United States Patent [19]

Aldridge et al.

[11] **3,909,935**

[45] **Oct. 7, 1975**

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

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[73] Assignee: **AMP Incorporated**, Harrisburg, Pa.

[22] Filed: **July 25, 1974**

[21] Appl. No.: **491,893**

Related U.S. Application Data

[62] Division of Ser. No. 321,505, Jan. 8, 1973, Pat. No. 3,842,392.

[52] **U.S. Cl.** ..... **29/628**; 29/203 H

[51] **Int. Cl.²** **H01R 43/00**

[58] **Field of Search** ..... 29/628, 629, 630 R, 630 A, 29/203 R, 203 D, 203 H, 203 HC, 203 J, 203 MM, 203 MW, 203 P, 203 S, 33.5; 339/47, 48, 49, 95, 97, 98, 99

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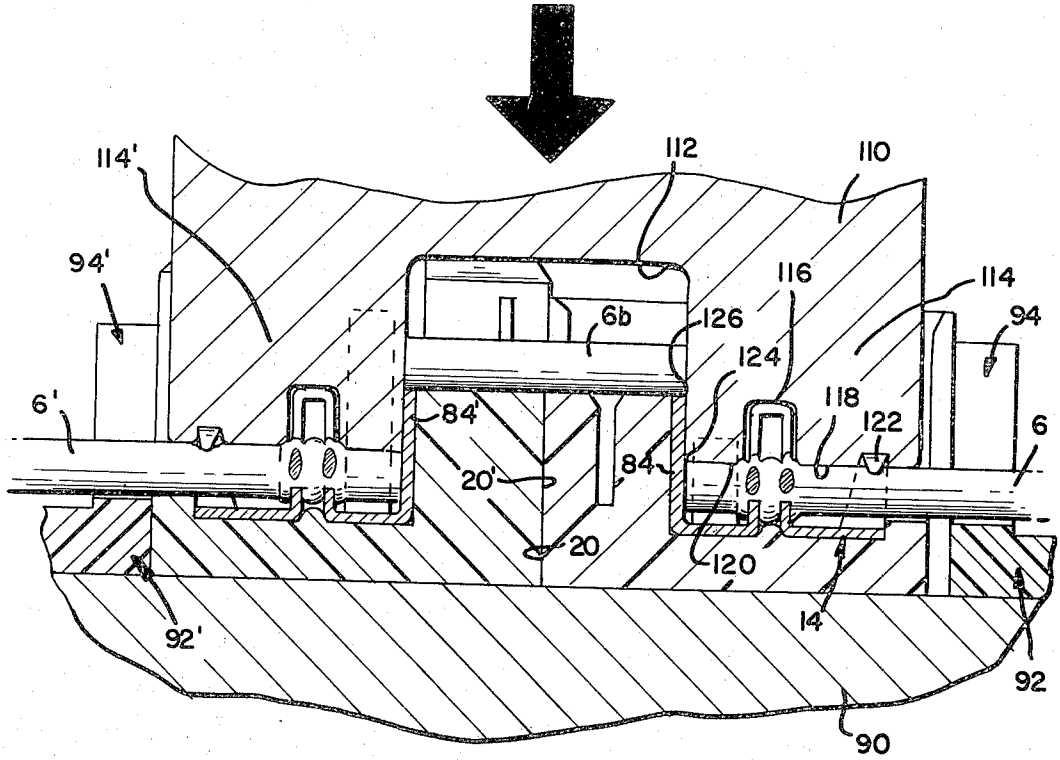
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Primary Examiner—C. W. Lanham
Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—Robert W. Pitts; Frederick W. Raring; Jay L. Seitchik

[57] **ABSTRACT**

A method for mechanically and electrically connecting conductors to multi-contact electrical connectors having rows of aligned terminals. Predetermined conductors can be electrically and mechanically connected to predetermined terminals in each of the separate connector housings positioned beside each other by locating the 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.

