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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:
H01R 9/07, 23/66	A1	WO 90/09044
		(43) International Publication Date: 9 August 1990 (09.08.90)

(21) International Application Number: PCT/US89/05587

(22) International Filing Date: 14 December 1989 (14.12.89)

(30) Priority data:
303,798 30 January 1989 (30.01.89) US

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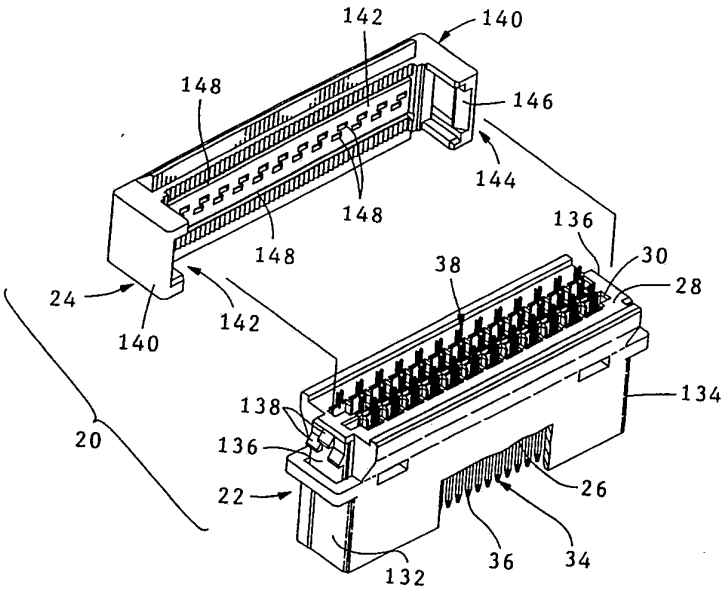
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: HIGH DENSITY RIBBON CABLE CONNECTOR AND DUAL TRANSITION CONTACT THEREFOR

(57) Abstract

An electrical terminal (32) for insertion into a passage (30) in a dielectric housing (22) or a high density ribbon cable connector (20) incorporating the terminal is disclosed. The high density ribbon cable connector (20) has an insulative housing (22) having passages (30) extending therethrough. Each of the passages (30) have an electrical terminal (32) secured therein. Each terminal (32) has a mating section (34), an intermediate section (40) and an insulation displacement section (38). A first transition section (60) is disposed between the mating section (34) and the intermediate section (56); a second transition section (72) is disposed between the intermediate section (56) and the insulation displacement section (38). The intermediate section (56) provides forwardly facing stop shoulders (58) for engagement with stop shoulders (64) in the insulative housing (22) to position the terminal (32) in a passage (30). Each terminal (32) is pushed into a passage (30) in the housing (22) by applying an insertion force on rearwardly facing shoulders (65) on the intermediate section (40). The first transition section (60) provides that the forwardly facing stop shoulders (58) on the intermediate section (40) are not in the same plane as the mating section (34) of the terminal (32). The second transition section (72) positions the insulation displacement section (38) out of the plane of the rearwardly facing insertion force shoulders (65). A termination cover (24) is used to press the ribbon cable (94) onto the insulation displacement sections (38) of the terminals (32), thereby terminating the conductors (92) of the ribbon cable (94) to respective terminals (32).



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HIGH DENSITY RIBBON CABLE CONNECTOR AND DUAL TRANSITION CONTACT THEREFOR

This invention relates to electrical connectors and contacts therefor and, in particular, to a high density ribbon cable connector and a dual transition contact therefor.

As printed circuit board components are down-sized, the printed circuit board area allocated for connectors is also decreased. As the smaller area is utilized, more contacts are placed in smaller and smaller connectors. The complementary connectors, typically a ribbon cable connector, must also contain a higher density of contacts. As the density of contacts in ribbon cable connectors increases, the spacing between adjacent conductors in ribbon cable decreases correspondingly. As the spacing between conductors in the ribbon cable decreases, the likelihood of adjacent contacts making electrical engagement with each other increases with the result that contacts must be designed to assure there is dielectric housing material separating the contacts.

In accordance with the present invention, an electrical terminal for insertion into a passage in a dielectric housing or a high density ribbon cable connector incorporating the terminal is disclosed. The high density ribbon cable connector has an insulative housing having a plurality of passages extending therethrough. Each of the passages has an electrical terminal secured therein. Each terminal has a mating section, an intermediate section and an insulation displacement section. A first transition section is disposed between the mating section and the intermediate section; a second transition section is disposed between the intermediate section and the insulation displacement section. The intermediate section provides forwardly facing stop shoulders for engagement with stop shoulders

in the insulative housing to position the terminal in the passage in which it is inserted. Each terminal is pushed into a passage in the housing by applying an insertion force on rearwardly facing shoulders on the intermediate section. The first transition section provides that the forwardly facing stop shoulders on the intermediate section are not in the same plane as the mating section of the terminal. A second transition section is disposed between the intermediate section and the insulation displacement section. The second transition section provides that the insulation displacement section is not in the same plane as rearwardly facing insertion force shoulders also on the intermediate section. A latching termination cover is used to press the ribbon cable onto the insulation displacement sections of the terminals, thereby terminating the conductors of the ribbon cable to respective terminals.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of a high density ribbon cable connector, in accordance with the invention, with the terminating cover exploded from the connector housing and with the housing partially cut away;

FIGURE 2 is a perspective view of terminals in accordance with the present invention carried on a carrier strip;

FIGURE 3 is a perspective view of the two types of contacts disclosed in the preferred embodiment;

FIGURE 4 is a view of the connector housing showing the conductor receiving face;

FIGURE 5 is an enlargement of a portion of Fig. 4;

FIGURE 6 is a perspective view of the housing of a connector, partially cut away, showing a contact

positioned in the housing and the housing structure for receiving a contact;

FIGURE 7 is a top view of a row of the first type of contacts in a cut-away housing;

FIGURE 8 is a top view of a row of the second type of contacts in a cut-away housing;

FIGURE 9 is a side view, partially sectioned, of the connector with a ribbon cable positioned to be terminated and the termination cover in a pre-termination position;

FIGURE 10 is an end sectional view of the connector of Figure 9, taken along the lines 10-10;

FIGURE 11 is a side view, partially sectioned, of the connector with a ribbon cable terminated thereto and the termination cover in a terminated position; and

FIGURE 12 is an end sectional view of the connector of Figure 11, taken along the lines 12-12.

A high density ribbon cable connector 20 in accordance with the present invention is shown in a perspective view in Figure 1. Although connector 20 is shown as an unshielded connector, it could be a shielded connector. Connector 20 includes housing 22 and termination cover 24, both molded of a dielectric material. Housing 22 has forward mating face 26, opposed conductor receiving rear face 28 and contact receiving passages 30 extending therebetween, with contacts 32 secured therein. In the preferred embodiment, contacts 32 are positioned in housing 22 with the mating portion 34, in the form of tab 36, in two rows spaced with centerlines 0.100 inch (2.5 mm) apart, with adjacent tabs in each row spaced with centerlines 0.050 inch (1.27 mm) apart, however the inventions is not limited to these contact spacings.

Contacts 32, as best seen in Figures 2 and 3, are stamped and formed from rolled strip stock, typically phosphorus bronze. A portion of the width of the rolled

stock is pre-milled to provide a thinner region along an edge of the strip stock. Each contact 32 has a mating portion 34 at one end, an insulation displacement plate 38 at the other end, and an intermediate portion 40 therebetween. The mating portion 34 of each contact 32 is stamped in the thicker portion of the stock; the insulation displacement plate 38 is stamped in the thinner region of the stock.

