 86 as described previously with respect to the first and second connector block segments. Each such slot 86 is open at its outer lateral extremity at the respective edge surface 87 or 89 and at both of its ends. The width of each slot 86 as measured in a direction parallel to the longitudinal axis of the block 25 is predetermined to be just larger than the largest insulated wire which the connector 24 is designed to accept.

Again referring to FIG. 9, it can be seen that while the main body of each contact strip 27 is embedded within the central core of the connector block 25, the wire stripping and gripping areas 70 and 72 extend from the bottom walls 88 of a pair of laterally aligned oppositely disposed slots 86 and partway into the slots 86 in order to provide a pair of opposed contacts to which access can be had by a wire with which electrical contact is to be made. At the same time as can be seen from the exemplary contact shown in FIG. 14, almost the entire periphery of the contact strip 27 including the outer edges 82 is securely supported by the periphery of the contact recesses 64 of the second connector block segment 42 cooperating with the contact retaining surface 50 of the first connector block segment 40. Thus, the contact strip 27 can be made of thin springy material since it is not required to be free-standing and is supported during the insertion of the wire and thereafter. Also because the ends of the contacts are recessed well back into the slots 86, the contacts are well protected against bending or any unintentional electrical contact with other contacts within the connector block, and the relief provided by the tapered edges 82 prevents distortion of the ends of the contact strip 27 during and after the insertion of a wire.

In order to facilitate wire insertion when handling 50 wires in a bundle each slot 86 in the connector block 25 also includes a wire restraining structure for holding an insulated wire, prior to insertion, in a position wherein it is easily inserted by a suitable tool. This wire restraining structure in the embodiment illustrated is in the form of a series of four protrusions 90 extending from opposite walls of each of the slots 86. The protrusions 90 seen in plan view in FIG. 15 and in profile in FIG. 9 are positioned in pairs in each slot, one pair being located, for example, on the walls 48 of the first connector block segment protruding toward each other in registry to provide an opening narrower than the diameter of the insulated wire to be used within the slot. This pair of protrusions 90 is located on the wall of the slot 86 approximately one insulated wire diameter toward the outer lateral extremity of the slot beyond the outer end of the stripping and gripping areas 70 of the contact strip 27. They are also located a preselected distance from the outer end of the open-ended slot 86 and a preselected distance from the contact retaining surface 50 of the first connector block segment 40.

The second pair of protrusions 90 is located on the walls of the open-ended slot 86 formed by the walls 65 of the second connector block segment 42. These protrusions 90 also define a passage narrower than the diameter of the insulated wire to be inserted and they are positioned the same distance from the outer lateral extremity of the slot 86, the same distance outside the outer end of the stripping and gripping area 70 and the same distance from the second end of the open-ended slot 86. Each of the slots 86 includes two pairs of the protrusions 90 located similarly to those described above. Each protrusion 90 is illustrated in one dimension as being rounded as seen in the profile in FIG. 9 and is in the other dimension of a predetermined width for purposes of accommodating a compatible insertion tool without destroying the protrusion 90 so that they remain usable again should the wire in the particular slot be removed and a new one inserted. The particular shape of these protrusions 90 is a matter of choice so long as they permit the insulated wire to pass with slight flexure of the walls of the slot 86 without removal of the insulation and define a passage narrow enough to hold the insulated wire after it passes between the protrusions 90.

Each slot 86 is also provided with a retaining means best illustrated in FIGS. 9 and 13*a*. The retaining means, in the illustrated embodiment, takes the form of a pair of wedge-like projections 92 extending from both walls of the slot 86 adjacent to the bottom wall 88 of the slot 86. Each projection 92 has a sloped wire receiving or deflecting surface 94 facing generally toward the outer edge surface of the wall and a wire retaining surface 96 extending perpendicularly from the wall of the associated slot 86 and facing the bottom wall 88 of the associated slot 86. The space between the wire retaining surface 96 and the bottom wall 88 of the slot is approximately equal to the width of the slot and consequently to the insulated diameter of the wire to be utilized in the connector 24. The wire retaining means 92 is located at the same distance between the first end of the open-ended slot 86 and the contact strip 27 as was the wire restraining structure 90 described earlier, and is also of the same width so that an application tool applied from the edge surface into the laterally extending slots 86 can force the associated wire onto the contact without destroying either the wire restraining structure 90 or the wire retaining means 92. It should be noted that a similar wire retaining means is not usually provided on the opposite side of the contact because, as will become apparent hereinafter and as is illustrated in FIG. 20, the wire is normally cut off on one side of the contact during insertion.

As in the case of the wire restraining structure the exact shape of the wire retaining means 92 can vary so long as it functions to hold the wire adjacent to be bottom wall 88 of the slot. The wire retaining means 92

acts after insertion of the wire as a means of preventing pullout of the wire and also as a strain relief on the gripped portion of the wire in the contact. It is also within the scope of the present invention to form the wire restraining structure **90** and the wire retaining means **92** extending from only one wall of the slot **86** to define a narrowed passage functioning in a manner similar to that of the illustrated embodiment.