5 Claims, 12 Drawing Figures



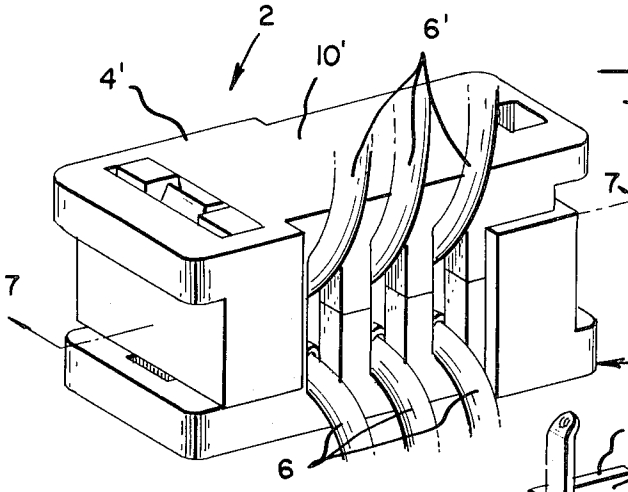

2
6'
10'
4'
7
7
4
6

Fig. 1

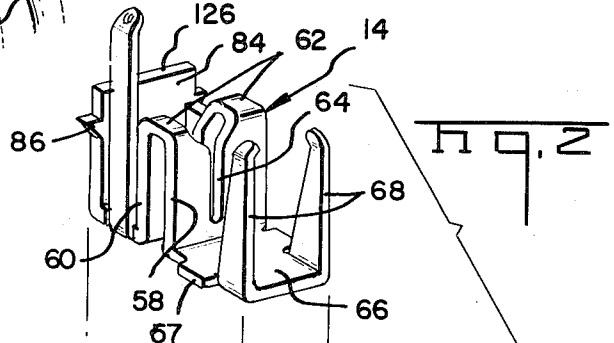

126
84
62
14
64
86
68
60
58
67
66

Fig. 2

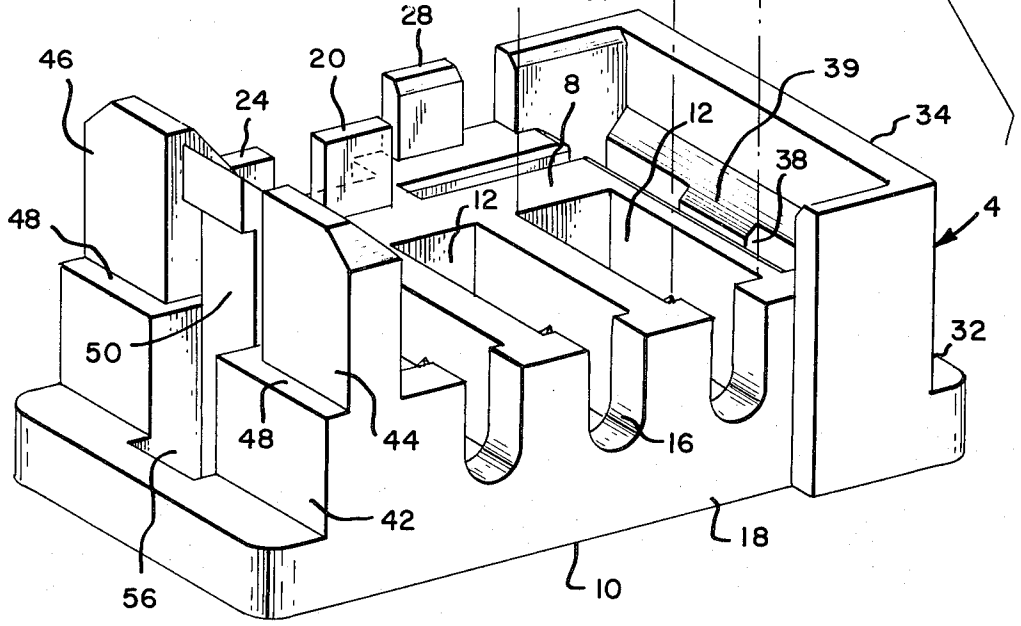

