

[54] **PRE-LOADED ELECTRICAL CONNECTORS, ASSEMBLY APPARATUS AND METHOD**

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

[58] Field of Search **339/47-49, 339/95, 97-99**

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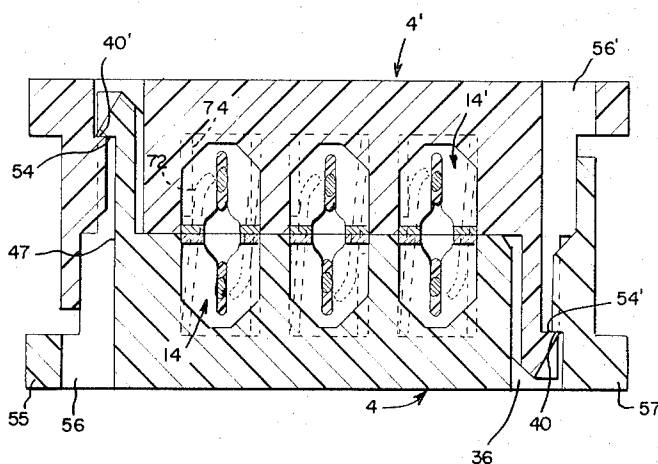
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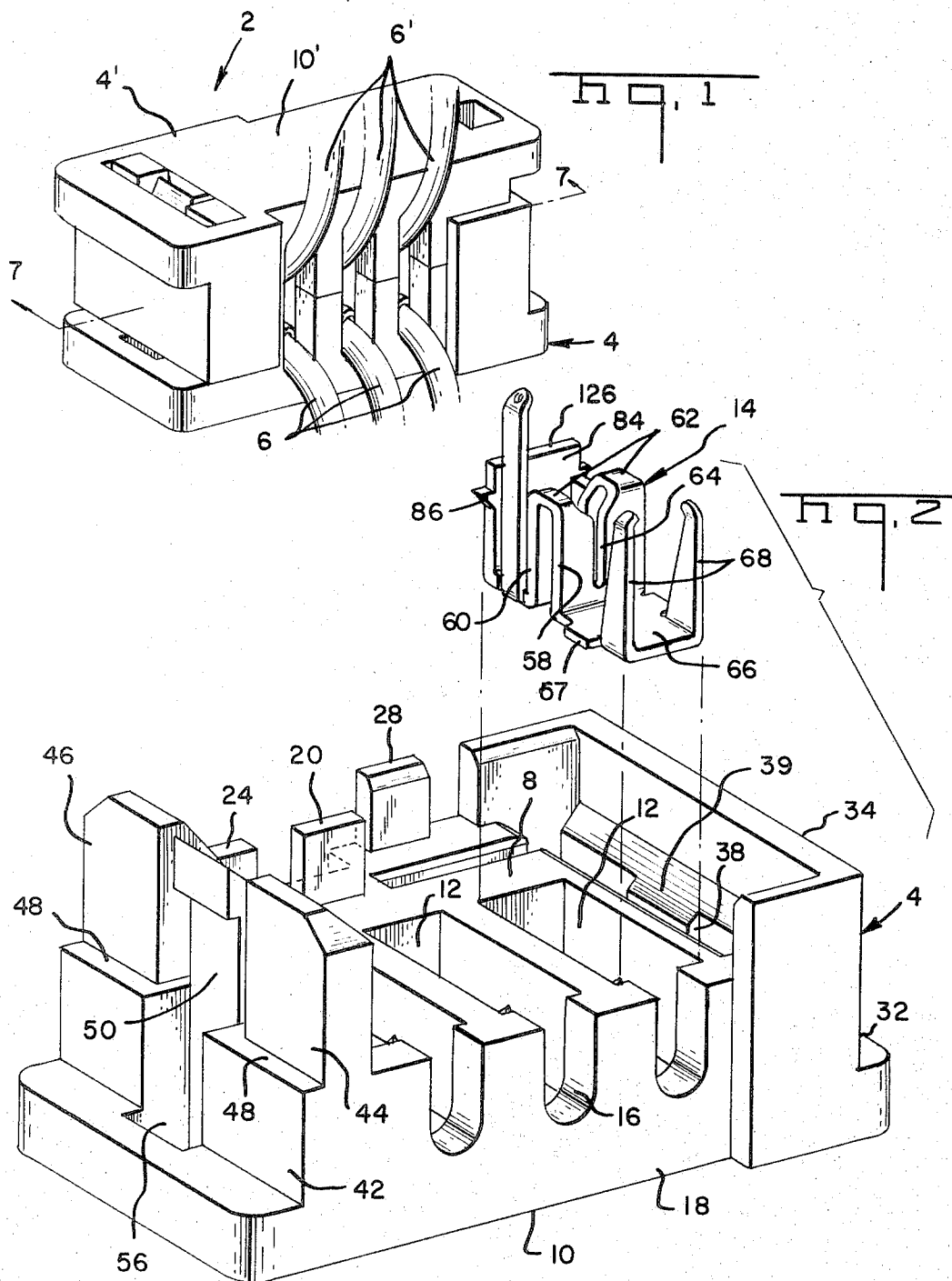
Primary Examiner—Joseph H. McGlynn
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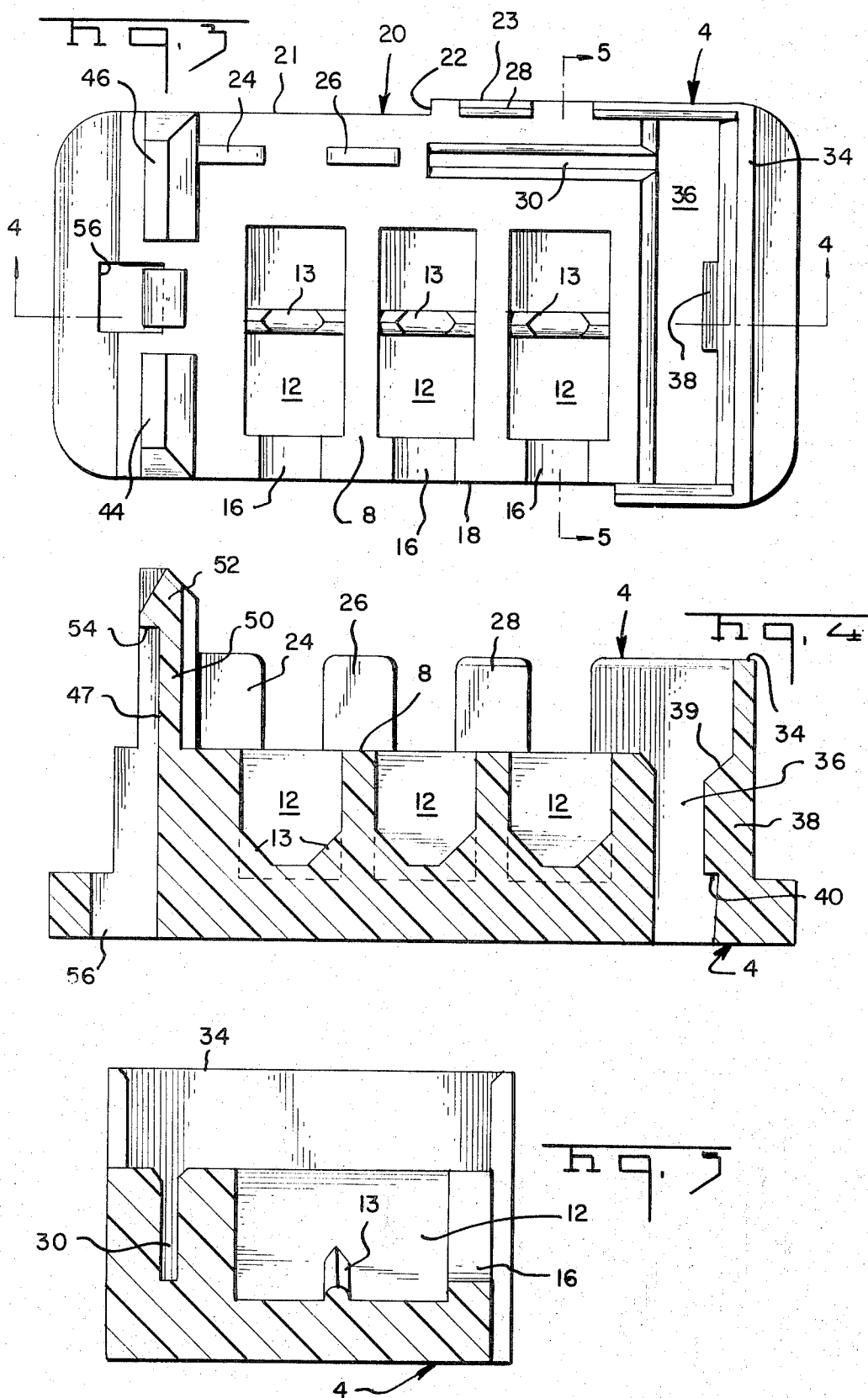
[57] **ABSTRACT**