The connector block **25** is also provided with reaction surfaces **98** which in the illustrated embodiment are disposed on the flexible fingers **46, 49, 58** and **61** as the case may ne adjacent to the slots **86.** The reaction surfaces which can best be seen in perspective in FIG. **12** are formed by the inner surfaces of a series of discrete channels **100** cut into the side surfaces **44** and **56** of the block near the outer extremity of the fingers just inside the edge surfaces **87** and **89.** Each channel **100** is symmetrically disposed with respect to the edge surfaces of the connector block **25** and with respect to the plane of the flat contact strip **27** which is located midway between the channel **100** on the first side surface **44** and the channel **100** on the second side surface **56.** The discrete short channels **100** are also aligned and of the same size and profile so that in an end view of the connector block they appear to be a continuous channel of generally U-shaped profile. It can be seen however from FIGS. **9** and **12** that the bearing surface **98** formed by the outer surface of each discrete channel **100** is rounded convexly on the side facing toward the central core **85** of the connector block. The purpose of the convex reaction surfaces is to provide a self-aligning feature for a reaction type installation tool when the tool is applied to the reaction surfaces. Thus, if the tool is applied to the connector block in a position where the insertion members or blades would engage edge surface of the walls of the slots rather than the slots **86** themselves, the reaction surfaces **98** cooperating with suitable locating surfaces on the tool will cause the tool to properly align itself without a conscious effort on the part of the operator. The reaction surfaces **98** then engage suitable reaction surfaces on the installation tool to cause the forces exerted during installation of a wire onto the contact strips **27** to be absorbed through the reaction surfaces **98** and back through the tool so that no other force need be exerted on the connector block during wire installation. In other words, the connector block could be wholly supported by the reaction surfaces of the tool and free of all mounts during installation of a wire. Thus the reaction surfaces **98** in combination with an appropriate tool minimize bending forces on the connector block and forces on the block mounts during wire installation.

The channels **100** also cooperate to hold a cap **101,** (FIG. **16**) in place on the connector block after all wiring has been completed. The cap **101** is a plastic channel, rectangular in cross section having a short side wall **103** and a long side wall **105** which enclose the side surfaces **44** and **56** of the connector block. The short side wall is positioned on the side of the block from which wires extend, terminating just above the wire retaining means **92** and cooperating therewith to prevent removal of the wire. The long side wall **105** is positioned on the side of the block where the wires have been cut off and covers the entire end of the slots **86** to prevent dirt and corrosion in the contacts. The side walls **103** and **105** are provided with a pair of opposing ridges **107** extending inwardly for the length of the cap. These ridges mate with the channels **100** of the block to provide a positive lock holding the cap in position. The cap may be applied by sliding it along the channels **100** or by flexing the side walls and moving the cap laterally onto the block **25.**

Similar reaction surfaces **98** and similar channels **100** are disposed respectively adjacent the four corners of the connector block formed by the intersection of the side and edge surfaces of the connector block. It will be evident to those skilled in the art that similar reaction surfaces might be employed on the inner walls of the adjacent slots or on the outer surfaces of the center core of the connector block without departing from the scope of the present invention. The location and design of the reaction surface illustrated in the preferred embodiment of the present invention is preferable to the other locations mentioned because it provides superior visibility of the slots while making a contact and ease of access for a reaction tool while providing a balanced reaction force on either side of the contact thus eliminating any tendency of a reaction tool gripping the oppositely disposed pair of reaction surfaces **98** to twist due to the force of inserting a wire onto the associated contact strip **27.**

It should also be noted as seen in FIG. **9,** that two additional slots **102** are provided at either end of the connector block and that each of the slots **102** is of a shallower depth than the remaining slots in the connector block. Each of the walls defining the slots **102** is also provided with a reaction surface **104** similar to the reaction surface **98** described above. The purpose of these additional reaction surfaces and slots is to accommodate a reaction tool such as the tool **106** illustrated in perspective in FIG. **8** having a pair of relatively movable connector gripping members **108** and **110** each of which spans approximately six slots in the associated connector block **25.** The purpose of the additional dummy slots **102** and reaction surfaces **104** is to facilitate insertion of wires into the extreme end slots **86** of the connector block **25** shown in FIG. **9,** while still engaging reaction surfaces uniformly across the width of the connector engaging members **108** and **110.**

The connector **24** described above has many advantages as has been pointed out during the foregoing description. One additional advantage of the entire construction of the connector over the prior art is that the intricate parts **40** and **42** having complicated surfaces are all formed out of easily moldable plastic while the metal part **27** is simple, flat and easy to manufacture.

It is believed that the operation of the connector **24** of the present invention will be better understood by an illustration of the insertion of a wire onto the connector as shown in the sequence of drawings beginning with FIG. **16** and running through FIG. **20.** In referring to these figures, only brief references will be made to the operation of the illustrated tool which is described and claimed in detail in the above noted copending patent application. FIG. **16** is a sectional view through one pair of laterally disposed and aligned slots **86** in the connector block **25** embodying the present invention; a wire **112** is shown positioned in the right-hand slot **86** against the outside of the wire restraining protrusions **90** within the slot **86.** It should be noted from this figure that the outer end of the contact strip **27** is located at least three insulated wire diameters from the outer extremity of the slot and at least two insulated wire diam-

eters from the first and second ends of the open-ended slot thus affording complete protection and insulation of the wire stripping and gripping area **70.**

In FIG. **17,** the wire **112** has been manually positioned inside the wire restraining protrusions **90** and is held adjacent to the outer end of the stripping and gripping area **70** of the contact strip **27.** This operation, although not illustrated, is accomplished manually by gripping the wire at either end of the open-ended slot **86** and forcing it past the narrowed passages defined by the protrusions **90.** It should also be noted that the positioning operation has not deformed or damaged the relatively hard insulation of the wire **112.** Rather it is accomplished by deflecting the flexible walls between the slots **86** to allow the wire to pass to this intermediate position. Also in FIG. **17,** the nose of the reaction tool **106** or a similar tool is shown being inserted into the channel **100** of the slot **86.** Proper positioning of the tool **106** is accomplished by a series of alignment teeth **113** (one of which is shown in phantom in FIG. **17**) which extend into the slots **86** of the block.