28
46
20
24
8
39
12
34
38
48
12
4
50
32
48
44
16
42
18
56
10

Fig. 3

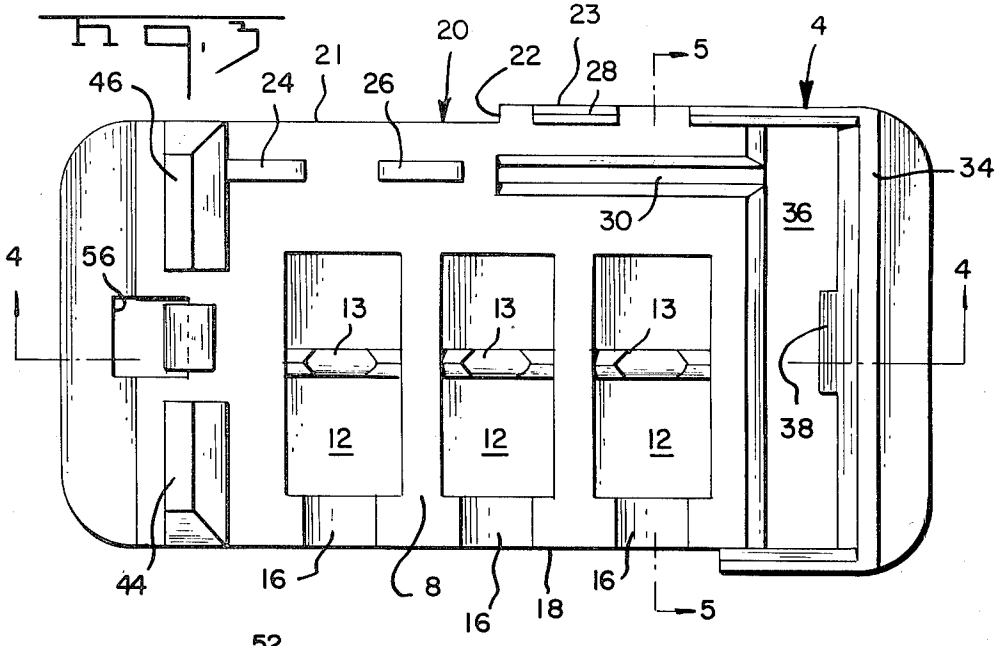


Fig. 4

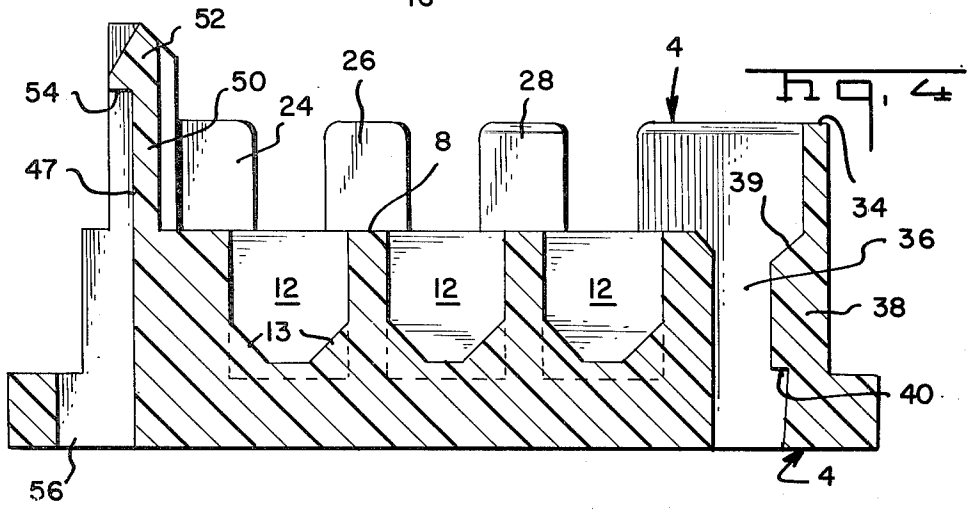
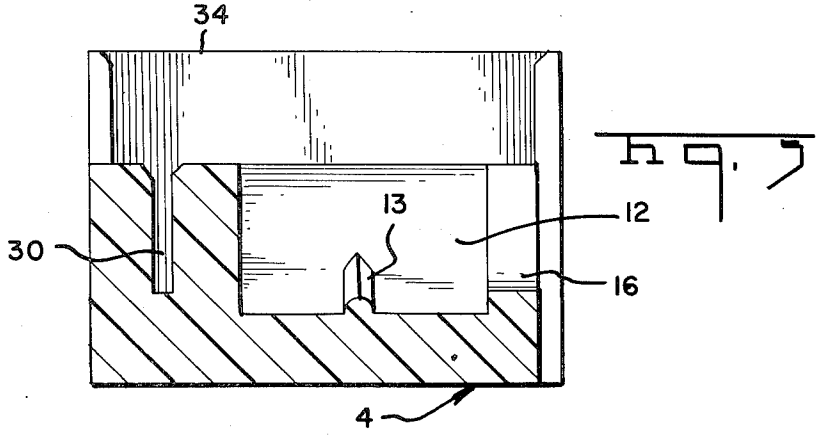