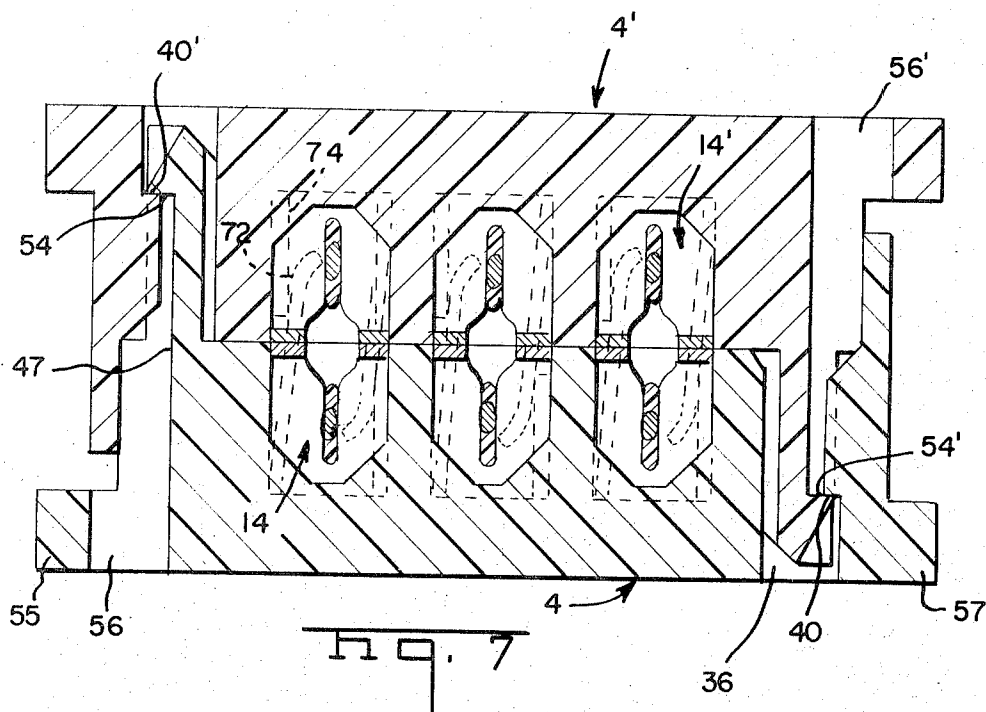
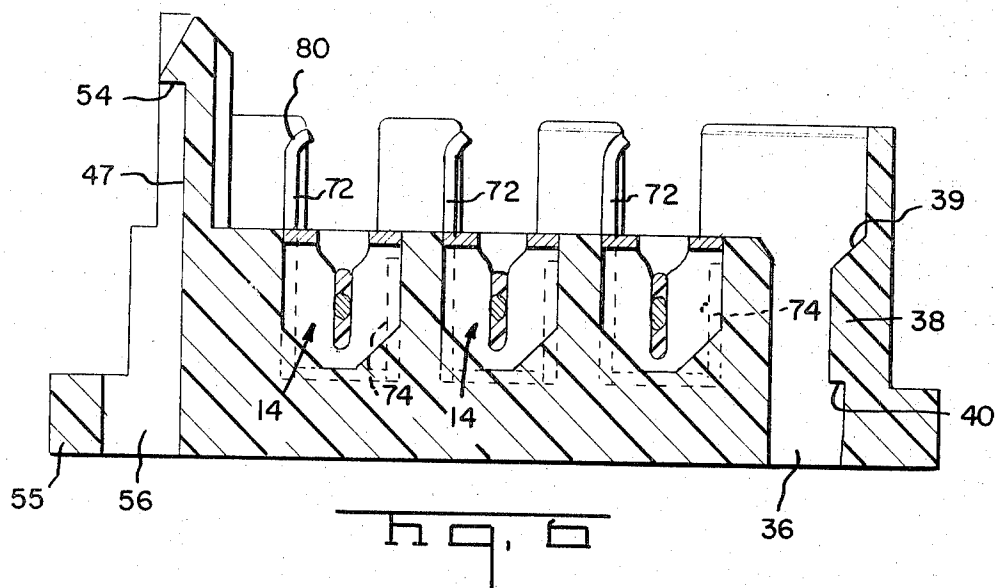
Multi-contact electrical connector assembly comprises two connector housings which are preloaded with contact terminals. The contact terminals have slotted plate-type conductor receiving portions so that conductors can be connected to the terminals by moving the conductors into the slots. Predetermined conductors can be electrically and mechanically connected to predetermined terminals in each of the housings by positioning the housings beside each other, locating intermediate portion of each conductor over corresponding aligned terminals in the housings, moving the conductors into the slots of the terminals, and cutting out the section of conductor which extends between the terminals.