Mating portion 34 comprises tab 36 having barbs 42 on side edges 44 thereof, and defining axis 46 therethrough. Upon insertion of contact 32 into a passage 30, barbs 42 plow through passage sidewalls 48 (see Figure 6) with plastic flowing around the barbs to provide an interference fit that secures tab 36 and hence contact 32 in passage 30. The intermediate portion 40 of contact 32 comprises a portion of the carrier strip 50. When contact 32 is severed from carrier strip 50, laterally facing sheared edge surfaces 52 are formed. The section 54 of the carrier strip between adjacent edge surfaces 52 of adjacent contacts 32 may have feed holes and is discarded. The section of the carrier strip that remains on each contact 32 comprises intermediate portion 40 and extends laterally, typically beyond tab 36, providing forward facing stop shoulders 58. In a preferred embodiment, tab 36 is off-set from the plane of the stock, which is the plane of carrier strip 50 and section 54, in a first direction, resulting in a first transition region 60 providing a first off-set.

Insulation displacement plate 38 is thinner to facilitate insulation displacement termination of ribbon cable 94 by reducing the force necessary to effect a termination. Insulation displacement plate 38 extends from section 56 on extension 62. Section 56 extends laterally, typically beyond extension 62, providing rearwardly facing stop shoulders 65 (see Figure 6). When

contacts 32 are inserted into housing 22, the insertion force is applied to shoulders 65 and hence the thicker portion of the contact to push contacts into respective passages 30. The insertion force overcomes the resistance to insertion incurred by barbs 42 providing an interference fit with walls 48. First transition region 60 provides that the forwardly facing stop shoulders 58 on section 56 are not in the same plane as the mating portion 34 of contact 32.

A first surface 66 of extension 62 extends coplanar with a first surface 68 of section 56. Ramped surface 70 on the opposing side of extension 62 makes the transition from the thicker stock of tab 36 and section 56 to the thinner, pre-milled stock of insulation displacement plate 38.

In a preferred embodiment, insulation displacement plate 38 is off-set at second transition region 72 from section 56 in the same direction that section 56 is off-set from tab 36, with insulation displacement plate 38 substantially parallel to section 56. Second transition region 72 provides that the insulation displacement plate 38 is not in the same plane as rearwardly facing shoulders 65.

Insulation displacement plate 38 extends to a pair of insulation piercing points 74 at the distal end spaced approximately as the centerline spacing of conductors in the ribbon cable to be terminated. Tapered lead-in surfaces 76 angle toward conductor receiving slots 78. Slot 78 extends into a widened base region 80 of plate 38 which begins about halfway along slot 78. Slot 78 is substantially parallel to axis 46 and laterally displaced therefrom.

Second transition region 72 provides an insulation displacement plate 38 that is out of the plane of section 56 such that an insertion tool can engage rearwardly

facing shoulders 65 to apply an insertion force to push contacts 32 into passages 30 of housing 22. The insertion tool in the preferred embodiment would bridge extension 62 and ramped surface 70. Without the second transition region 72 it would be more difficult to apply an insertion force to shoulders 65.

As best seen in Figures 3, 5, 7 and 8, there are two types of contacts 32 with the general features described above. Contact 32a will be referred to as an outside contact as insulation displacement plate 38 of contacts 32a form the two outer rows of insulation displacement plates, as seen in Figures 4 and 5. Contact 32b will be referred to as an inside contact, as insulation displacement plate 38 of contact 32b forms the two inner rows of insulation displacement plates in Figures 4 and 5.

In the preferred embodiment, the mating portion of outer row of contacts 32a and the mating portion of adjacent inner row of contacts 32b form a first row 84 of tabs 36. Similarly, the mating portion of the other outer row of contacts 32a and the mating portion of the adjacent inner row of contacts 32b form a second row 86 of tabs 36.

Due to the high contact density, that is the closeness of the spacing between contacts 32 and the relative width of base region 80, if the insulation displacement plates 38 were not offset from the mating portion of contacts 32 such as towards side wall 88,90, the lateral edges of base region 80 of adjacent contacts would engage, thereby shorting out. Even if the lateral edges did not engage, dielectric material separating adjacent contacts may not provide sufficient dielectric material to withstand voltages to be practical. The dual transitions between mating portion 34 and insulation displacement plate 38 provides for a greater inter-insulation displacement plate spacing which minimizes the potential arcing between contacts.

The outer contacts 32a in row 84 are identical to the outer contacts 32a in row 86, the outer contacts 32a in row 86 being rotated 180 degrees around axis 46. The inner contacts 32b in row 84 are identical to the inner contacts 32b in row 86, the contacts 32b in row 86 being rotated 180 degrees around axis 46. In the preferred embodiment, the insulation displacement plate 38 of inside contacts 32b is offset inwardly toward the interior of the connector housing from the axis 46 of tab 36. The insulation displacement plate 38 of the outside contacts 32a is offset outwardly toward side walls 88,90 from axis 46 thereof. The conductor receiving slot 78 in contacts 32 is offset laterally from axis 46. The offset is one-half of the centerline spacing of conductors 92 in ribbon cable 94. The preferred embodiment's connector is described to be terminated to a ribbon cable 94 having conductor 92 centerline spacing of 0.025 inch (0.635 mm). Thus, the lateral offset in the preferred embodiment is 0.0125 inch (0.317 mm).

The insulation displacement plates of terminals 32c, 32d, 32e and 32f terminate four adjacent conductors in ribbon cable 94. Adjacent conductors in the ribbon cable, thus being terminated, are conductive with the mating portion 34 of adjacent contacts across centerline 96. Thus, if the conductors of the ribbon cable alternately carry a signal, ground, signal, ground, etc., all ground conductors are terminated to contacts such that all mating portions 34 in a row 84 carry a ground while all mating portions 34 in a row 86 carry signals.

As seen in Figure 5, slot 78 is offset one-half of the centerline spacing to the left of axis 46 of contact 32c. A line segment interconnecting the axes of contacts 32c and 32d is normal to the centerline 96 of face 28. Slot 78 is offset one-half of the centerline spacing to the right of axis 46 of contact 32d. As stated above, the

centerline spacing between axes 46 of contacts 32d and 32f is 0.050 inches (1.27 mm).

A line segment interconnecting the axes of contacts 32e and 32f is normal to centerline 96. Slot 78 is offset one-half of the centerline spacing to the right of axis 46 of contact 32. Slot 78 is offset one-half of the centerline spacing to the left of axis 46 of contact 32e. It can thus be seen that slots 78 of contacts 32c, 32d, 32e and 32f are spaced to correspond to the centerline spacing of the conductors of a ribbon cable adapted to be terminated thereon.

In the preferred embodiment, passage 30 for either an inside or an outside contact is virtually identical, as seen in Figures 7 and 8. The differences are that for an outside contact, the passage offsets outwardly toward a side wall of housing 22 whereas for an inside contact, the passage offsets inwardly toward centerline 96. Furthermore, ribs 104 are on wall 106 for all contacts and allowance is made for base 80 to be offset such that slot 78 is offset laterally from axis 46 in opposite directions for inside and outside contacts, as best seen in Figures 7 and 8.

The spacing between side edges 44 of adjacent tabs 36 in a row of tabs 84 or 86 is the minimum distance 154 between any two points of any features of adjacent contacts in a row 84 or 86. As seen in Figures 7 and 8, all features of inside contacts are maintained spaced from adjacent inside contacts at least the minimum distance 154. Likewise, all features of outside contacts are maintained spaced from adjacent outside contacts at least the minimum distance 154. The dual offsets provided by first transition region 60 and second transition region 72 assure that all features of intermediate portion 40 and insulation displacement plate 38 of adjacent inside and outside contacts remain at least the minimum distance 154

apart. Thus, where a projection of a feature of adjacent contacts overlies each other, they are at least the minimum distance 154 apart, for example, the corners 156 and 158 of intermediate portion 40 of contacts 32 as best seen in Figure 6.