Fig. 5



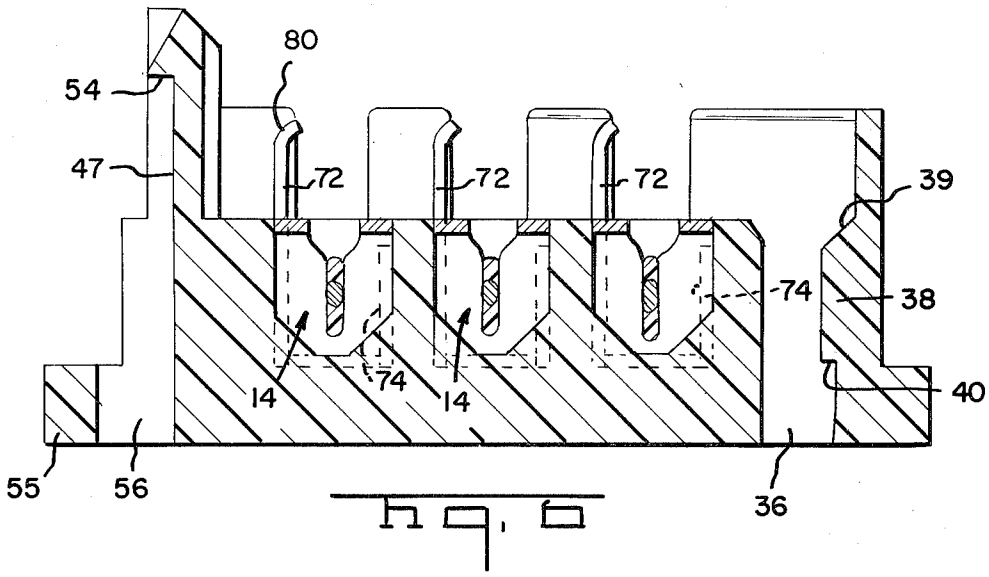

80
54
47
72
72
72
39
74
38
40
14
74
14
55
56
36

Fig. 6

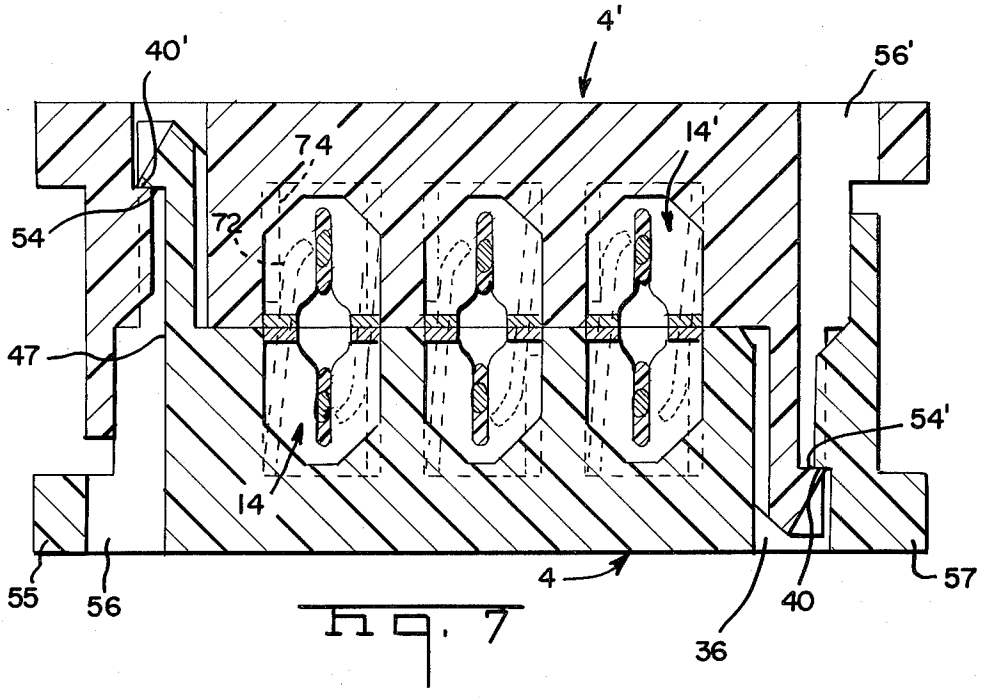