At this stage of the installation, the first connector gripping member **108** is positioned in the channels **100** and the locating surfaces on the tool **106** in cooperation with the bearing surfaces **98** have positioned the tool **106** longitudinally with respect to the connector block **25** so that a wire insertion member **114** in the tool **106** is in registry with the slot **86** in which the wire **112** is held by the wire restraining structure **90.**

Referring now to FIG. **18,** the tool **106** is shown in position to complete the insertion Of the wire **112** into the connector block **25.** In this position, both the first and second connector gripping members **108** and **110** are in gripping position engaging the channels **100** and the bearing surfaces **98** disposed adjacent one edge surface on the first and second side surfaces **44** and **56** of the connector block **25,** thus providing a symmetrical reaction force and providing a balanced reaction to the force applied to the wire **112** and the contact during insertion of the wire **112.** In FIG. **18** the wire insertion member **114** of the tool has moved to the left between the connector gripping members **108** and **110** and is about to engage the wire **112.** The mechanism for moving the wire insertion member **114** and for causing the relative movement of the connector gripping members **108** and **110** forms no part of the present invention and will not be discussed herein.

In FIG. **19,** the wire insertion member **114** has moved further to the left and is extended beyond the extremity of the remainder of the tool **106** and into the slot **86.** In this position the flat front surface **116** of the wire insertion member **114** is in engagement with the wire and has partially forced it onto the stripping and gripping area **70.** It should be noted that the illustrated wire insertion member **114** is recessed or relieved on the flat face **116** in three different areas spaced between the open ends of the slot **86.** The first recess **118** is positioned midway between the ends of the slot **86** and is of a suitable depth to accommodate the contact strip **27** where it extends into the slot **86** without the wire insertion member **114** physically engaging the contact strip **27.** A second relieved area **120** is provided midway between the recess **118** and the first end of the wire receiving slot **86.** In the illustration of FIG. **19** the recess **120** has already received the upper pair of protrusions **90** of the wire restraining structure and is about to receive the retaining means **92** as the wire passes thereover. It will be apparent from FIG. **19** that the width and location of the wire restraining structure **90** and the retaining means **92** is important if they are to retain their usefulness after a wire has been installed by a wire insertion member **114** similar to that illustrated in the figure. It should also be noted that the relieved area **120** is deeper than the recess **118** because, as has been mentioned earlier, the wire restraining structure **90** is positioned much closer to the outer extremity of the slot **86** than is the outer end of the contact strip **27.** A third relieved area **122** in the insertion member **114** is positioned on the opposite side of the contact strip **27** approximately midway between the contact and the second open end of the slot **86.** In the illustration of FIG. **19** this slot has already received the wire restraining structure **90** which is also positioned in registry with the slot **122** to avoid destruction of the restraining structure by the wire insertion member **114.** The wire insertion member also includes a cutting blade **125** near its lower extremity within the slot **86.** The cutting edge of this blade **124** is facing the bottom wall **88** of the slot **86** and extends beyond the remainder of the outer end **116** of the wire insertion member **114** as illustrated in FIG. **19,** the cutting blade **124** engages the insulative covering of the wire **112** below the contact and on its opposite side from the retaining means **92.**

Referring now to FIG. **20,** it can be seen that the complete installation of the wire **112** into the connector block **25** has been accomplished. The upper insulated portion of the wire **112** has passed the retaining means **92** and is held between the retaining means and the bottom wall **88** of the slot **86.** The insulation has been stripped from the wire **112** by the contact strip **27** leaving a metal-to-metal electrical and mechanical contact **126.** The cutting blade **124** has forced the lower end of the wire into contact with the bottom wall **88** of the slot **86** and has severed the excess wire by passing therethrough and indenting the wall **88** of the slot. The free end of the wire thus severed is recessed in the slot **86** slightly removed from the second open end thereof and protected from undesired electrical contact with other wires in the system. After the tool has been removed, the wire **112** is held in the position shown in the FIG. **20** by a combination of the retaining structure **92** and the mechanical grip of the gripping area **70** of the contact **27** on the conductive portion of the wire **112.**

The wires of each bundle utilized with the connector of the present invention are commonly color coded in pairs each wire having a two colored insulation. In order to facilitate insertion of the desired wires onto the preselected contacts of the connector, the outer end of each wire receiving slot **86** is provided with a pair of color coded areas **128** (FIG. **15**) each matching one of the two colors of the appropriate wire. The color coded areas **128** are, in the illustrated embodiment, positioned on either side of the recessed center portion **128***a* of the edge surface **87** or **89** of the corresponding wall of the slot **86** in question. This positioning of the color coded areas **128** affords easy visual observation of the proper slot **86** with which the wires **112** or **32** in question are to be matched prior to the manual positioning of the wire within the wire restraining structure **90.** This is especially true since the wires are positioned in the slots **86** by lateral movement past the edge surfaces **87** or **89** of the connector block **25.** The color

coded areas 128 could, however, be positioned anywhere along the edge surfaces 87 and 89 so long as it remains on the edge surfaces 87 and 89 for ease of observation and matching.