The spacing between the closest points of inside contacts 32b across centerline 96, as best seen in Figure 5, is also maintained at least minimum distance 154 apart.

Figure 6 shows a cutaway view of a part of housing 22 showing detailed features of passage 30. Tab 36, upon insertion into a respective passage 30, is guided into the narrower forward portion 98 by cooperating tapered end 100 and tapered lead-in surfaces 102 which laterally position tab 36 for entry into forward portion 98. Tab 104 protruding inward along the forward portion of passage wall 106 forces tab 36 against the opposite passage wall 108 to minimize the position tolerance of tabs 36.

First transition region 60 provides the transition from narrow forward portion 98 to recess 110. Tapered lead-in surfaces 112 facilitate first transition region 60 entering recess 110 and permit a radius on contact 32 between tab 36 and section 56.

During insertion of a contact into a contact receiving passage 30, forwardly facing shoulders 58 seat against rearwardly facing shoulders 64 to precisely position contact 32 in passage 30. Thus, shoulders 58 provide a datum on contacts 32 relative to which all contact structure is referenced. Similarly, shoulders 64 provide a datum on housing 22 relative to which structure along passage 32 is referenced.

Surface 68 of section 56 engages a wall 114. Lateral edge surfaces 52 extend between the clear walls 116,118. Walls 116 and 118 extend rearwardly to tapered lead-ins 120, with wall 116 offset at tapered lead-in 122.

Second transition region 72 provides a transition from section 56 engaging wall 114 to base region 80 engaging a wall 123. Second transition region 72 is received in recess 124. Tapered lead-in 126 guides second transition region 72 into recess 124 during insertion of a contact 32 into passage 30. With a contact 32 positioned in passage 30, there is a small amount of clearance between shoulders 128 and base 80 as at 130. Shoulders 128 support base 80 during termination of cable 94.

Housing end walls 132, 134 have terminating cover alignment ribs 136 extending outwardly therefrom. Latch means 138 are provided on ribs 136 to cooperate with complementary latch means on terminating cover 24 to secure the terminating cover to housing 22. Terminating cover 24 is elongate, having latch arms 140 at opposite ends thereof, with an inner surface 142 extending therebetween for engaging ribbon cable 94. Latch arms 140 have a channel 144 complementary to ribs 136 which cooperates with ribs 136 during movement of termination cover 24 from a pretermination position to a termination position to guide cover 24 parallel to slots 78. Latch arms 140 also have complementary latch means 146 adapted to engage latch means 138 to retain cover 24 on housing 22. Figures 9 and 10 show termination cover 24 on a pretermination position wherein latch means 138 in complementary latch means 146 maintain terminating cover 24 such that inner surface 142 is spaced from insulation piercing points 74 of contacts 32 to permit insertion of a ribbon cable 94 therebetween.

During termination of ribbon cable 94 onto connector 20, terminating cover 24 may be placed in tool 150, cable 94 passed between plates 38 and inner surface 142 with conductors 92 positioned to correspond to slots 78, thence housing 22 pressed toward cover 24 as indicated by arrow 152. Conductors 92 are terminated on respective plates 38

as insulation displacement plates 38 pass into recesses 148 and inner surface 142. This provides some plastic adjacent to each recess 148 to support the insulation surrounding a conductor being terminated in a plate passing into the recess.

Figures 11 and 12 show terminating cover 24 having been moved from a pretermination position to a termination position with latch means 138 in complementary latch means 146 securing cover 24 to housing 22 in the terminated position.

Although the first and second transitions have been described herein above in the preferred embodiment as providing that section 56 is displaced out of the plane of mating portion 34 and plate 38 is displaced out of the plane of both section 56 and mating portion 34, it is contemplated within the scope of the invention that variations may be made. One possible variation is to provide a mating portion 34 that is substantially coplanar with a thinner insulation displacement plate 38 with intermediate portion 56 rotated 90 degrees such that the first and second transitions are a twist.

CLAIMS:

1. A connector (20) for terminating to a ribbon cable (94) having close, uniformly spaced conductors (92) surrounded by insulation, said connector having an insulative housing (22) defining a cable receiving face (28) a mating face (26) and a first row of terminal receiving passages (30) extending therebetween, each of said passages (30) having an electrical terminal (32) secured therein, and wall means facing adjacent terminals in said row of terminals defining a predetermined distance (154) therebetween, each said terminal (32) comprising a mating section (34) defining an axis (46), an insulation displacement section (38), at least a portion of each insulation displacement section extending beyond said cable receiving face (28) for termination thereto of the ribbon cable (94), said terminal characterized by an intermediate section (40), a first transition section (60), and a second transition section (72), said first transition section (60) between the mating section (34) and the intermediate section (40), said first transition section (60) displacing the mating section (34) from the plane of the intermediate section (40) in a first direction normal to said row of terminal receiving passages (30), said second transition section (72) between the intermediate section (56) and the insulation displacement section (38), said second transition section (72) displacing the insulation displacement section (38) from the intermediate section (40) in a second, opposite direction from the first direction, such that the insulation displacement section (38) is offset from the axis (46) of the mating section (34), alternate terminals in said row having the insulation displacement sections (38) thereof offset from the axis of the mating sections (34) in opposite directions normal to the row.

2. A connector (20) for terminating to a ribbon cable (94) as recited in claim 1, characterized in that the intermediate sections (40) of adjacent terminals (32) in a row partially overlie each other and are spaced at least said predetermined distance (154) apart.

3. A connector (20) for terminating to a ribbon cable as recited in claim 1, characterized in that the insulation displacement section (38) of each terminal (32) includes an insulation displacement slot (78), said slots (78) being offset from the axis (46) of the mating section (34) of a respective terminal (32) parallel to said row.

4. A connector (20) for terminating to a ribbon cable (94) as recited in claim 1, characterized in that the insulation displacement slot (78) of terminals (32) in said first row are offset from the axis (46) of the mating section (34) of said terminals parallel to said first row in a first lateral direction.

5. A connector (20) for terminating to a ribbon cable (94) as recited in claim 3, characterized in that the offset of the insulation displacement slot (78) from the axis (46) of the mating section (34) of a terminal (32) parallel to said row is one-half of the spacing between the axes (46) of adjacent terminals (32) in said row.

