

ELECTRICAL CONNECTOR AND CONNECTOR ASSEMBLY

The present invention relates to an electrical connector, more specifically to such connector having a plurality of contacts in one or more row.

A typical electrical connector comprises an insulating housing and at least one contact secured in the insulating housing. However, as electrical circuits become increasingly complex and with higher performance, it is typical that the plurality of contacts are secured in the insulating housing at smaller centerline spacing or in higher density. In personal computers and many office or business electronic machines such as copiers, facsimile machines, etc., it is typical that a large number of closely spaced contacts are secured in two or more rows in an insulating housing.

One typical example of such connectors is a so-called drawer connector. One connector half is mounted in a main body while another connector half is mounted in a module which is pluggable into a module compartment in the main body. That is, in certain types of electronic machines and equipment such as copy machines are designed such that there are two or more removable parts to be electrically and mechanically integrated for convenience of service and maintenance. One or more drawer connectors are used at the interface between the main body and the module to effect interconnection.

One typical example of such drawer connectors is disclosed in Japanese Patent Publication No. 276575/89. It is typical that hermaphroditic housings are used for connector halves in which the male contacts are disposed in a row and the female contacts are disposed in another row.

Another example of an hermaphroditic connector is disclosed in U.S. Patent No. 4,737,118. A plurality of

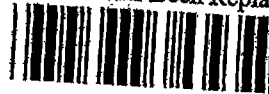
contacts of identical construction is disposed in a row in an identical connector housing. A pair of identical housings in a reversed vertical orientation with respect to each other are with the matable contacts engaging
5 with one another.

The conventional drawer or hermaphroditic electrical connectors as mentioned above utilize identical resilient contacts normally curved in one direction which are resiliently biased when mated with
10 one another. In other words, the contacts are identical and act as both male and female contacts. When a pair of such identical connectors are mated with one another, all contacts in one connector cause a pivotal action toward the contacts of the other and also the connector
15 housings in which such contacts are secured.

Such conventional connectors operate satisfactory when the number of contacts is relatively limited and the connector is relatively large in dimension. However, in compact and high performance electronic
20 equipment, contacts are normally secured in the housing in a plurality of rows with small centerline contact pitch. In such applications, contacts of one row are oriented in opposite direction to those of another row to compensate for biasing force to the contacts.
25 However, such compensation is not possible when the contact are disposed in an odd number of rows, for example, 3 rows. Also, the insertion force of the conventional hermaphroditic contacts is relatively high and not practical for electrical connector having a
30 large number of contacts.

It is therefore an object of the present invention to provide an electrical connector having a large number of contacts with small spacing therebetween.

It is another object of the present invention to
35 provide a low insertion force electrical connector assembly having hermaphroditic housing and contacts.



It is still another object of the present invention to provide an electrical connector having an odd number of rows of contacts.

In order to solve the above problems of the conventional electrical connectors and achieve the above objects, the electrical connector according to the present invention has a plurality of male and female contacts disposed alternately in at least one row in an insulating housing, thereby offsetting or balancing any undesirable forces that may be applied to the housing.

Also, the connector assembly according to the present invention comprises a pair of identical or hermaphroditic housings having a plurality of contact receiving cavities and a plurality of male and female contacts disposed alternately in each row of the contact receiving cavities in the housings.

Preferred embodiments of the electrical connector according to the present invention will be described in detail by reference to accompanying drawings in which:
FIGURE 1 is an exploded isometric view of one preferred embodiment of the electrical connector made in accordance with the present invention.

FIGURE 2 is a isometric view of several contacts to be used in the electrical connector in Figure 1.

FIGURE 3 is a cross-sectional view of one preferred embodiment of a mated connector assembly of the hermaphroditic electrical connector in accordance with to the present invention.

Illustrated in Figure 1 is an exploded isometric view of the electrical connector of the present invention. The electrical connector 10 comprises an insulating housing 20, a plurality of right angle contacts 30, a pin alignment plate 40 and a pair of board retention members 50. The electrical connector 10 is designed to be mounted on a circuit board (not shown in Figure 1).