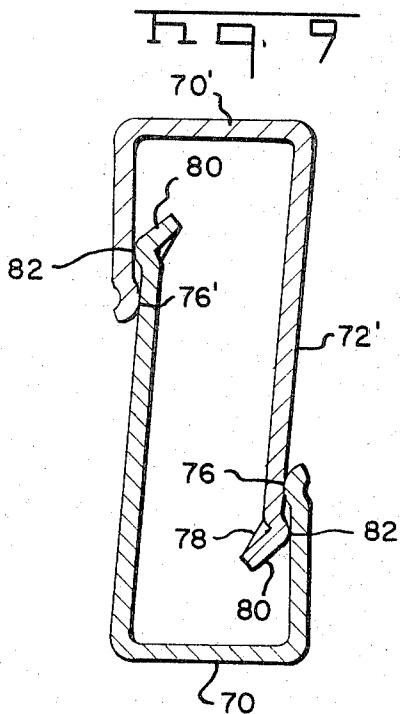
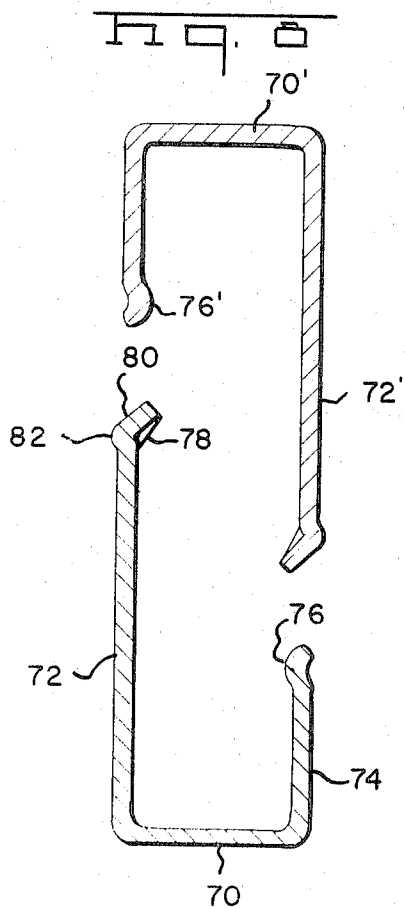
12 Claims, 12 Drawing Figures