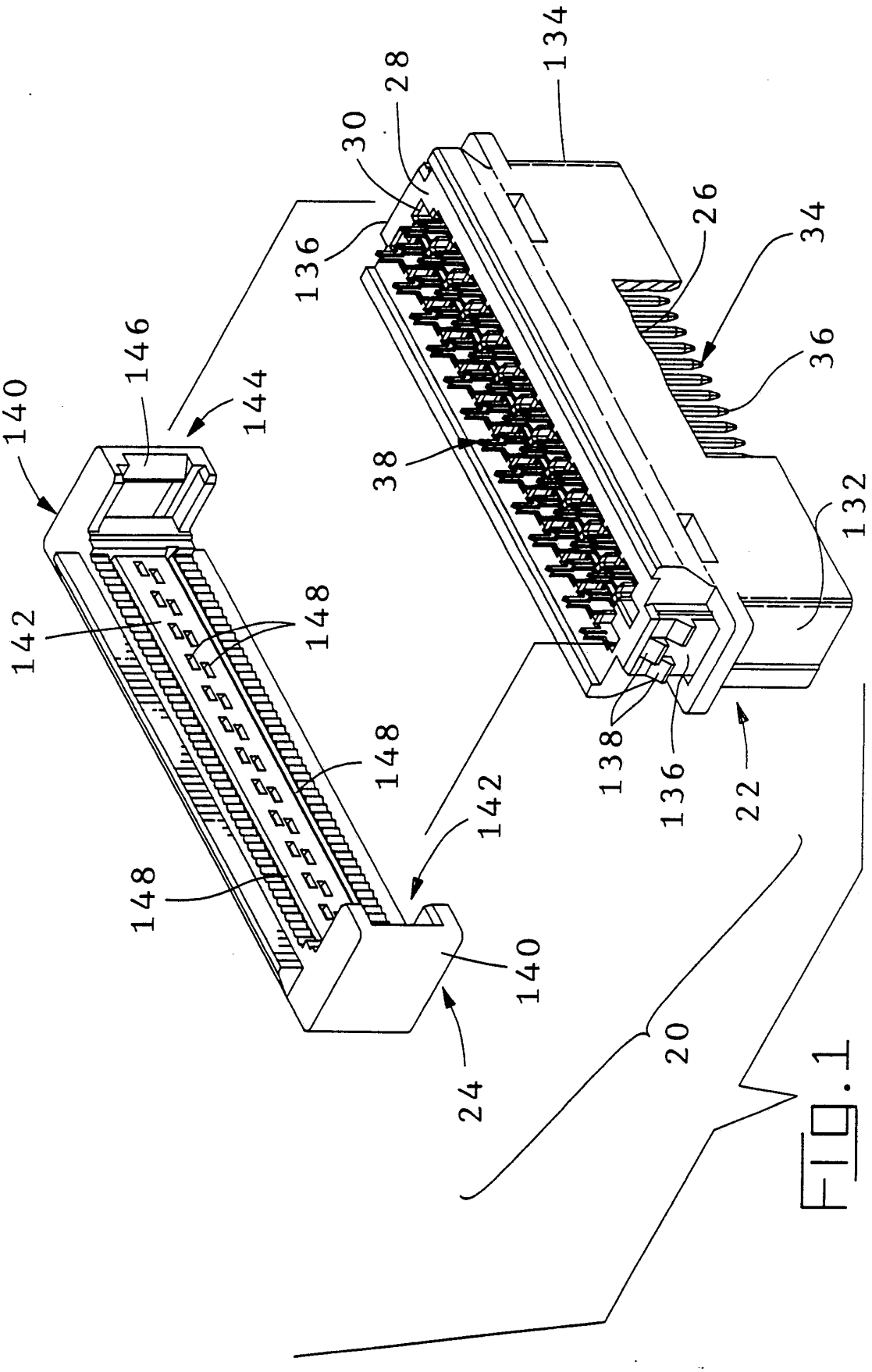
6. A connector (20) for terminating to a ribbon cable (94) as recited in claim 1, further characterized by a second row of terminal receiving passages (30) substantially parallel to said first row, said second row of passages having like terminals (32) secured therein, wherein the insulation displacement sections (38) of terminals (32) in each row offset from the axis (46) of the mating section (34) toward the other row of contacts partially overlie in each other and are spaced at least said predetermined distance (154) apart.

7. A connector (20) for terminating to a ribbon cable (94) as recited in claim 6, characterized in that a terminal (32) in said first row with the mating section (34) displaced from the intermediate section (40) in said first direction is identical to a terminal (32) in said second row, with the mating section (34) displaced from the intermediate section (40) in said second direction, whereby the terminal (32) in said second row is oriented 180 degrees relative to said terminal (32) in said first row.

8. A connector (20) for terminating to a ribbon cable (94) as recited in claim 6, characterized in that the insulation displacement slot (78) of terminals (32) in said first row are offset from the axis (46) of the mating section (34) of said terminals (32) parallel to said first row in a first lateral direction and the insulation displacement slot (78) of terminals (32) in said second row are offset from the axis (46) of the mating section (34) of said terminals (32) parallel to said second row in a second lateral direction, said second lateral direction being opposite to said first lateral direction.

9. A connector (20) for terminating to a ribbon cable (94) as recited in claim 1, characterized in that said intermediate section (40) further comprises a rearwardly facing shoulder (65), on which an insertion force can be applied to insert said terminal into said passage.

10. A connector (20) for terminating to a ribbon cable (94) as recited in claim 1, characterized in that said intermediate section (40) further comprises a forwardly facing stop shoulder (58) for engaging a stop surface in said passage upon insertion thereinto.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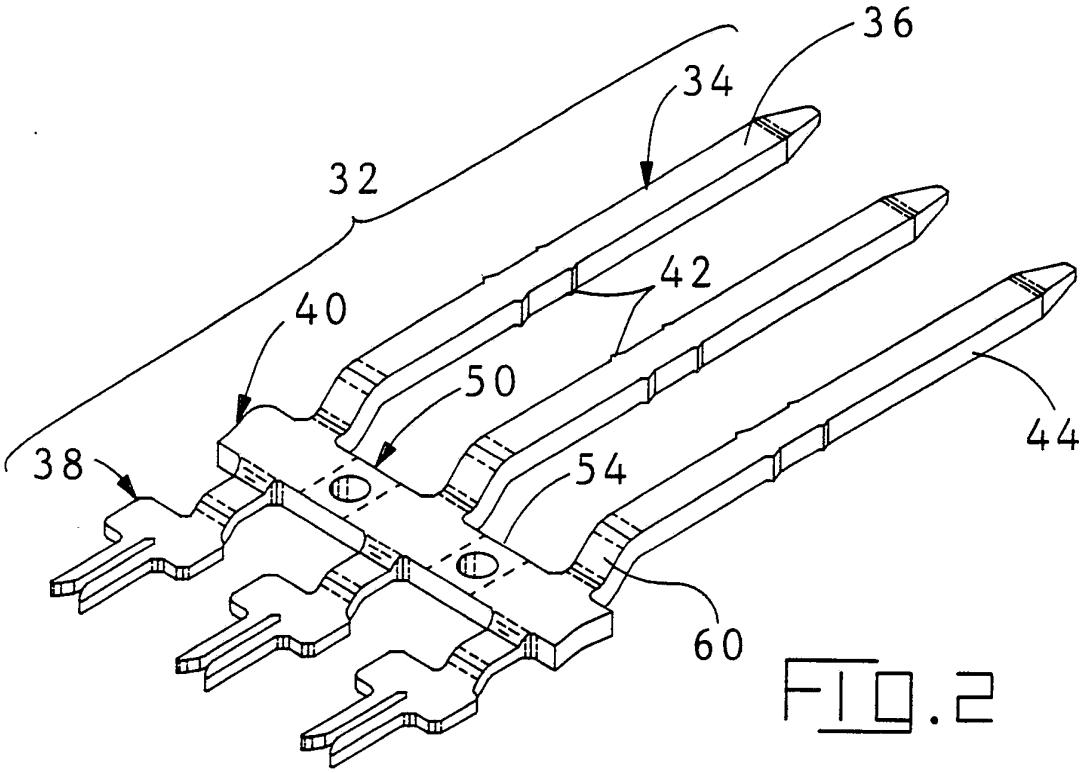
20