The insulating housing 20 has 3 rows of contact receiving cavities 21a, 21b, 21c, from its mating face 22 to its rear face 23. A first row of contact cavities 21a is in a shroud 24. A second row of contact receiving cavities 21b, is on the bottom face of the shroud 24 while a third row of contact receiving cavities 21c is on the upper face of a rib 25 separated from and in parallel with the shroud 24. A slot 26 is formed in the upperwall of the shroud 24 while a guide projection 27 is formed on the bottom face of the rib 25. A pair of mounting flanges 28a, 28b are formed at both ends of the insulating housing 20 extending rearwardly in parallel with each other. A pair of openings 29a, 29b are formed in and extend through the mounting franges 28a, 28b for receiving the board retention members 50.

Now, the contacts 30 comprises 3 rows of right-angle contacts 30a, 30b, 30c to be received in the contact receiving cavities 21a, 21b, 22c in the insulating housing 20, respectively. Each row of contacts 30a-30c contains male contacts 31 and female contacts 32 disposed alternately. Each of the male contacts and female contacts 31, 32 comprises a contact section 33, a retention section 34 and a solder tail 35 bent at a substantially right angle.

Each row of contacts 30a-30c is made by stamping and forming an electrically conductive metal plate or strip. The solder tail 35 of each contact 31, 32 is substantially a pin contact having a generally rectangular cross-section. The contact section 33 of the male contact 31 is generally straight but curved downwardly at the front or mating end while that of the female contact 32 has a raised semicircular portion at the front end.

The pin alignment plate 40 is made from an insulative material and is generally a plate member

having a plurality of openings 41 equal in number to the number of contacts 30. As apparent from Figure 1, the openings 41 to receive solder tails 35 are disposed in 6 rows that is two columns of three openings in an alternating pattern, while the contact sections 33 of the contacts 30 are disposed in 3 rows of contact receiving cavities 21a-21c as mentioned above. In addition, the openings 41 in the pin alignment plate 40 are offset in alternate rows so that the openings 41 will make a straight line obliquely or about 45 degrees with respect to the edge of the pin alignment plate 40. The pin alignment plate 40 also has a pair of slots or cut-outs 42 at both ends to receive the board retention members 50.

The board retention members 50 are made from a generally flat metal plate by conventional stamping techniques. Each board retention member 50 has a generally flat retention or base section 51 having a few barbs 52 on side edges and a pair of resilient legs 53 separated by a vertical slot 54. The outer edges of the retention legs 53 have barbs or serrations 55 to bite into an inner wall of a hole in a circuit board as known in the art.

Preferably the board retention members 50 are inserted through aligned slots 42 and the openings 29 in the insulating housing 20 from the bottom of the insulating housing 20, thereby firmly securing the pin alignment plate 40 and the insulating housing 20. Needless to say that the pin alignment plate 40 is mounted on the insulating housing 20 from the bottom with the solder tails 35 of the contacts 30 passing through the openings 41. Alternatively, the pin alignment plate 40 may be retained by friction force in the insulating housing 20, thereby eliminating the slots (or cut-out portions) 42.

Now, illustrated in Figure 2 is a part of the contacts 30 which are integrally formed along a carrier strip 39 by stamping a metal strip. It is preferable that the contacts 30 are also intercoupled at the retention section 34 until they are severed from the carrier strip 39 for assembly with the insulating housing 20. Note that male and female contacts 31, 32 are formed alternately and desired number of male and female contacts are removed from the carrier strip 39 and bent at a different locations for the different rows of the contacts 30a-30c.

It is to be noted that the first, second and third rows of contacts 30a-30c may be made of identical contacts. In other words, the contacts 30a-30c are identical to one another except the length of the solder tails 35. This means that the contact strip is preferably designed in accordance with the contacts 30a having the longer solder tails 35 and the second and third rows of contacts 30b, 30c are made by cutting the solder legs 35 at gradually shorter locations. In this way, the total production cost can be minimized.

Illustrated in Figure 3 is a longitudinal cross-sectional view of a mated connector assembly 100 according to the present invention. The connector assembly 100 comprises a pair of hermaphroditic electrical connectors 200, 300 which are substantially identical to the electrical connector 10 in Figure 1 and to be mounted on respective co-planar circuit boards 260, 360 near edge portions thereof.