The mounts 26 and 29 referred to earlier in the general description of the present invention are illustrated in detail in FIGS. 4 through 7. Referring specifically to FIG. 5, a mount 26, suitable for mounting the right-hand end of the connector block of the present invention having the single key way 77 (FIG. 9), is illustrated in front elevation and includes a first or right-hand mounting block 130 having a stepped generally circular central opening 132, snap-in mounting means 134 and a mount index 136. Both the snap-in mounting means 134 and the mount index 136 extend from a flat base 138 and are perpendicular to the axis of the central opening 132. They are designed and spaced to retain and orient the mount in the desired manner on the frame of the wiring system 10. As an added assurance to proper orientation the mount index has a tab 136*a* along one side thereof to require a specially shaped mounting hole described hereinafter. The stepped central opening 132 includes a large circular opening 140 and a smaller partially circular opening 142 joined by a longitudinal bearing surface 144. The small opening 142, best seen in FIG. 5, has a pair of spaced cutouts 146 extending beyond the circular profile on one side thereof. A secondary opening 148 extends through the mounting block 130 in the same direction as and parallel to the partially circular opening 142 therein. The secondary opening extends partially between the cutouts 146 and is separated from the central opening by a flexible wall 150 which in its undistorted form is flat and extends on one side between the cutouts 146 to form a flat surface on one side of the partially circular opening 142 of the mounting block 130.

A right-hand cam detent cap 152 having a hollow rectangular center 154, a multisided detent surface 156, and a circular bearing flange 158 is received in the central opening 132 of the right-hand mounting block 130. The hollow center 154 includes a key surface 160 which is received in the single key way 77 of the mounting post 81, the post extending through the center 154 from the detent end to the circular flange end of the detent cap 152. The outer end of the hollow center 154 also has a retaining surface 162 which cooperates with both of the mounting ribs 93 to positively retain the mounting post within the hollow center 154 (FIGS. 6 and 7). The detent surface 156 frictionally engages the walls of the smaller central opening 142 of the mounting block 130 and the flat flexible wall 150. The frictional engagement is made at the lines of intersection of the multiple flat sides with the wall of the opening 142 and is sufficient to maintain the cam detent cap 152 in any desired position of rotation corresponding to the engagement of a surface 156 with the wall 150.

During rotation of the connector block 25, the wall 150 of the central opening 132 yields as the cam detent cap is rotated out of a stable position to one where the edge of a pair of adjoining flat surfaces engages the bottom wall 150. The position of flexure of the bottom wall 150 although not unstable, is less stable than the position in which one of the flat surfaces 156 on the periphery of the cam detent cap engages the bottom wall 150 of the central opening. For purposes of illustration, FIG. 5 includes a dashed line position of the hollow center 154 of the cam detent cap 152 and the bottom wall 150 of the central opening each in its intermediate position between adjacent stable positions of rotation. In the illustrated embodiment the cam detent cap is 12 sided resulting in a stable position every 30 degrees of rotation.

The left-hand mount 29 illustrated in FIG. 5A is identical to the right-hand mount 26 described above with exceptions. First of all the large circular opening 141 of the left-hand mount is smaller in diameter than the corresponding large circular opening 140 of the right-hand mount and receives a smaller circular bearing flange 159 of a left-hand cam detent cap 153. Secondly, the left-hand cam detent cap 153 has a hollow rectangular center 155 having a pair of key surfaces 161 therein and aligned to mate with the pair of key ways 79 on the left-hand mounting post 83 of the connector. Thirdly, the mount index 137 and tab 137*a* of the left-hand mount 29 are positioned on the opposite side of the snap-in mounting means 134A which is identical to the snap-in mounting means 134. All three of these differences between the left-hand mount 29 and the right-hand mount 26 cooperate to assure proper orientatiOn of the connecJor 24 prior to wire installatiOn thereby assuring that the wire retaining means 92 are disposed above the contact when the connector is oriented for wire application to a given side. This assures that the remaining wire (FIG. 20) will be held behind the retaining means 92 on the side of the contact opposite cutoff of the excess wire so that the retaining means 92, the metal-to-metal contact 126 and later the cap 101 (FIG. 16) cooperate in maintaining the electrical connection of the wire, the wire retaining means 92 and the cap 101 simultaneously cooperating tO provide strain relief for the insulated portion of the wire.

Having now described the various components of the wire termination system referred to earlier, the cross-connect wiring system of FIGS. 1 through 4 will be described in further detail to illustrate the cooperation of the various components of the present invention within the novel system. As can be seen from FIG. 2, the vertical leg 18 of the frame 11 is in the form of a generally rectangular sheet metal channel having a wide central wall 164 connecting shallow side walls 166, the outer extremities of the side walls 166 being turned inwardly toward each other to provide vertical edges 168 which engage and enclose the bundle separation channel 34.

Referring now to FIG. 4, it can be seen that the horizontal leg 20 of the frame is formed as an extension Of the vertical leg 18 by means of appropriate cutouts 170 permitting a right angle bend in the channel. The profile of the horizontal leg 20 can best be seen in FIG. 3 and is identical to the channel described with respect to the vertical leg 8. The outer end of the horizontal leg terminates in a flat metal mounting tab 172 (FIG. 1) having a pair of openings for receiving fastening means such as screws 174. The vertical leg 18 is provided on each of its side walls 166 with a series of mount receiving openings 176 and 178. The mount receiving openings 176 are spaced apart a distance equal to the center-to-center spacing of two snap-in mounting means 134 or 134A when a pair of mounting blocks are disposed end-to-end as illustrated in FIG. 4. They are also of an appropriate size to receive and hold an assocaited snap-in mounting. The remaining mount receiving openings 178 are each spaced closely below their associated mounting opening 176 and are of an appropriate

size to receive the associated mount index 136 or 137 of the appropriately oriented mount 26 or 29. Each opening 178 also includes a cutout 178*a* extending from the opening toward the associated opening 176 to accommodate the appropriate tab 136*a* or 137*a*. Thus only the openings 178 will accommodate the mount indices 136 and 137.