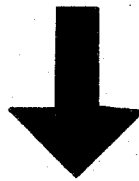
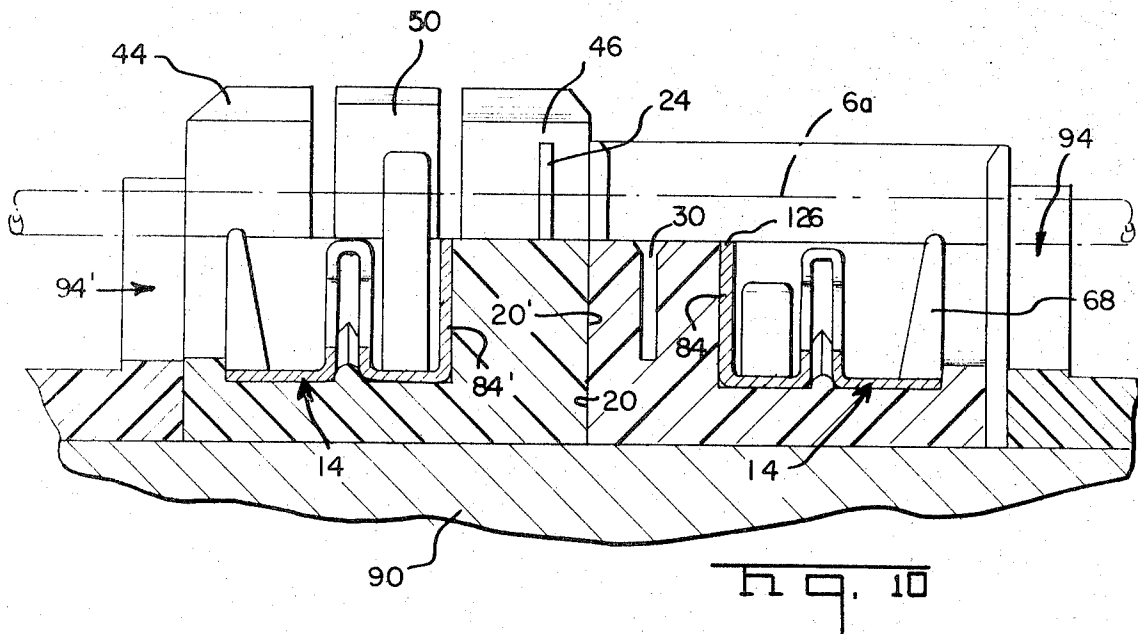
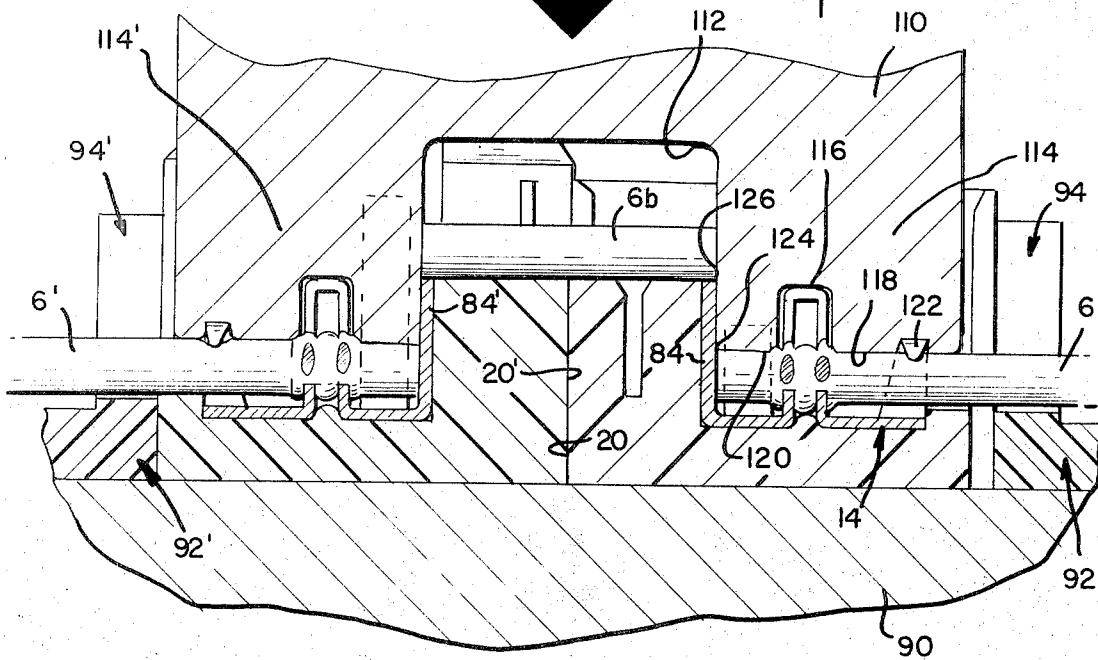
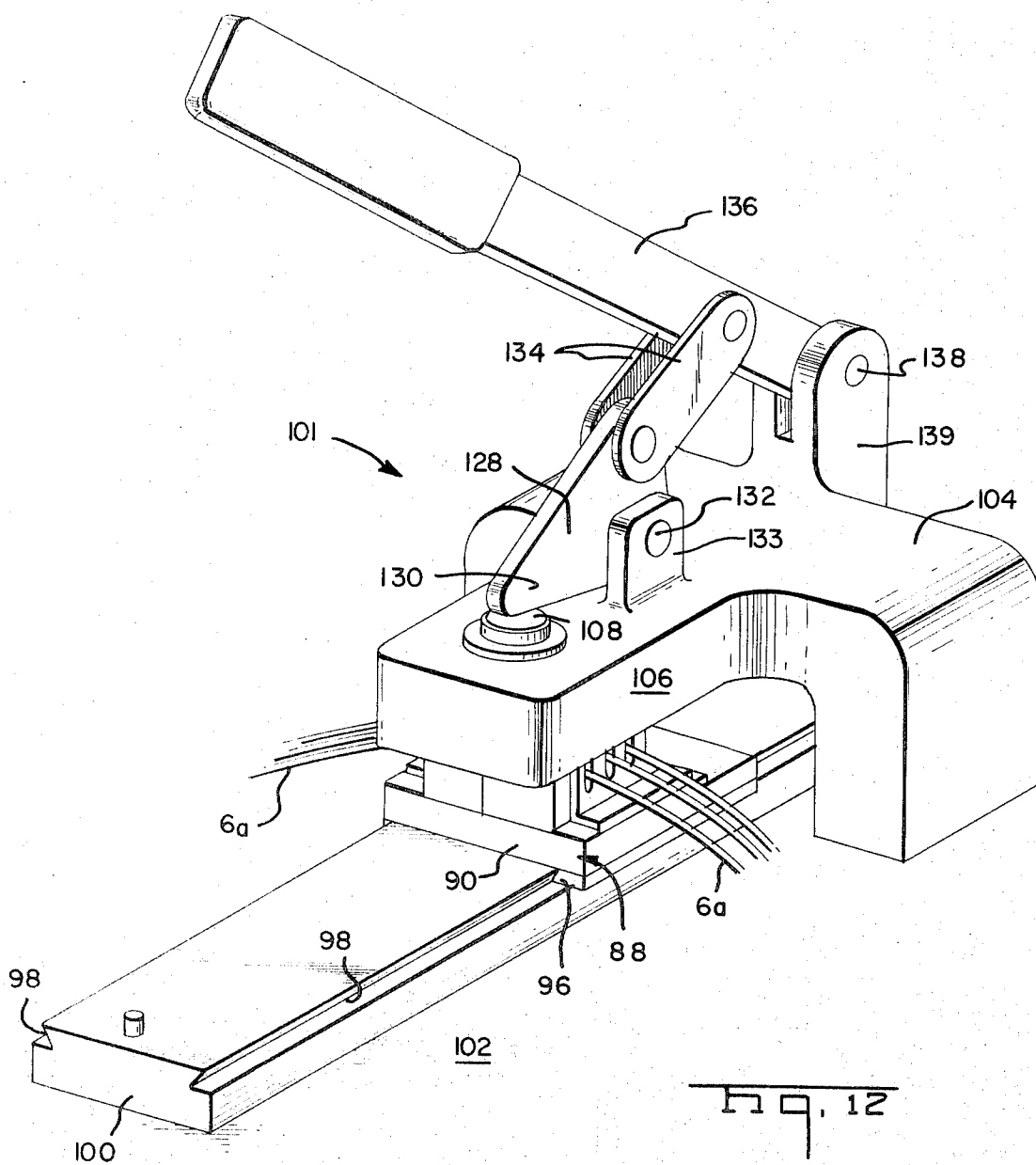


