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(54) **ASSEMBLY METHOD FOR A PRINTED CIRCUIT BOARD ELECTRICAL CONNECTOR**

(71) Applicant: **Amphenol Corporation**, Wallingford, CT (US)

(72) Inventors: **Zlatan Ljubijankic**, Mississauga (CA); **Barbara H. Marten**, Toronto (CA); **Ming Jong**, North York (CA); **Andy Toffelmire**, Whitby (CA)

(73) Assignee: **Amphenol Corporation**, Wallingford, CT (US)

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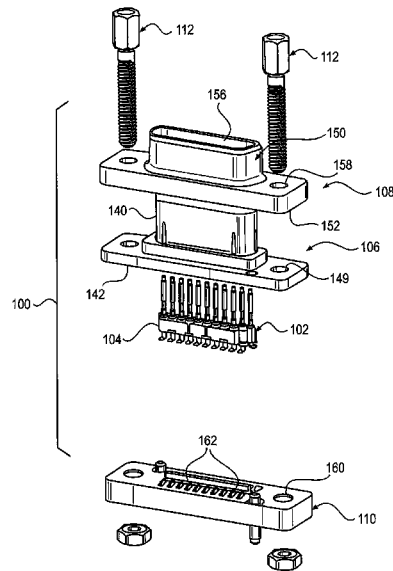
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Primary Examiner — Edwin A. Leon
Assistant Examiner — Matthew T Dzierzynski
(74) *Attorney, Agent, or Firm* — Blank Rome LLP

(57) **ABSTRACT**
A method of assembling an electrical connector that is configured for mounting to a printed circuit board. The method has the steps of providing contact wafers with a plurality of contacts; bending the tail ends of each contact wafer; interleaving the contact wafers to form one or more contact wafer assemblies; loading the contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of mating ends of the plurality of contacts at a mating interface of the electrical connector; and inserting the insert into a shell of the electrical connector.

25 Claims, 6 Drawing Sheets



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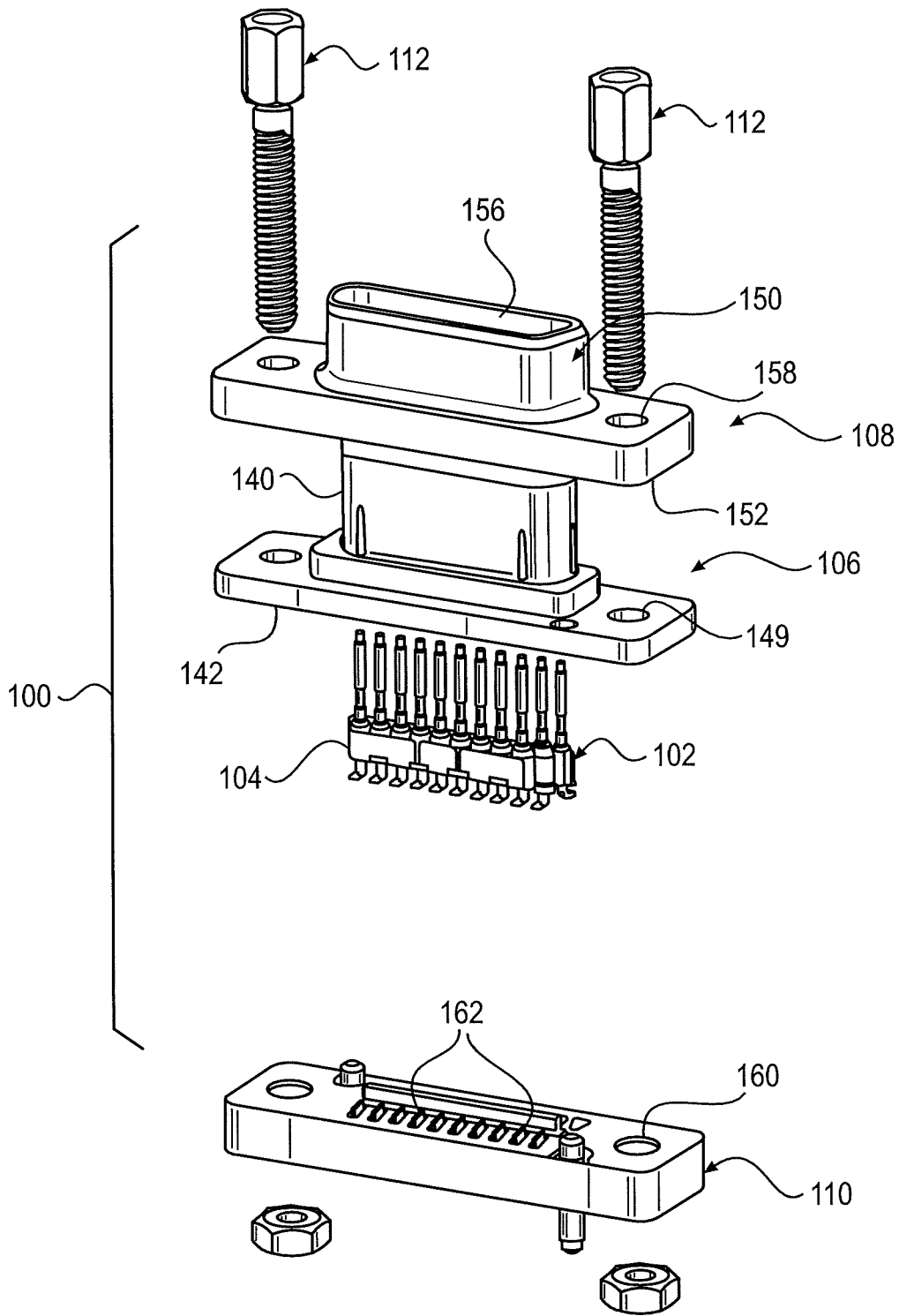