The fixed frame member 22 is also in the form of a generally rectangular channel (FIG. 2) and includes a central wall 180 connecting side walls 182 of similar dimensions to the central wall and side walls of the vertical leg 18. The outer ends of the side walls 182 are each turned in toward each other to form inner walls 184 which do not quite abut each other at their outer extremities, are disposed adjacentto the cable 30 within the frame 11 and form a mounting surface for the bundle separation channel 34. The upper end of the fixed frame member 22 includes a folded tab 186 adapted to underlie the flat mounting tab 172 of the horizontal leg 20 of the movable frame member. The folded tab 186 is also provided with a pair of threaded holes 188 which receive the screwS 174 rigidly to affix the movable frame member 16 to the fixed frame member 22 thus forming the rigid frame 11 for the system. The fixed frame member 22 is also provided on its opposite side walls 182 with a series of mount receiving openings 176 and 178 which are sized and spaced in like manner to those on the vertical leg 18 and cooperate therewith to provide spaced pairs of mount receiving openings disposed horizontally of each other on opposite legs of the frame 11. In other words, a mount receiving opening 176 is always disposed horizontally across from a similar mount receiving opening 176 with the associated mount receiving opening 178 and cutout 178a disposed in all cases just below the respective mount receiving opening 176.

It can be seen that a series of connectors 24 are mounted on one side of the frame 11 by means of a series of vertically arranged right-hand mounts 26 positioned in the respective mount receiving openings 176 and 178 on one side wall 166 of the vertical leg 18 and by a series of left-hand mounts 99 similarly disposed on the corresponding side wall 182 of the fixed frame member 22. Because the mount receiving openings 176 which receive the snap-in mounting means 134 or 134A are spaced on centers as indicated above, adjoining left-hand or right-hand mounts abut each other at their bases and the remainder of the adjacent mounting blocks form a U-shaped cross-connect wire passage 190 which provides for orderly passage of cross-connect wires from the point of connection to a contact, around one end of the frame 11 and to the desired contact on the opposite side of the frame 11.

In each case, the mount receiving openings 178 are appropriately spaced from and below the associated mount receiving openings 176 so that there is no possibility of improperly inserting a left-hand mount 29 at the right-hand end of a connector 24 since as was explained earlier, the mount index 137 and tab 137a for the left-hand mount 29 are oppositely positioned with respect to the snap-in means 134A than is the mount index 136 on the right-hand mount 26.

Therefore referring to FIGS. 5 through 7, if the larger circular opening 140 of the right-hand mount and the circular flange 158 of the right-hand detent cap 152 are oriented outwardly from the connector to be mounted, and if the smaller circular opening 141 of the left-hand mount 29 and the smaller circular bearing flange 159 of the left-hand detent cap 153 are oriented outwardly from the connector to be mounted, there is no possibility of inserting a mount in the frame in any but a proper manner, i.e., in a manner so as to present the connector 24 to the installation tool 106 in the proper position with the wire retaining means 92 positioned above the associated contact strips 27 on the side of the connector presented for installation. It will further be seen that it will not be possible to misorient the connector block by applying the cam detent caps 152 and 153 to the wrong end of the connector due to the mating single and double keys and key ways provided in the respective ends of the connector and inside the respective cam detent caps. Nor can the cam detent caps be inserted into the wrong mount due to the different diameters of the large circular openings 140 and 141 and the cooperating bearing flanges 158 and 159.

In the illustrated embodiment, the bundle separation channel 34 is illustrated as a piece of rectangular plastic wiring duct having a flat mounting base 192 and right angled side walls 194 extending from either side of the mounting base 192. Each of the side walls 194 further includes a series of separated bundle receiving slots 196 which are open-ended at their outer extremities away from the flat mounting base 192. The outer ends of the side walls 194 include outwardly disposed beads 198 for receiving and holding the vertical edges 168 on the vertical leg 18, see FIG. 2. The bundle separation channel 34 is vertically disposed and extends between the frame members 16 and 22 with its flat mounting base 192 affixed to the inner walls 184 of the fixed frame member 22 by means such as screws or rivets, not shown. The side walls 194 of the bundle separation channel extend across the central portion of the frame 11 to the vertical leg 18 of the movable frame member 16. The beads 198 at the outer extremities of the side walls 194 are engaged by the vertical edges 168 of the vertical leg 18 on the movable frame member and are spring loaded slightly toward each other so that the channel forming the vertical leg 18 acts as a cover for the bundle separating channel, the bundle receiving slots 196 constitute long flat horizontal openings, each corresponding to the space between a pair of adjacent connectors 24 on either side of the frame 11.

The wire guiding duct 36 is in the illustrated embodiment also in the form of a slotted plastic wiring duct common to the electrical industry. It is mounted with its flat base 200 against the outer side of the central wall 164 of the vertical leg 18 on the movable frame member 16. Mounting is effected by suitable means, not shown. The slotted side walls 202 of the wire guiding duct extend outwardly from the base 200 and from the frame 11 and each includes a series of spaced slots 204 which are open-ended and similar in construction to the slots 196 of the bundle separation channel 34. The outer extremity of each side wall 202 is provided with a bead 206 (FIG. 2) which acts to retain a removable duct cover 208.