FIG. 1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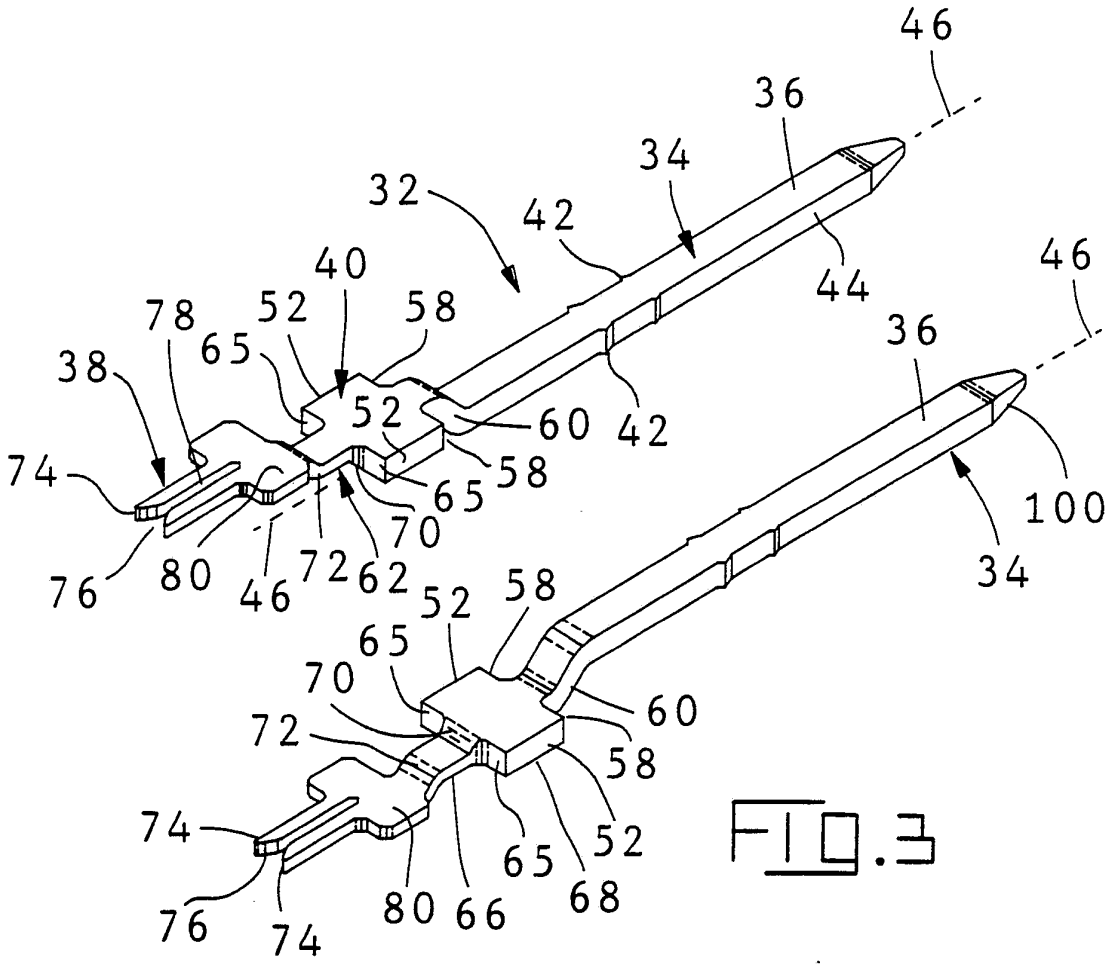
60

FIG. 2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72
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FIG. 3

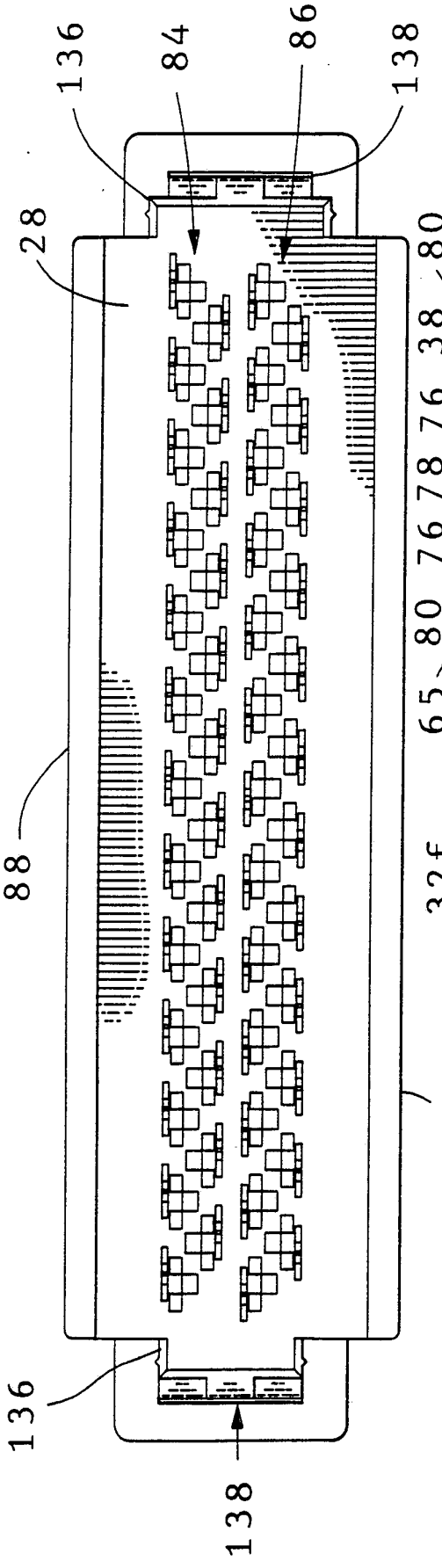
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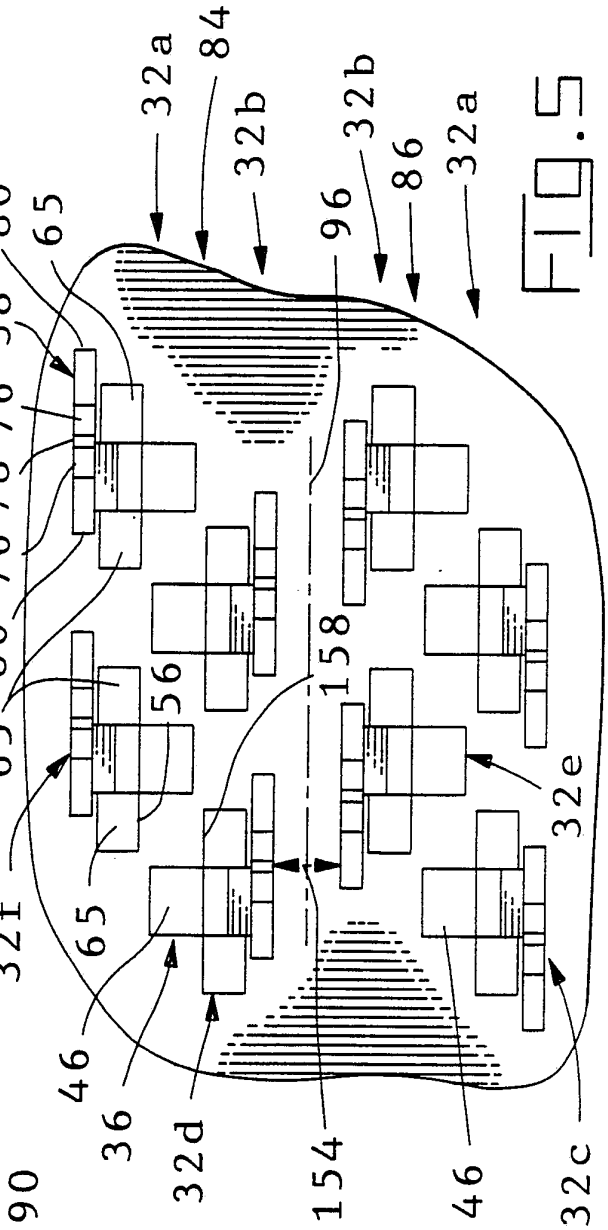
FIG. 4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32c
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FIG. 5