FIG. 1

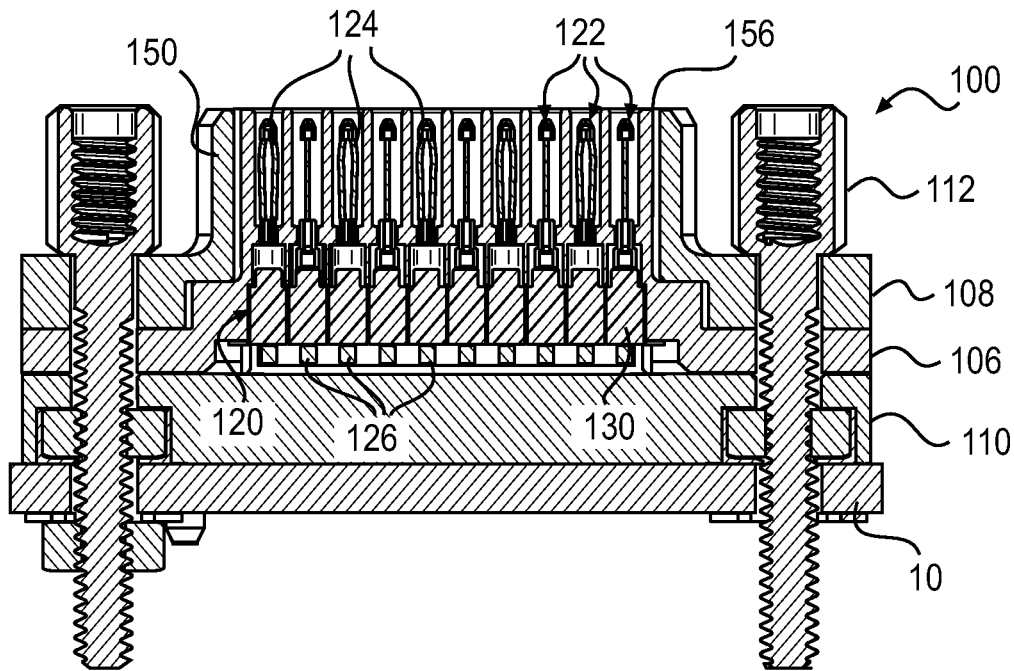


FIG. 2A

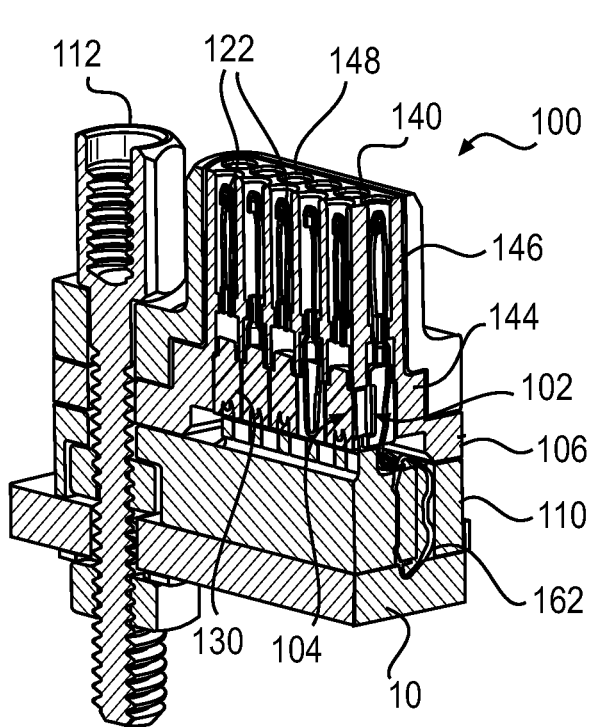