4'
40'
56'
74
14'
72
54
47
54'
14
55
56
4
40
57
36

Fig. 7

Fig. 8

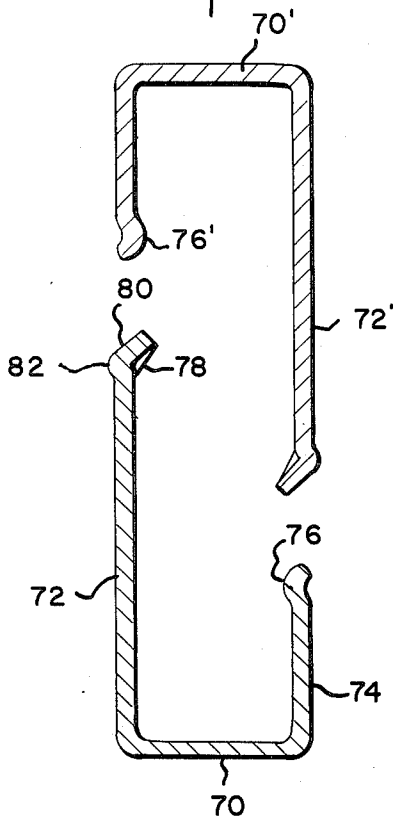
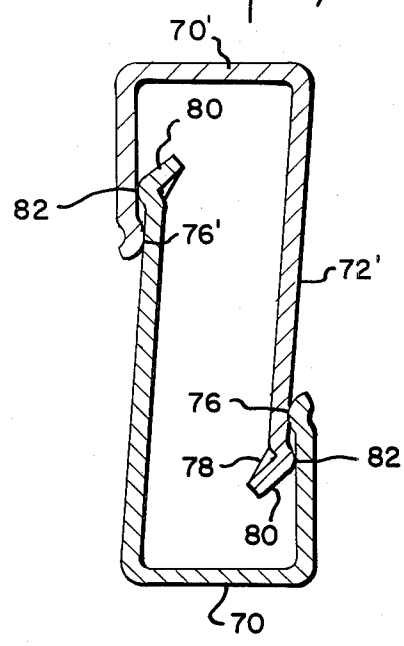