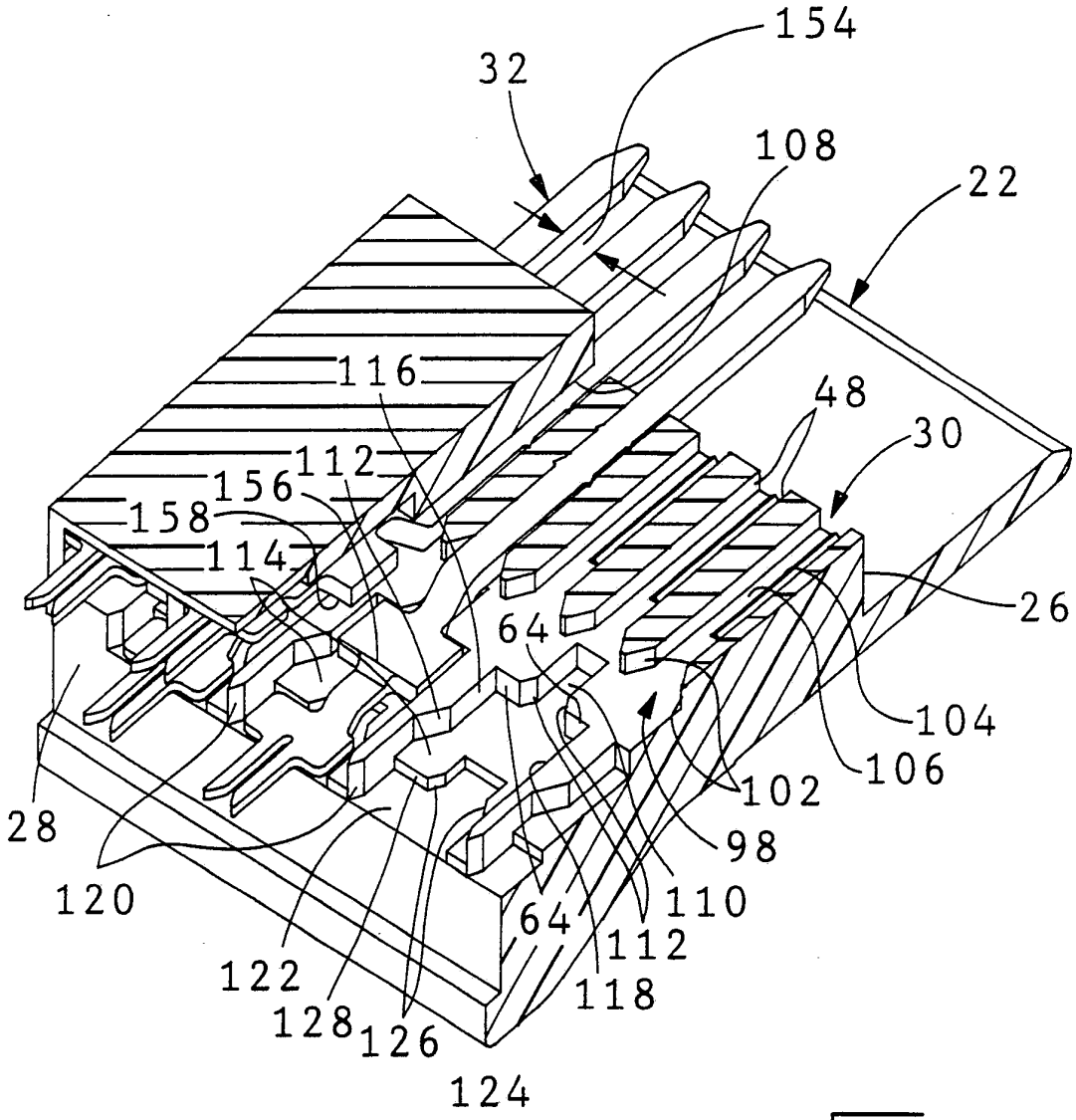
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FIG.6

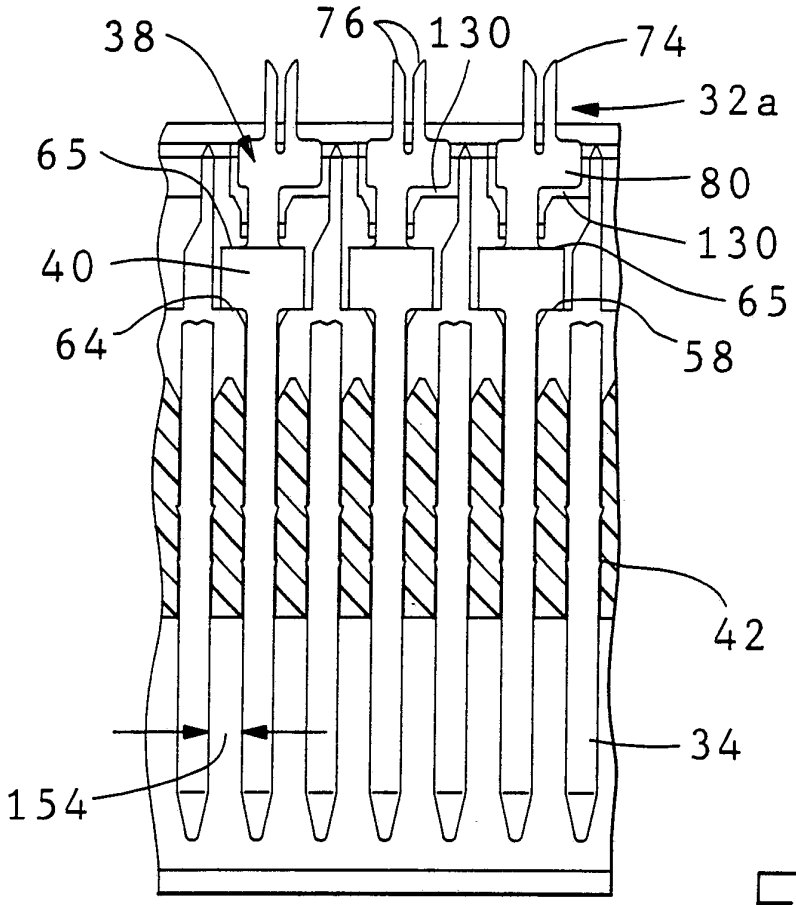
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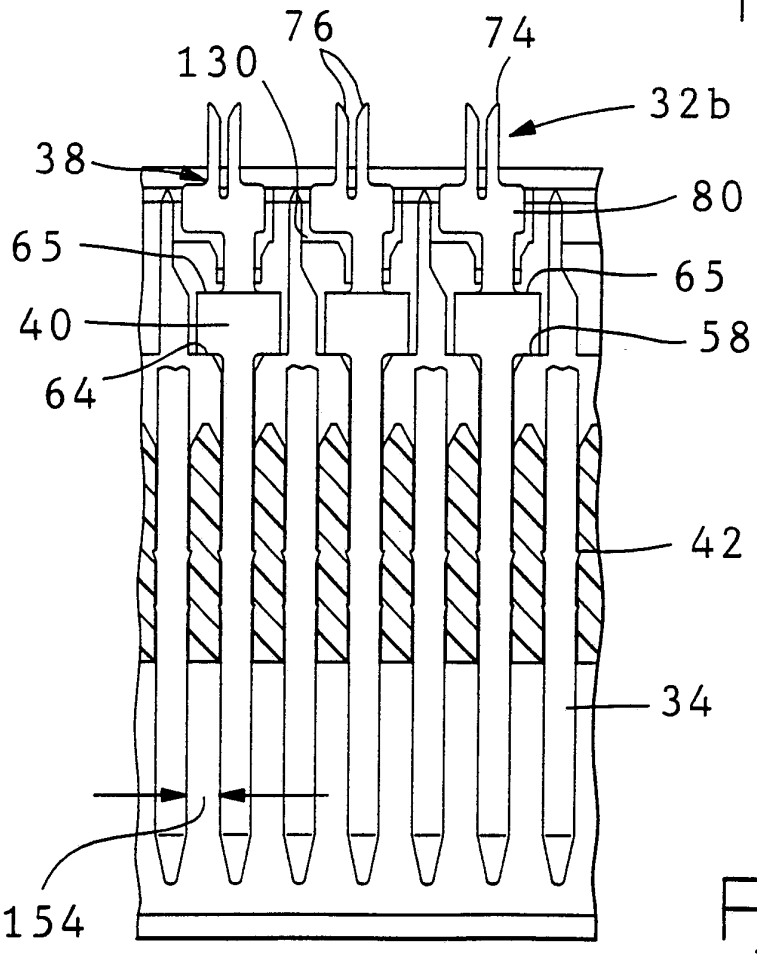
FIG.7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154