In an illustrative embodiment of the wire termination and splicing system of the present invention the wiring cabinet 10 for 600 pairs of conductors would have base dimensions of 8-½ inches × 11 inches and a height of 29 inches. The frame 11 would accommodate 12 of the connectors 24 on each side thereof and the bundle separation channel 34 would have 12 slots on each side thereof. Each of the connectors 24 has an overall

length from the end of one mounting post to the end of the other of 7.7 inches an overall width of 0.9 inch and an overall thickness of 0.3 inch. Each of the slots **86** has a width measured in a direction parallel to the longitudinal axis of the connector **24** of 0.05 inch, and a depth of 0.275 inch. The outermost edge of the wire restraining protrusion **90** is located 0.10 inch from the adjacent edge of the connector **24** and is spaced from the opposed protrusion **90** a distance of 0.025 inch; the retaining projections **92** are disposed **0.075''** from the adjacent protrusions **90**, are spaced from the bottom of the associates slot **86** 0.045 inch and are spaced from each other to provide a gap therebetween of 0.015 inch to accommodate a 22–26 gauge conductive wire. The lateral dimension of the channel **100** is 0.05 inch and the outer edge of the channel is spaced 0.050 inch from the adjacent outer edge of the connector **24.** The contact strips **27** has an overall length of 0.53 inch, an overall width of 0.09 inch and the notches **74** and **76** have a depth of 0.108 inch. The wiring of the novel system is accomplished by removal of the movable frame member **16** which exposes the feeder cable **28** and the distribution cable **30** within the central cavity of the frame **11** and below the bundle separation channel **34.** Removal of the movable frame member **16** also provides access to the open-ended slots **196** in the bundle separation channel **34.** The outer covering of the feeder cable **28** is removed leaving a series of exposed bundles each containing **50** insulated wires in color coded pairs. The bundles are separated and draped over consecutive slots **196** on one side of the bundle separation channel **34** so that the wires extend outwardly from the channel **34** through the preselected slots **196** therein. The same operation is repeated for the distribution cable **30** with each bundle of wires being brought out through one slot **196** on the opposite side of the bundle separation channel **34** from those of the feeder cable **28.** The movable frame member **16** carrying the wire guiding duct **36** with the cover **208** removed therefrom is then set into place engaging the beads **198** at the outer ends of the side walls **194** of the bundle separation channel **34** to form a closed chamber having bundles of wires extending through the slots **196** at either side thereof. Beginning at either side of the frame, the top connector **24** is mounted in its respective mount-receiving openings and the bundle of wires is positioned over the top of the connector **24** from the associated slot **196.** The color coding of the wires is matched to the color coding on the outer ends of the fingers of the connector **24** and the wires are installed in the manner described earlier with respect to FIGS. **15** through **20.** To facilitate installation of the **50** wires on the one side of the connector **24,** the connector **24** is oriented as illustrated in FIG. **1** through **4** at an angle to provide easy access for the installation tool **106.** During installation, the excess wire in each contact is cut off so that it does not interfere with other connections to be made at a later time. After all connections have been made to the first side of the connector **24,** it is rotated on its mounts 180° to a position as illustrated in FIG. **3** wherein the **50** connected feeder cable wires are out of the way and the second side of the connector **24** is oriented for easy installation of cross-connect wires **32.** This process is repeated for each succeeding lower connector **24** on the same side of the frame **11** so that the wires extending from the slots **196** below the connector **24** being worked upon do not interfere with the connections being made. The same process is again repeated vertically from the top to the bottom of the distribution side of the system. After this phase of the installation is complete, it can be seen that there is provided a neat, orderly bank of feeder cable connections on one side of the frame **11** and an equally neat, orderly bank of distribution cable connections on the opposite side of the frame. It can be further seen that each of the connections is protected by being made onto a buried contact within the connector blocks **24** and is further protected by the application of the cap **101** to the side of the connector block **24** having these connections. Suitable cross-connect wires **32** are then connected to the second sides of the connectors **24** which are readily disposed in an easy access position to the installer. Each pair of cross-connect wires **32** is connected to a pair of contact strips **27,** is brought out along the connector **24** through the cross-connect wire passage **190** formed by the right-hand or left-hand mount into the closest adjacent slot **204** on the wire guiding duct **36** upwardly or downwardly inside the wire guiding duct **36** and out the appropriate slot **204** adjacent the desired connector **24** on the opposite side of the frame **11.** The wires then are extended through the associated cross-connect wiring passage **190** and are connected to a predetermined pair of contacts thereby establishing a completed circuit between a pair of wires on the feeder cable **28** and a pair of wires on the distribution cable **30.** These second connections are of the nature of temporary connections and may be moved and reestablished as phones are installed and removed from the buildings to be serviced. After the cross-connect wiring has been completed, the cover **208** is placed over the wire guiding duct **36** to protect the cross-connect wires **32** from further disturbance until changes are desired, and a cap **101** is placed on the connectors **24** to cover the junctures of the cross-connect wires **32** with the connectors **24.**

It should be noted that the location of the wire guiding duct **36** on the outside of the movable frame member serves after installation of the cross-connect wires **32** to act as a deterrent to removal of the movable frame member **16** thereby acting as an anti-tampering device for the wires in the cables **28** and **30** and the connections thereof to the connectors **24.**