Fig. 9



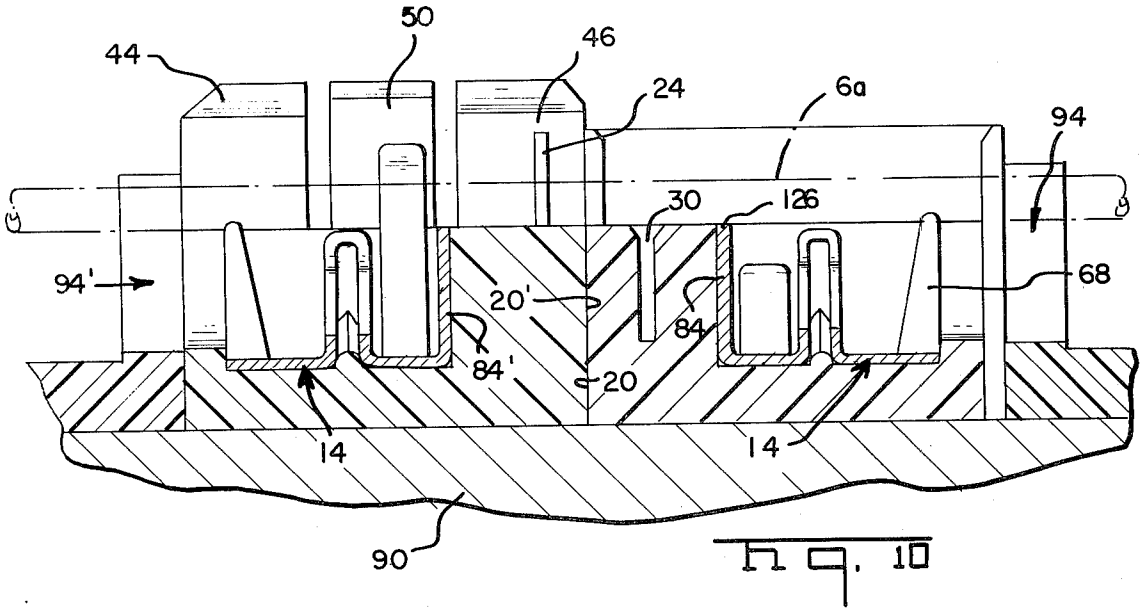

50
44
46
24
6a
94
30
126
94'
68
20'
84
84'
20
14
14
90

Fig. 10

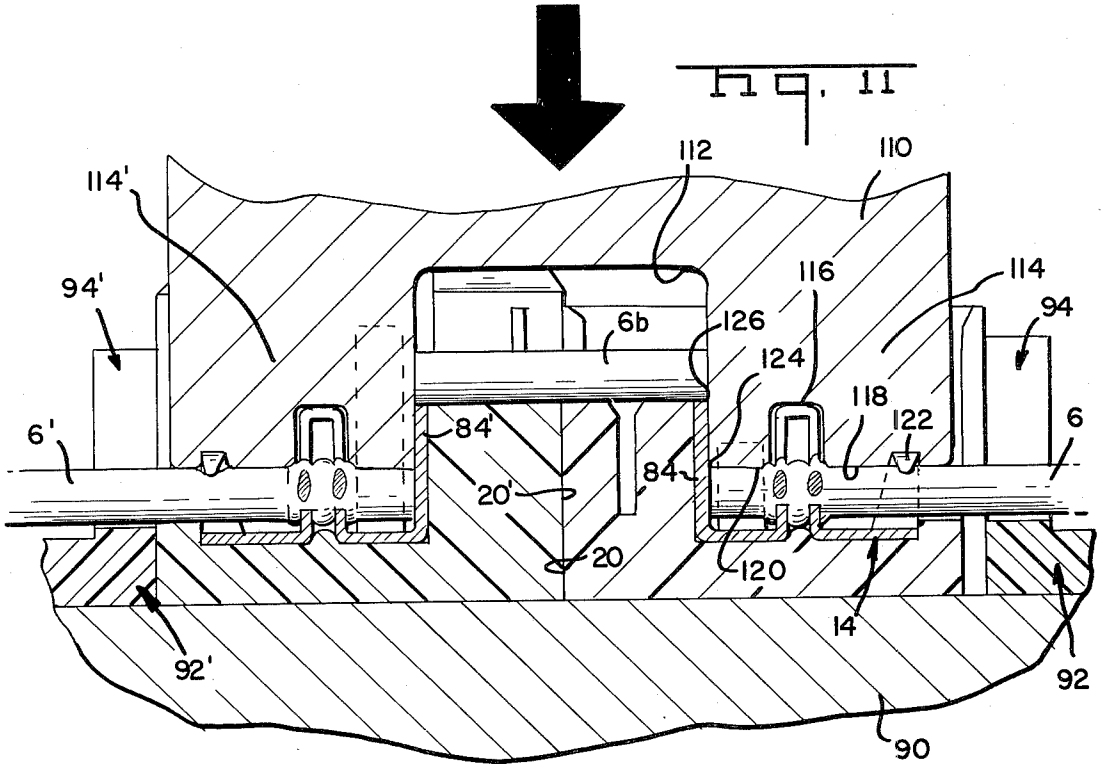

112
110
114'
116
114
94'
6b
126
94
124
118
122
6'
84'
6
84
20'
20
120
14
92'
92
90