FIG. 2B

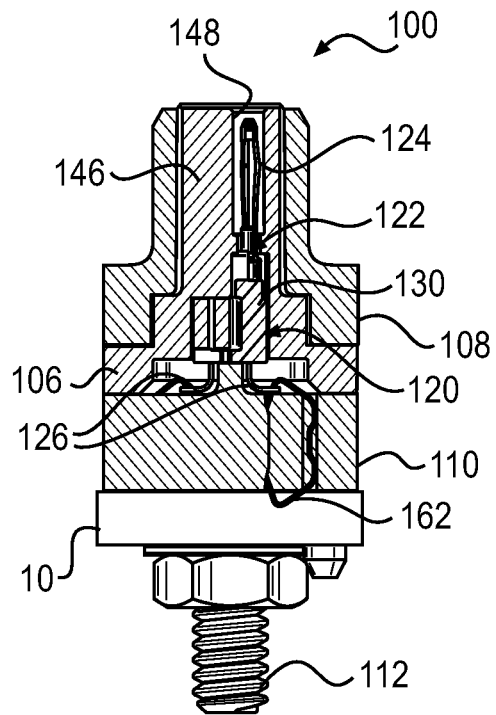


FIG. 2C

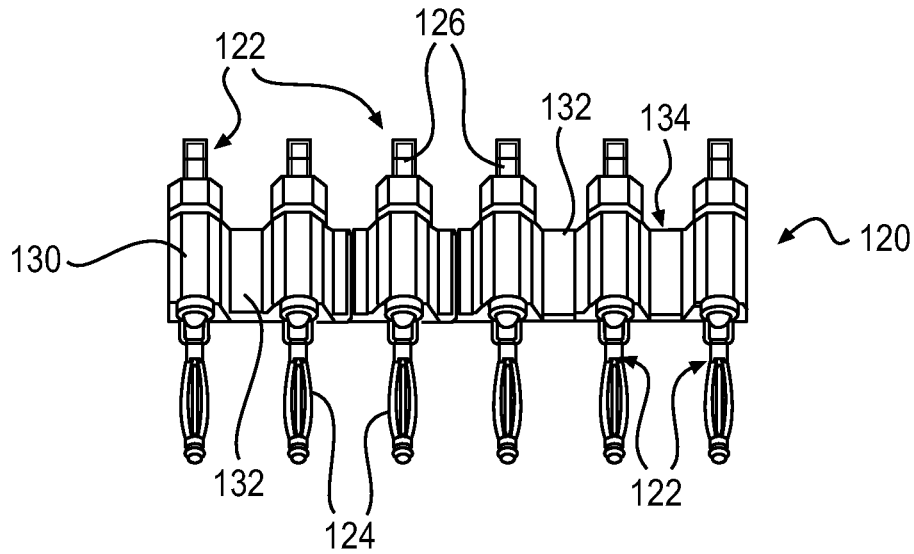