More in detail, the electrical connector 200 is identical to the electrical connector 10 while the electrical connector 300 uses the same insulating housing 320 as the insulating housing 20 in Figure 1 but in the up-side-down relationship. That is, the electrical connectors 200 and 300 are hermaphroditic to each other. The insulating housing 220 of the first

electrical connector 200 is right-side-up and the shroud 224 is located at the upper or remote position from the circuit board 260. On the other hand, the insulating housing 320 of the second electrical connector 300 is up-side-down with respect to housing 220, and its shroud 324 is located at the lower or closer position to the circuit board 360. In this arrangement, the rib 325 of the second insulating housing 320 is received in the shroud 224 of the insulating housing 220 while the rib 225 of the first insulating housing 220 is received in the shroud 324 of the insulating housing 320. Also, the guide projections and the slots 26 of the both electrical connectors 200, 300 are intermated with each other. Additionally, as seen in Figure 3, pin alignment plate 40 is mounted to the housing 20 on the shroud side of the housing proximate circuit board 360. The solder tails 335 of contacts 330 are bent to be received in the openings 341 of plate 340.

As shown in Figure 3, the contacts 230, 330 of both electrical connectors 200, 300 are intermated with each other. It should be noted here that the male contacts 231 of the first electrical connector 200 mate with the female contacts 332 of the second electrical connector 300 and that the female contacts 232 of the first electrical connector 200 mate with the male contacts 332 of the second electrical connector 300. Also, it should be noted that the male contacts 231, 331 in one row of the contacts 230, 330 correspond to the female contacts 232, 332 in adjacent row or rows of the contacts 230, 330. This arrangement thus minimizes the stress to the insulating housings 220, 320 due to the biasing force applied to the intermated contacts 230, 330. The spacing between adjacent rows of contact receiving cavities and thus the contacts inserted therein is maintained constant by the arrangement.

The preferred embodiments of the electrical connector and the connector assembly according to the present invention have been described in detail hereinbefore. However, it is to be understood that the present invention is not limited to the shown
5 embodiments and various modifications can be made without departing from the subject matter of the present invention. For example, the board locks 50 may be any other conventional design as shown in Japanese UM
10 Publication No. 42645/89 and U.S. Patent No. 5336111. The pin plate 40 may have a plurality of slots extending from one (outer) edge of such plate rather than openings. Such a pin alignment plate is shown in many prior art publications including U.S. Patent Nos.
15 5,037,334, 5,167,531 and 5,336,109. In such arrangement, the pin alignment plate may be slidably assembled with the board retention members of the electrical connector. Alternatively, the pin alignment plate may be integrally formed with the insulating
20 housing rather than a separate plate. Also, the contacts 30 may have straight solder tails rather than solder tails bent at right angle. In such a design, the circuit boards 260, 360 would be disposed parallel to each other.

25 As apparent from the above description and the illustrated drawings, the electrical connector and the electrical connector assembly feature the use of the plurality of male and female contacts disposed alternately in a line or row. Accordingly, any force to
30 be applied to the insulating housing by the normal force of the intermating contacts is minimized, thereby achieving high density hermaphroditic or drawer connector having a large number of contacts in desired number of rows, for example, 3 rows. Most importantly,
35 the intermating of the alternating male and female contacts reduces the insertion force of the electrical

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connector assembly.



What is Claimed Is:

1. An electrical connector having a plurality of contacts in at least one row in an insulating housing, characterized in that:
 - 5 said contacts comprise male and female contacts alternately disposed in a row to mate alternatively disposed female and male contacts in a matable connector.
 2. The connector of claim 1 wherein said housing
10 includes mounting flanges extending rearwardly from ends thereof, said flanges including openings extending there through for receiving board retention members, said flanges being adapted to receive a pin alignment plate for receiving solder tails of said contacts.
 - 15 3. The connector of claim 1 wherein a shroud and a rib spaced from and parallel to said shroud extend forwardly at the mailing face of said housing, said shroud being dimensioned to receive a rib of an identical other housing in a reversed vertical orientation to said
20 housing; and at least two rows of contacts, a first row being disposed on an inner wall of said shroud and a second row disposed on said rib whereby upon mating said connector with said other housing said contacts of the respective shrouds engage with contacts of the ribs of
25 the opposite housing.
 4. A connector assembly comprising a pair of insulating housings and a plurality of contacts secured in each of said insulating housings in at least one row, characterized in that:
30 said insulating housings are hermaphroditic; and
 said contacts in each insulating housing comprise male and female contacts alternately disposed in a row to mate female and male contacts in the other insulating housing.
 - 35 5. The connector assembly of claim 2 wherein each of said housings includes a plurality of row of contacts





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each row including alternately disposed male and female
contacts such that upon rotating and aligning the tow
housings for mating, the male and female contacts of
each row are positioned for mating with complementary
5 contacts in the other housing.

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