Fig. 11

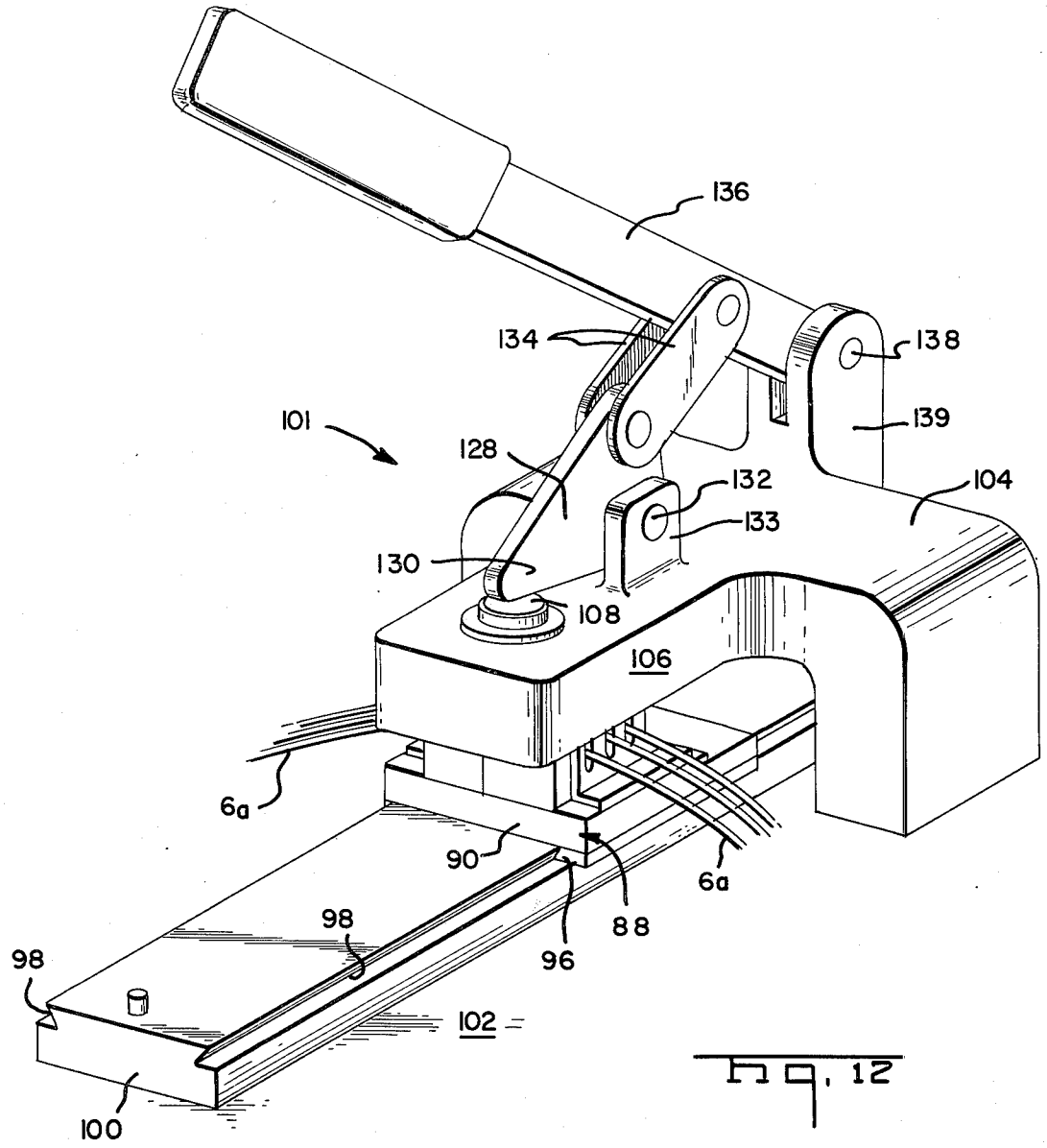

136
134
138
139
101
128
132
104
133
130
108
106
6a
90
6a
98
88
98
96
102
100

Fig. 12

PRE-LOADED ELECTRICAL CONNECTORS, ASSEMBLY APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

This is a divisional application of pending prior application Ser. No. **321,505** filed on Jan. **8, 1973** now U.S. Pat. No. **3,842,392.**