Fig. 11





PRE-LOADED ELECTRICAL CONNECTORS, ASSEMBLY APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

This invention relates to multi-contact electrical connecting devices such as multi-contact electrical connectors and to apparatus for installing such connectors on conductors. The invention is herein disclosed in a preferred embodiment comprising a pair of mateable hermaphroditic connectors but the principles of the invention are applicable to a wide variety of multi-contact connecting devices.

It is common practice in the electrical connector art to produce multi-contact electrical connectors by first cutting electrical leads from a coil of wire, stripping insulation from the ends of the leads, crimping electrical contact terminals onto the stripped ends, and finally inserting the terminals into the cavities of an electrical connector housing. Frequently, and particularly in the manufacture of electrical harnesses, the terminals cannot be inserted indiscriminately into the cavities but must be inserted into specific predetermined cavities in the housing since the leads or wires in a harness are not necessarily of the same length and each lead must be connected to a predetermined lead in a mating harness when the harness is put to use. This method of installing connectors on conductors is time consuming and insufficient and has several comparative disadvantages which can result in the production of defective harnesses. For example, during the interval between crimping of the terminals onto the conductors and insertion of the terminals into the cavities of the connector housing, the electrical leads must be repeatedly handled and transported from one work location to another. The terminals are subject to damage during this interval and if one or more terminals in a finished harness is found to be damaged, it must be replaced or the harness discarded. Furthermore, the fact that predetermined terminals must be inserted into predetermined cavities in the connector housing gives rise to the possibility of a terminal being inserted into the wrong cavity and the production of a defective harness. The present invention is generally addressed to the solution of some of these manufacturing problems.

It is also common practice in the connector art to produce an electrical connector assembly consisting of a male part and a female part so that four distinctly different types of parts are required for a multi-contact electrical connector assembly (male contact pins, male housing, female contact sockets, and female housings). Hermaphroditic connector assemblies are known to the art (connector assemblies consisting of two identical housings and one type of contact terminal) but the number of types of hermaphroditic assemblies available is very limited. The instant invention is further addressed to the provision of an improved hermaphroditic connector which can be substituted under many circumstances for currently used types of male-female connector assemblies.

It is accordingly an object of the invention to provide an improved multi-contact electrical connector and an improved multi-contact electrical connector assembly. A further object is to provide an improved hermaphroditic connector and connector assembly. A still further object is to provide a connector assembly, which may or may not be hermaphroditic, to which conductors

can be assembled in an improved manner. A further object is to provide a pair of mateable preloaded electrical connectors having contact terminals therein to which predetermined conductors can be connected in a manner which will reduce the possibility of wiring errors as regards the electrical connections between the conductors and the terminals in the connectors. A further object is to provide an improved method and apparatus for connecting conductors to the terminals in a pair of mateable preloaded electrical connectors.

These and other objects of the invention are achieved in a preferred embodiments thereof which are briefly described in the foregoing abstract, which are described in detail below and which are shown in the accompanying drawing in which:

FIG. 1 is a perspective view of a hermaphroditic electrical connector assembly in accordance with the invention, the two connector parts being coupled to each other thereby to connect the wires extending into each connector part.

FIG. 2 is a perspective view of a hermaphroditic electrical connector housing in accordance with the invention showing a contact terminal exploded from one of the contact receiving cavities of the housing.

FIG. 3 is a plan view of the housing of FIG. 2.

FIGS. 4 and 5 are views taken along the lines 4—4 and 5—5 of FIG. 3.

FIG. 6 is a view taken along the lines 6—6 of FIG. 3 but showing contact terminals and conductors installed in the contact receiving cavities of the housing.

FIG. 7 is a view taken along the lines 7—7 of FIG. 1.

FIG. 8 is a sectional view, on an enlarged scale, of the contact portions of two mateable contact terminals of the type shown in FIG. 2, this view showing the contact portions separated from each other.

FIG. 9 is a view similar to FIG. 8 but showing the contact portions in engagement with each other.

FIG. 10 is a fragmentary cross-sectional view showing two connector parts positioned side-by-side in a connector holding jig preparatory to the formation of electrical connections between terminals in the connector parts and a conductor.

FIG. 11 is a view similar to FIG. 10 but showing the positions of the parts at the conclusion of the connection operation.

FIG. 12 is a perspective view of one form of assembly apparatus for connecting conductors to terminals in connectors in accordance with the invention.