FIG. 3

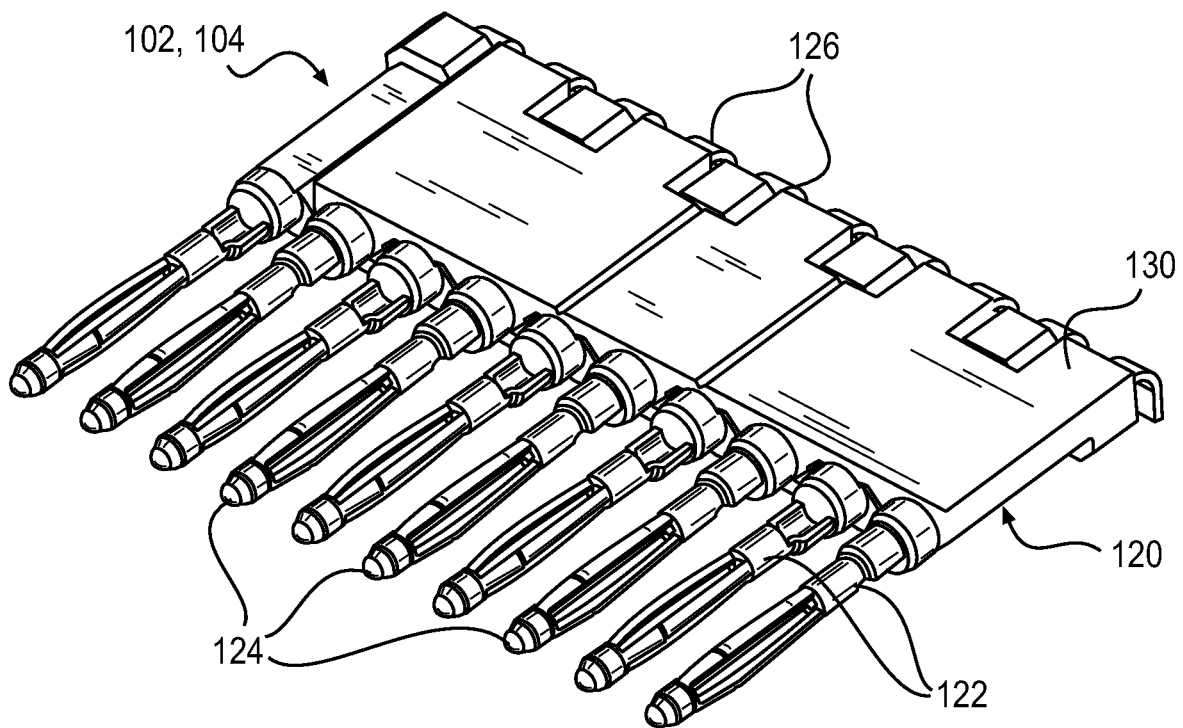


FIG. 4A

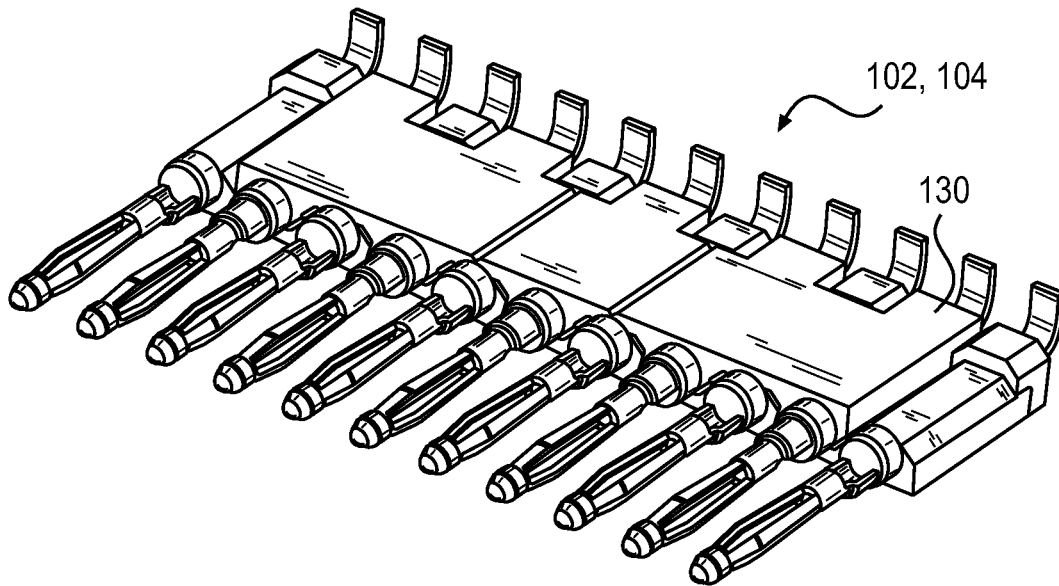


FIG. 4B