This invention is a method relating to multi-contact electrical connecting devices such as multi-contact electrical connectors and to the use of apparatus for installing such connectors on conductors. The invention is herein disclosed as used in connection with a pair of mateable hermaphroditic connectors but the method can be used with 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 housings 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 inefficient 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.

The method employed here insures that the apparatus inserts the proper conductor into its appropriate terminal on each of the connecting devices. The essential aspect of this method is that a single conductor is aligned with corresponding terminals in more than one connector. Apparatus for inserting conductors into multi-contact connectors are disclosed in U.S. Pat. Nos. **3,758,935, 3,769,701, 3,800,390** and **3,803,695.** None of these patents involve the application of a single conductor to corresponding terminals of mateable electrical connectors. Although not limited to utilization with mateable connectors, the instant method is particularly useful in that respect.

It is accordingly an object of the invention to facilitate the use of 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 preloaded electrical connectors, whether or not the connectors are mateable.

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. two, 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 accomodation 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 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 inwardly 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 moves 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 arms **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.

We claim:

1. A method of connecting predetermined conductors to predetermined terminals in each of two mateable electrical connectors said connectors having a row of contact terminals therein, each terminal occupying

a distinct position in said row in one connector and corresponding to the terminal in the same position in the other connector, each contact terminal having a contact portion and a conductor-receiving portion which is adapted to receive a conductor upon movement of said conductor laterally of its axis towards said conductor receiving portion, said method comprising the steps of:

positioning said connectors adjacent to each other with said row of terminals in each connector extending substantially parallel to the row of terminals in the other connector, and with the said contact portion of each row proximate to the contact portion of the said terminals in the other row and the said wire-receiving portions remote from each other,

locating intermediate portions of said conductors across said rows with the axes of each conductor in alignment with the said conductor-receiving portions of two corresponding terminals in each of said rows, said connectors being positioned so that each pair of corresponding terminals is in alignment,

moving said conductors laterally of their axes towards said terminals and securing each conductor to the conductor-receiving portions of two opposed corresponding terminals, and

cutting out the portion of each conductor which extends between each pair of corresponding terminals.

2. The method set forth in claim **1** in which said portion of each conductor is cut out concomitantly with movement of each conductor into said conductor-receiving portions of two corresponding terminals.

3. A method of connecting predetermined conductors to terminals in each of two multi-contact electrical connectors or the like, said connectors being of the type comprising an insulating housing having said contact terminals therein, each of said terminals having a conductor receiving portion which is adapted to receive a conductor upon movement of said conductor laterally of its axis and into said conductor receiving portion, said conductor receiving portions in each of said connectors being arranged in side-by-side relationship in a row, said method comprising the steps of:

positioning said two connectors in side-by-side relationship with said rows of conductor receiving portions extending parallel to each other and with corresponding conductor-receiving portions in said two rows in alignment,

locating said conductors in parallel side-by-side relationship with the axes of said conductors extending normally, and across, said rows and with the spacing between adjacent conductors being equal to the spacing between adjacent conductor-receiving portions in said rows,

severing said conductors along at least one severing line which extends between said rows, and

moving said conductors laterally of their axes and into said conductor-receiving portions.

4. The method set forth in claims **3,** said rows being spaced apart by a predetermined distance, said severing step being carried out by severing said conductors along two parallel severing lines, each of said severing lines being between said rows and being adjacent to one of said rows.

5. The method set forth in claim **3** in which said portion of each conductor is severed concomitantly with movement of each conductor into said conductor-receiving portions of two corresponding terminals.

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