As shown in FIG. 1, a multi-contact electrical connector assembly 2 in accordance with the invention comprises a pair of connector parts 4, 4' which can be coupled to, and decoupled from, each other to connect and disconnect the conductors 6 and 6'. The connector part 4 and the contact terminals 14 which are contained in this connector part are identical to the connector part 4' and the terminals 14'. Accordingly, a description of the connector part 4 and a description of one of the contact terminals 14 will suffice for both connector parts. The same reference numerals, differentiated by prime marks will be used to identify corresponding structural features of the two connector parts.

Connector part 4 comprises a housing 4 of insulating material having an upper or mating face 8 and an underside or rearward face 10. A plurality of contact receiving cavities 12 extend into the housing from the

mating face 8, and are arranged in a row which extends between the ends 32, 42 of the housing. Each cavity has a central transversely extending rib 13 (FIGS. 3 and 5) which serves to support and locate a contact terminal mounted therein as will be explained below. Openings 16 are provided in the side 18 which extends between the ends 32, 42 and communicate with the cavities 12 for the accommodation of the conductors 6 as shown in FIG. 1. The side 20 which faces in the opposite direction from the side 18 is centrally offset or stepped as shown at 22 and three upstanding teeth 24, 26, 28 project from the mating face 8 adjacent to side 20 of the housing. The tooth 28 is immediately adjacent to the portion 23 of the side 20 so that when the connector 4 is mated with the connector 4' the teeth 28, 28' will be against the portions 21, 21' of the sides 20, 20' as indicated in FIG. 3. An elongated recess 30 extends inwardly on the mating face 8 in alignment with the teeth 24, 26 which are set back from the portion 21 of the side 20. When the two housings are mated, the recess 30 will receive the teeth 24', 26' of the housing 4' and the recess 30' will similarly receive the teeth 24, 26 of the housing 4. It will be apparent from FIG. 2 that the teeth 24, 26, 28 are located on the mating face 8 such that wires or conductors extending between the teeth will extend over cavities 12 and will be above and in alignment with the contact terminals contained in these cavities. As will be explained below, these teeth serve to locate the conductors when the connector is installed on a plurality of conductors.

A partial hood 34 extends upwardly, as viewed in FIG. 2, from the righthand end 32 of the housing 4 and partially surrounds the mating face 8. An opening 36 (see FIG. 3) extends through the housing adjacent to the end 32 from the mating face to the lower or rearward face 10, this opening being generally rectangular and having a central inwardly extending boss 38 which defines a downwardly facing shoulder 40. The upper side 39 of base 38 is inclined downwardly toward the rearward face 40 in order to facilitate the flexing of the latch arm 50' of the connector part 4' during coupling as will be described below.

An additional pair of spaced apart teeth 44, 46 extend from the mating face 8 adjacent to the end 42, these teeth having a thickness which is substantially equal to, and slightly less than, the width of the opening 36 so that the teeth 44, 46 of the connector part 4 can enter the opening 36' of the connector part 4' as shown in FIG. 7. The teeth 44, 46 are inwardly spaced from the side 42 so that ledges 48 are provided adjacent to the teeth at their fixed ends. A flexible latch arm 50 extends from the lefthand end of the mating face 8 between the teeth 44, 46 and has a pointed upper end 52 and a downwardly facing shoulder 54 adjacent to its upper end. An opening 56 extends through the housing from the rearward face 10 thereof and has one side which merges with the outwardly facing side 47 of the latch arm to permit access to the end of the latch arm for decoupling purposes when the connector part 4 is coupled to the part 4'.

It will be apparent from the foregoing that the housing 4 can be coupled to the housing 4' by locating the housings in face-to-face relationship and in end-to-end inverted relationship (end 32 of housing 4 in alignment with end 42' of housing 4') and moving the housings towards each other. During such movement, the latch arm 50 will move against the boss 38' and be flexed in-

wardly until the shoulder 54 is against the shoulder 40' of the housing 4' as shown in FIG. 7. The teeth 24, 26 will enter the recess 30', and the tooth 28 move across the side portion 21' of side 20' as discussed above. The relationship of the housing 4' to the housing 4 is, of course, the same as that of the housing 4 to the housing 4'. It should be noted (FIG. 7) that when the housings are coupled, the mating faces are against each other and portions of the ledges 48 are against the side portions of the boss 38.

The two housings can be disengaged from each other by inserting thin blades through the openings 56, 56' and disengaging the ends of the latch arms from the shoulders 40, 40'. Advantageously, projections 55, 57 are provided at the ends of the housings to permit manual gripping of the two parts during separation.

Each of the electrical contact terminals 14 has a central conductor receiving portion made up of a pair of parallel plate-like members 58, 60 which are connected at their upper or free ends by spaced-apart straps 62. Conductor receiving slots 64 extend into these plate sections from their upper ends so that a conductor can be moved downwardly between the plate sections and into the slots. The slots are of a width such that they will penetrate the insulation of the conductor and deform the metallic core thereof so that the edges of the slots will be brought into intimate electrical contact with the metallic cores of the conductors as shown in FIG. 7. Advantageously, the slot in the plate section 60 is relatively narrower than the slot in the plate section 58 so that the slot in the former plate section will drastically deform the metallic core of a conductor 6 and establish good electrical contact therewith while the slot in the plate section 58 will penetrate the insulation of the wire but will not drastically deform the metallic core. This arrangement provides good electrical contact in combination with a mechanical strain relief for the wire as explained in U.S. Pat. No. 3,617,983. A flange 66 extends normally outwardly from the plate section and arms 68 extend upwardly from the end of this flange. These arms are adapted to be crimped into embracing relationship with a conductor to provide a strain relief therefor.