FIG.8

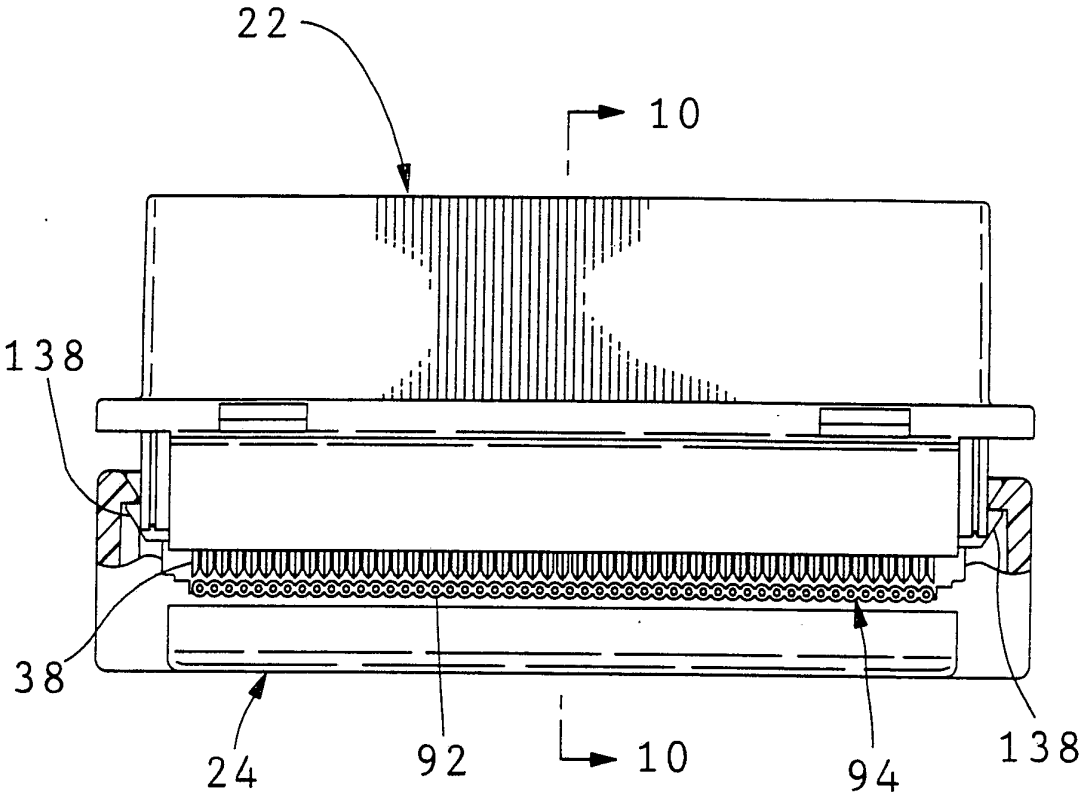

FIG.9

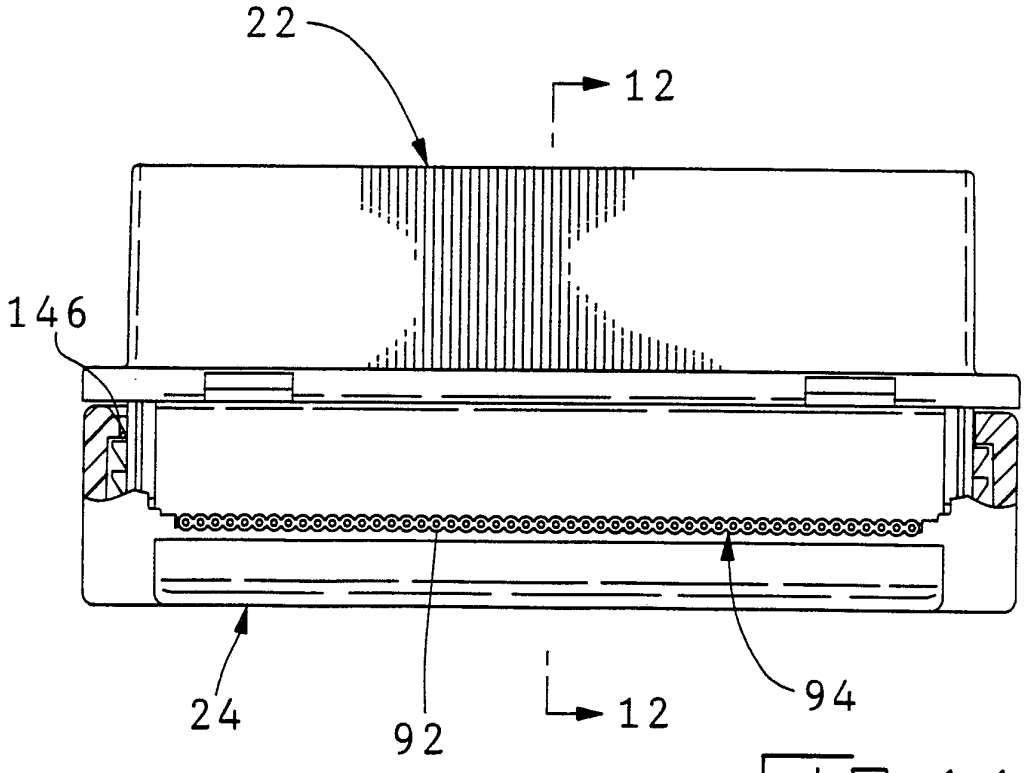

FIG.11

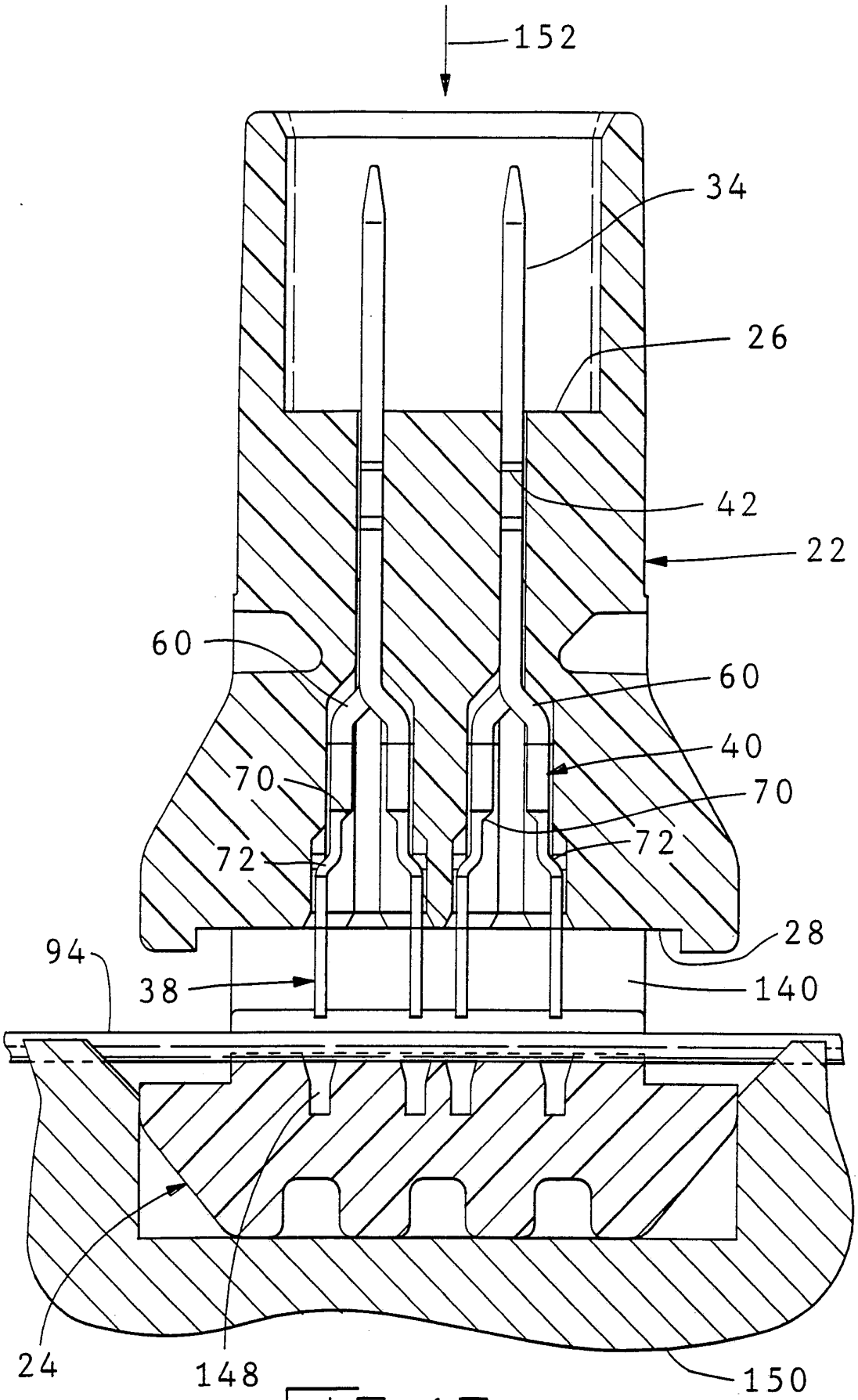

FIG. 10

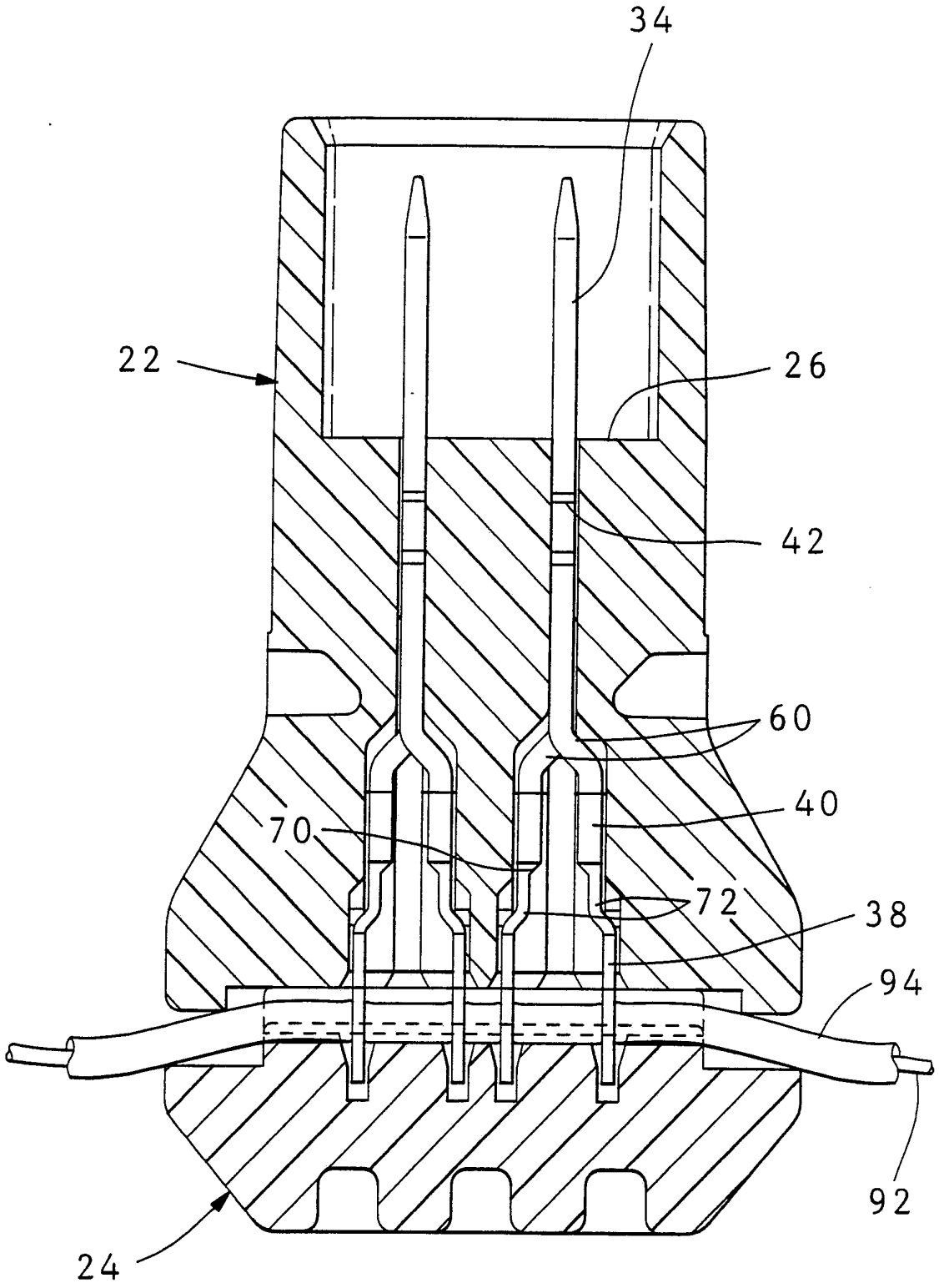

FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 89/05587

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H01R9/07 ; H01R23/66

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H01R

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,212356 (OMRON TATEISI ELECTRONICS CO.) 04 March 1987 see page 2, last paragraph - page 12; figures 1-4	1, 3, 9, 10
X	EP,A,242019 (BURNDY CORPORATION) 21 October 1987 see page 26, last paragraph - page 33, line 15; figures 1-28	1, 3, 4
A		5
X	GB,A,2090481 (THOMAS & BETTS CORPORATION) 07 July 1982 see page 3, line 94 - page 4, line 11; figures 1, 6	1, 3, 4
A		5, 8

[10] Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
23 MAY 1990	26.06.90
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	TAPPEINER R.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/US 89/05587

SA 34664

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 23/05/90
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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		US-A- 4442594	17-04-84