It will be evident to those skilled in the art that the relationship of the reaction surfaces on the connector and on the tool to the contacts is not limited to the exact geometry shown. In the preferred embodiment of the present invention, the reaction surfaces **98** have been illustrated as being symmetrically disposed with respect to the particular pair of contacts **27** onto which a wire or pair of wires is to be installed. It is within the scope of the present invention for the geometry of the connector and the tool to vary so long as certain conditions are met. Two or more reaction surfaces are required to be simultaneously engaged by compatible reaction members on a compatible tool. The balanced reaction forces need not be equal on each reaction surface engaged by the tool. It is sufficient for the purposes of the present invention that the resultant of all reaction forces be essentially equal, opposite and colinear with the resultant of all insertion forces. It is inherent in such a structure that for a connector having similar contacts and similar wires these resultant forces will be located substantially within an area defined by the particular reaction surfaces engaged by the tool and

transverse to the direction or path of wire insertion. In such a case, there will be no rotational influence or twisting force on the connector as a whole nor on the tool outside of the area bounded by the reaction surfaces even if the reaction surfaces are disposed at different distances from the stripping and gripping area or are displaced laterally of each other on the connector block. In other words, if the connector block were suspended in mid air within the gripping members of the reaction tool, a wire could be inserted by operation of the tool with no other force being exerted on the connector.

It is understood that the present invention is not restricted to the specific embodiments set forth above in the specification and is limited only by the scope of the claims.

What is claimed is:

1. An insulated wire termination and splicing connector comprising a first connector block segment of electrically insulating material having a longitudinally extending essentially planar first contact-retaining surface thereon and a plurality of pairs of laterally disposed first indentations extending therethrough, a second connector block segment of electrically insulating material having a longitudinally extending essentially planar second contact-retaining surface thereon and a plurality of pairs of laterally disposed second indentations extending therethrough, at least one of said contact-retaining surfaces having a plurality of contact recesses therein respectively in alignment with certain of said pairs of indentations, said connector block segments being arranged with said contact-retaining surfaces in face-to-face relation and with the pairs of laterally disposed first indentations being in alignment with corresponding ones of the pairs of laterally disposed second indentations to provide aligned pairs of laterally disposed open-ended wire-receiving slots in alignment with said contact recesses, a plurality of essentially flat contacts disposed between the contact-retaining surfaces of said connector block segments and in said contact recesses and each including first and second stripping and gripping means extending respectively into individual ones of one of said laterally disposed pairs of slots for stripping insulation from and thereafter gripping a wire forced thereon, and means holding said connector block segments in proper alignment with respect to each other to hold said contacts in said contact recesses and in positions with respect to the associated pair of laterally disposed slots, said means holding said connector block segments in proper alignment comprising a plurality of alignment pins extending from at least one of said connector block segments and a plurality of openings in the other of said connector block segments receiving said alignment pins to provide positive mechanical locking of the first and second connector block segments with respect to each other and with respect to said contacts, each of said contacts being provided with a pair of apertures therein intermediate of said first and second stripping and gripping means, and a pair of said alignment pins being disposed in each of said contact recesses and extending therefrom and through the apertures in the associated contact and into the respective aligned openings in the other connector block segment.

2. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and a pair of edge surfaces respectively joining the edges of said side surfaces, said connector block having a plurality of pairs of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surfaces toward each other and into said side surfaces, a plurality of contacts disposed in said connector block and each including first and second stripping and gripping means extending respectively into individual ones of one of said pairs of laterally disposed slots for stripping insulation from and thereafter gripping a wire forced thereon, and reaction surfaces on said block and spaced from said contacts for engagement by a reaction tool to be used in forcing a wire into a slot and onto a contact, said reaction surfaces being integral with said connector block and each comprising a surface facing generally in the direction of wire insertion for the respective slot, each of said reaction surfaces being a convex surface adapted to cooperate with alignment means on a tool to cause the tool properly to align with a predetermined slot to assure proper insertion of a wire onto a contact.

3. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and a pair of edge surfaces respectively joining the edges of said side surfaces, said connector block having a plurality of pairs of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surfaces toward each other and into said side surfaces, a plurality of contacts disposed in said connector block and each including first and second stripping and gripping means extending respectively into individual ones of one of said pairs of laterally disposed slots for stripping insulation from and thereafter gripping a wire forced thereon, and retaining means integral with said connector block and disposed in said slots for holding a stripped and gripped wire in the bottom of the associated slot, each of said retaining means comprising a pair of wedge-shaped projections extending from opposite walls of the respective slot toward each other to define a narrow passage having an undistorted width less than the width of said slot, each of said wedge-shaped projections having a sloped deflecting surface facing generally toward the associated edge surface and a wire retaining surface generally facing the bottom of the respective slot, the wire retaining surfaces being spaced from the bottom of the respective slot a distance approximately equal to the width of said slot and cooperating to retain a wire at the bottom of the respective slot after insertion of the wire onto the stripping and gripping means of said contact.

4. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and a pair of edge surfaces respectively joining the edges of said side surfaces, said connector block having a plurality of pairs of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surfaces toward each other and into said side surfaces, a plurality of contacts disposed in said connector block and each including first and second stripping and gripping means extending respectively into individual ones of one of said pairs of laterally disposed slots for stripping insulation from and thereafter gripping a wire forced

thereon, and insulated wire restraining structure integral with said connector block and disposed in said slots and spaced from the associated contact in a direction toward the associated edge surface a distance to position an insulated wire in the associated slot in position to be forced upon the wire stripping and gripping means of the associated contact, each of said insulated wire restraining structures comprising two pairs of facing protrusions on opposite walls of the respective open-ended slot, one pair of facing protrusions being located between the associated contact and a first end of the respective open-ended slot and the other pair of facing protrusions being located between said contact and the second end of the respective open-ended slot thereby to restrain an insulated wire on both sides of said contact prior to installation of the wire onto said contact.

5. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and a pair of edge surfaces respectively joining the edges of said side surfaces, said connector block having a plurality of pairs of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surfaces toward each other and into said side surfaces, a plurality of contacts disposed in said connector block and each including first and second stripping and gripping means extending respectively into individual ones of one of said pairs of laterally disposed slots for stripping insulation from the thereafter gripping a wire forced thereon, insulated wire restraining structure integral with said connector block and disposed in said slots for positioning an insulated wire in the associated slot in position to be forced upon the wire stripping and gripping means of the associated contact, and retaining means integral with said connector block and disposed in said slots for holding a stripped and gripped wire in the bottom of the associated slot, said restraining structure including at least one protrusion extending from a wall defining the associated slot to provide an opening between said one protrusion and the opposed wall of the associated slot narrower than the diameter of the associated insulated wire, said restraining structure being located in said slot outwardly of the associated contact and disposed from said retaining means a distance loosely to hold an insulated wire therebetween, said retaining means including at least one projection extending from a wall of the associated slot to define an opening between said projection and the opposed wall of the associated slot narrower than the diameter of an associated insulated wire, said retaining means being spaced from the bottom of the associated slot a distance equal substantially to the width of said slot, whereby an insulated wire can be manually positioned between said wire-restraining structure and said wire retaining structure in position for insertion and subsequent electrical connection to the associated contact.

6. The insulated wire termination and splicing system connector set forth in claim 5 wherein said wire-restraining structure further comprises at least one additional protrusion extending from one wall of said slot in registry with said one protrusion and located on the opposite side of said contact.

7. A wiring system comprising an insulated wire termination and splicing connector including an elongated connector block of electrically insulating material, a first longitudinally extending row of contacts on said connector block and a second longitudinally extending row of contacts on said connector block angularly displaced with respect to said first row of contacts, selected ones of the contacts in said first row of contacts being electrically connected to selected ones of the contacts in said second row of contacts, each of said contacts including stripping and gripping means for stripping insulation from and thereafter gripping a wire forced thereon to make an electrical and mechanical connection between the wire and said contact, and a pair of mounts respectively mounting the opposite ends of said connector block for rotation of said connector block about the longitudinal axis thereof and upon said mounts, whereby said connector block can be rotated upon said mounts to provide ready access to said first row of contacts for connection of a first group of wires thereto after which said connector block can be rotated upon said mounts to provide ready access to said second row of contacts for connection of a second group of wires thereto, at least one of said mounts comprising a fixed mounting block having a central opening therein, a yieldable wall portion extending along a part of the periphery of said central opening and a multi-sided detent cap rotatably mounted within said central opening and adapted to rotate to multiple stable positions by causing the yieldable wall of said mounting block to deflect during intermediate positions between said stable positions, said connector block including longitudinally extending mounting studs disposed at each end of said connector block, said cam detent cap receiving a predetermined one of said mounting studs so that the connector block is mounted in a predetermined orientation for rotation on said pair of mounts, said cam detent cap being provided with a stud receiving opening for receiving one of said mounting studs and wherein the predetermined one of said mounting studs is of a shape compatible with the stud receiving opening in said cam detent cap thereby to positively assure the proper orientation of the connector block in said pair of mounts.

8. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and a pair of edge surfaces respectively joining the edges of said side surfaces, said connector block having a plurality of pairs of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surfaces toward each other and into said side surfaces, a plurality of contacts disposed in said connector block and each including first and second stripping and gripping means extending respectively into individual ones of one of said pairs of laterally disposed slots for stripping insulation from and thereafter gripping a wire forced thereon, and a cap mounted on and engaging said connector block for covering a portion of each of the slots along one edge surface of said connector block and accommodating wires connected to and extending from the associated contacts in said slots along said one edge surface of said connector block, said cap including an end wall covering the outer lateral extremities of the associated slots, a longer side wall covering all of one end of the associated slots along one of said side surfaces of said connector block, and a shorter side wall covering a portion of the other end of the associated slots along the other of said side surfaces of said con-

nector block, the free edge of said shorter side wall being spaced from the bottom of the associated slots a distance to receive insulated wires therebetween.

9. An insulated wire termination and splicing connector comprising an elongated connector block of electrically insulating material having a pair of longitudinally extending side surfaces and an edge surface respectively joining one of the edges of said side surfaces, said connector block having a plurality of laterally disposed open-ended wire-receiving slots therein extending respectively from said edge surface and into said side surfaces, a plurality of contacts disposed in said connector block and each including stripping and gripping means extending respectively into individual ones of said laterally disposed slots for stripping insulation from and thereafter gripping a wire forced thereon, insulated wire-restraining structure integral with said connector block and disposed in said slots for positioning an insulated wire in the associated slot in position to be forced upon the wire stripping and gripping means of the associated contact, and retaining means integral with said connector block and disposed in said slots for holding a stripped and gripped wire in the bottom of the associated slot, said restraining structure including at least one protrusion extending from a wall defining the associated slot to provide an opening between said one protrusion and the opposed wall of the associated slot narrower than the diameter of the associated insulated wire, said restraining structure being located adjacent one end of said slot outwardly of the associated contact and disposed from said retaining means a distance loosely to hold an insulated wire therebetween, said retaining means including at least one projection extending from a wall of the associated slot to define an opening between said projection and the opposed wall of the associated slot narrower than the diameter of an associated insulated wire, said retaining means being spaced from the bottom of the associated slot a distance equal substantially to the width of said slot, whereby an insulated wire can be manually positioned between said wire-restraining sturcture and said wire-retaining sturcture in position for insertion onto and subsequent electrical connection to the associated contact.

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