An additional flange or plate section 70 extends from the plate section 60 and has contact arms 72, 74 extending upwardly from its side edges. As shown best in FIG. 8, the contact arms 72 is relatively long and its upper end 78 is above the upper ends of the plate sections 58, 60 of the terminal. The upper end of arm 72 is formed inwardly to provide an inclined surface 80 and a boss 82. The shorter contact arm 74 extends generally parallel to arm 72 and is formed inwardly to provide a spherical surface 76 on its inner side. When two contact terminals are inverted and moved towards each other, the contact arms engage each other as shown in FIG. 9. The boss 76' slides over the surface 80 and flexes the arm 72 inwardly until boss 76' is moved past the contact boss 82. As is apparent from FIG. 9, redundant contacts are achieved at four separate locations and the long and flexible arms 72, 72' are flexed inwardly by the short and stiff arms 74, 74' to provide the continuing contact pressure required for a low resistance and stable electrical connection.

A shearing plate 84 extends normally of the flange or plate section 70 and parallel to the plate sections 58, 60. The upper edge 126 of this shearing plate cooperates with an insertion apparatus to sever the conductor

being inserted into the slot 64 as will be described below.

The contact terminals 14 are assembled to the housing 4 by merely moving them into the cavities 12 as indicated in FIG. 2. Ears 67, which extend laterally from flange 66, dig into the walls of the cavity as do the laterally extending barbs 86 at each side of the shearing plate 84 so that the contacts will be securely anchored in their respective cavities. The ribs 13 of the cavities are received between the plate sections 58, 60 at the lower ends thereof and support these plate sections against buckling during installation of the connector on conductors.

Referring now to FIGS. 10-12, the conductors 6, 6' are connected to the terminals 14, 14' by means of an apparatus 101 which has insertion punches 110 (FIG. 11) for pushing the conductors into the conductor receiving portions of aligned terminals in two connector parts. The two connector parts 4, 4' are positioned on a holding jig 88 having a base 90 and a pair of spaced apart L-shaped locating clamps 92, 92'. These plates have aligned recesses 94, 94' which are spaced apart by distances corresponding to the spacing between adjacent cavities 12 in the connector parts. The connector parts 4, 4' are located in side by side relationship between the locating plates 92, 92' with their sides 20 against each other with corresponding contact terminals in the two part in alignment with each other, and with the vertical legs 94 of the clamps against the sides 18, 18'. The base 90 has rails 96 on its underside so that it can be slid in grooves 98 on the sides of a fixed rail 100 mounted on the base section 102 of the apparatus 101. The apparatus has a generally U-shaped head frame 104 on which there is provided a forwardly extending arm 106. A ram 108 is mounted in suitable bushings in arm 106 and is resiliently biased upwardly by suitable springs (not specifically shown) against one end 130 of a bell crank 128. A plurality of wire cutting and inserting punches 110 are mounted on the lower end of ram 108, one punch being provided for each pair of aligned terminals 14, 14' in the connector parts. Each insertion and cutting punch 110 has a central recess 112 and depending legs 114, 114' on each side of this recess, these legs being substantially identical and mirror images of each other. The leg 114 has a central relatively shallow recess 116 which is adapted to receive the spaced apart plates 158, 160 of the conductor receiving section of the terminal 14 and has on the righthand side of this recess forming or die surfaces 122 on its lower end for curling the arms 68 of the terminal onto the conductor 6. On the lefthand side of recess 116, the leg 114 has an edge 124 which cooperates with upper edge 126 of the previously identified shearing plate 84 of the terminal 114. The lower edge portions 118, 120 of the leg 114 immediately adjacent to the recess 116 are adapted to engage the conductor and push it downwardly into the conductor receiving slots 64 of the terminal.

The insertion punches on the lower end of the ram are moved downwardly by means of a linkage comprising the previously identified bell crank 128 which is pivoted at 132 between ears 133 extending from the upper surface of the arm 106. Bell crank 128 is pivotally connected by parallel links 134 to a lever arm 136 which in turn has its end pivoted at 138 between additional ears 139 which are integral with the head frame 104. It will be apparent that the ram 108 and therefore

the insertion punches 110 can be moved downwardly as viewed in FIG. 12 by merely swinging the lever 136 downwardly from its position as shown.

When conductors are to be attached to terminals in the connector parts 4, 4', the two connector parts are first positioned on the jig 88. Elongated conductors 6a are then located in each aligned pair of openings 93, 93' in the vertical legs 94, 94' of the locating plates 92, 92'. Conductors located in aligned pairs of slots 93, 93' will extend between the teeth 24, 26, 24', 26' between the teeth 26, 28, 26', 28', and between the teeth 28, 28' and partial hoods 34, 34'. This operation will locate one conductor above each aligned pair of terminals 14, 14' in the two connector parts.

The jig 88 is then slid along the rail 100 until it is against a suitable stop (not specifically shown) and is located beneath the ram 108 with an insertion punch 112 above each conductor 6a. The handle 136 is then swung downwardly to drive the punches 110 against the conductors and push the conductors downwardly into the aligned terminals in the connectors. During such downward movement of the punches 110, the conductors are severed by the edges 126, 124 and 126', 124' of the punches 110 and the shear plates 84, 84'. This severing operation produces a short section 6b of scrap conductor which extends between the aligned terminals and results in the joining of the conductors 6, 6' to the terminals in the two connector parts. Thereafter, the ram is returned to its normal position, the connector parts are removed from the jig 88 and they can be coupled to each other as shown in FIG. 1.

The practice of the invention results in several advantages and economies in the manufacture of electrical harnesses and in the installation of connectors on conductors. A significant advantage is that predetermined conductors are connected to specifically predetermined terminals in the connector housings when the conductors are laced through the jig and inserted and trimmed as illustrated in FIGS. 10 and 11. It follows that the possibility of the commission of errors is virtually eliminated with regard to the positions of the wires in the connectors. In other words, after a given conductor 6 has been located in alignment with a predetermined aligned pair of terminals 14, 14' it is inevitable that the resulting conductors 6, 6' will be connected to each other when the two connector parts are mated with each other. There can be no errors of the type discussed above of misplacement of conductors in either of the connector housings.

A further advantage of the invention is that there can be no damage to the terminals since they are contained in and protected by the housing. Finally, the time required for location of the conductors 6a in the jig is substantially less than the time required inserting individual terminals into predetermined cavities of a housing in accordance with prior art practice. This is because the operation of locating a given one of the conductors 6a above a given pair 14, 14' of terminals actually determines the identity of the conductors which in the completed connector assembly will be connected to the same predetermined pair of terminals. The location of a single conductor 6a thus results in the determination of the locations of two separate conductors 6, 6' in the housings.

Modifications of the invention within the scope of the appended claims will be apparent to those skilled in the art. For example, the principles of the invention are not

necessarily apparent all only to hermaphroditic connectors and terminals although hermaphroditic terminals are advantageous under many circumstances.

What is claimed is:

1. First and second electrical connectors, said connectors being pre-loaded with electrical contact terminals to which conductors can be attached, said connectors being mateable with each other,

said first and second connectors each comprising an insulating, housing having a mating face and a rearward face, said mating faces being against each other when said connectors are coupled, a plurality of contact receiving cavities extending into said housing from said mating face, said cavities being in side-by-side relationship and forming a row, an electrical contact terminal in each of said cavities, each of said contact terminals comprising a contact portion and a conductor-receiving portion, each of said conductor-receiving portions having a conductor receiving slot means extending inwardly in a direction normal to said mating face, said slot means being side-by-side in said row and each slot means being adapted to receive a conductor which extends across said mating face and across said row upon movement of said conductor laterally of its axis towards said mating face and into said slot means,

each of said contact portions having contact surfaces which are proximate to said mating face and which are adapted to engage, and form an electrical connection with, complementary contact surfaces upon relative movement of said complementary contact surfaces towards said mating face and into engagement with said contact surfaces,

said contact surfaces of said contact terminals in one of said connectors being complementary to said contact surfaces of said contact terminals in the other one of said connectors whereby,

predetermined conductors can be connected to said terminals in said first and second connectors by positioning said first and second connectors adjacent to each other with their mating faces in side-by-side relationship and facing in the same direction, locating said conductors with their axes extending across said mating faces and in alignment with said conductor-receiving slot means of each of two corresponding terminals in said first and second connectors, moving said conductors laterally of their axes into said slot means, and cutting out the portion of each conductor which is between each corresponding pair of terminals.

2. First and second electrical connectors as set forth in claim 1, said insulating housings and said contact terminals being hermaphroditic.

3. First and second electrical connectors as set forth in claim 1, said contact terminals being hermaphroditic.

4. First and second electrical connectors as set forth in claim 3, each of said contact terminals being of formed sheet metal, said conductor-receiving portion comprising a pair of plate-sections, said slot means of each of said terminals comprising a slot extending into each of said plate sections.

5. First and second electrical connectors as set forth in claim 4, said plate-sections extending parallel to each other and having outer ends, said outer ends being joined by spaced-apart strap sections.

6. First and second electrical connectors as set forth in claim 5, each of said contact terminals having its contact portions extending from one of said plate sections and comprising a pair of contact arms extending towards said mating face, at least one of said arms extending beyond said outer ends of said plate sections.

7. First and second electrical connectors as set forth in claim 6, each of said contact terminals having conductor gripping means extending from the other one of said plate sections, said conductor gripping means being engageable with a conductor to grip, and provide a strain relief for, a conductor extending into said slots in said plate sections.

8. First and second electrical connectors as set forth in claim 7, each of said contact terminals having conductor severing means integral with said contact portion, said conductors severing means comprising a shearing member extending beside said contact arms, said shearing member being cooperable with an insertion apparatus to shear the portion of said conductor which extends beyond said contact arms during insertion of said conductor into said slots.

9. First and second electrical connectors as set forth in claim 1, said insulating housings being hermaphroditic.

10. First and second electrical connectors as set forth in claim 9, each of said insulating housings comprising a one piece molding of polymeric materials, said contact-receiving cavities extending into said mating face.

11. First and second electrical connectors as set forth in claim 10, each of said housings having openings in one side thereof which extends beside, and parallel to, said row, said openings communicating with said cavities for the accommodation of said conductors.

12. First and second electrical connectors, each of said connectors comprising an insulating housing having electrical contact terminals therein, said housings and said terminals being hermaphroditic,

each of said housings having a mating face and a rearward face, a plurality of contact-receiving cavities extending into said housing from said mating face, said cavities being in side-by-side relationship and forming a row, each of said housings having openings in one side thereof which extends beside, and parallel to, said row, said openings communicating with said cavities,

each of said electrical contact terminals comprising a sheet metal stamped and formed member having a conductor gripping portion, a conductor receiving portion, a contact portion, and a shearing member, said portions of said terminal and said gripping member being in alignment with each other in the order recited with said conductor gripping portion adjacent to said one side of said housing and said shearing member adjacent to the other side of said housing which is opposite to said one side, said gripping portion comprising a pair of spaced-apart arms extending towards said mating face, said arms being adapted to be crimped onto a conductor, said conductor receiving-portion comprising a pair of aligned plate sections having aligned slots extending therein for reception of a conductor, said contact portion comprising a pair of contact arms extending towards said mating face, said shearing member comprising a shearing plate, whereby

predetermined conductors can be connected to predetermined terminals in said first and second connectors by positioning said first and second connectors adjacent to each other with said other sides proximate to each other, with said mating faces facing in the same direction, and with said housings inverted end-for-end, and upon subsequently locating said conductors with their axes extending across said mating faces and in alignment with the conductor receiving portions of a pair of corresponding aligned contact terminals in said

first and second housings, and thereafter moving said conductors laterally of their axes into the conductor-receiving portions of said corresponding terminals, shearing said conductors in the planes of said shearing plate, and crimping said conductor gripping portions onto said conductors, and said first and second connectors can thereafter be coupled to each other to disengageably connect said conductors to each other.

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