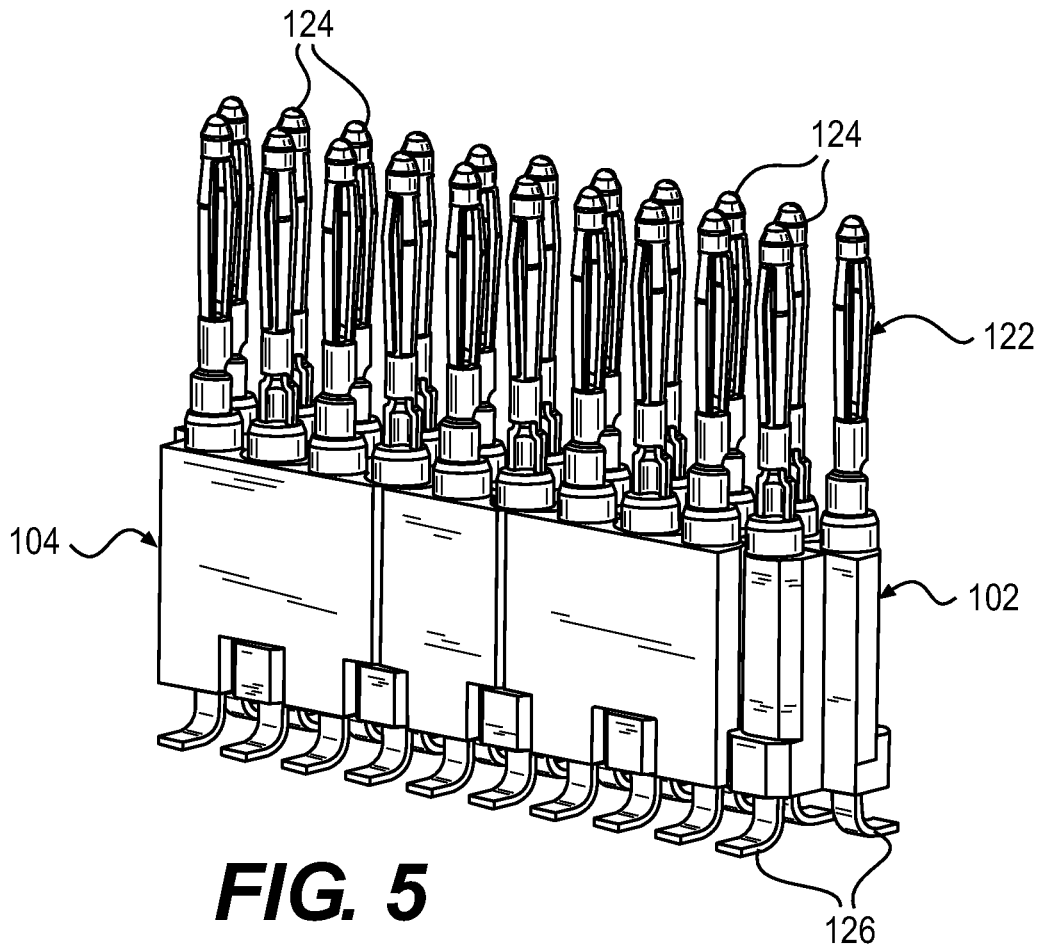


FIG. 5

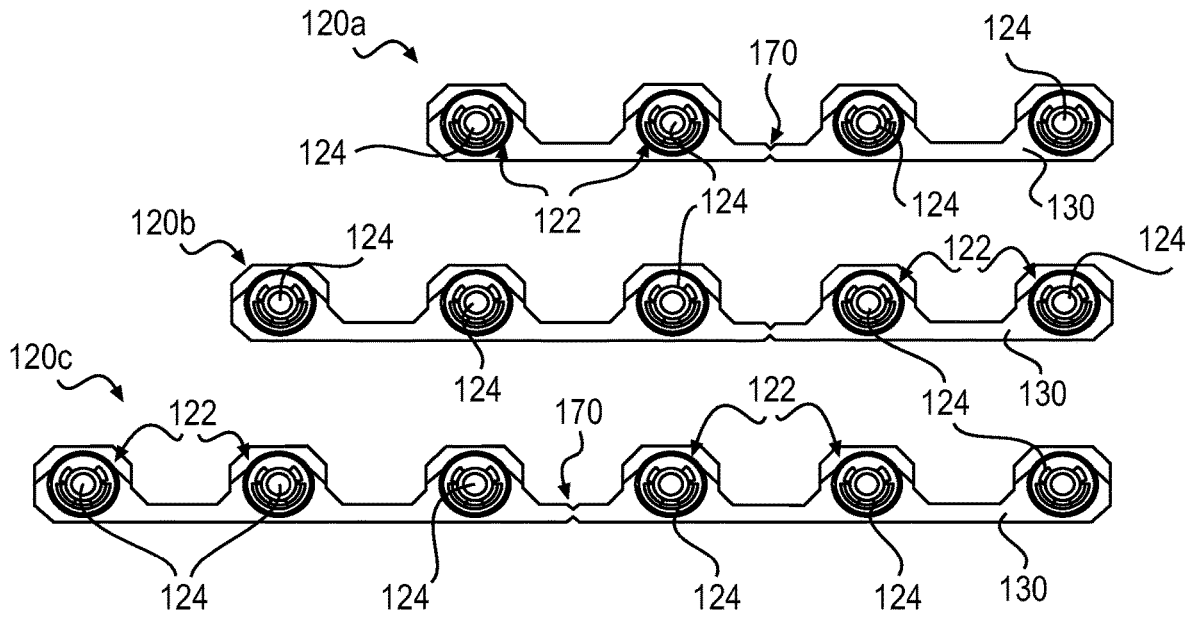


FIG. 6

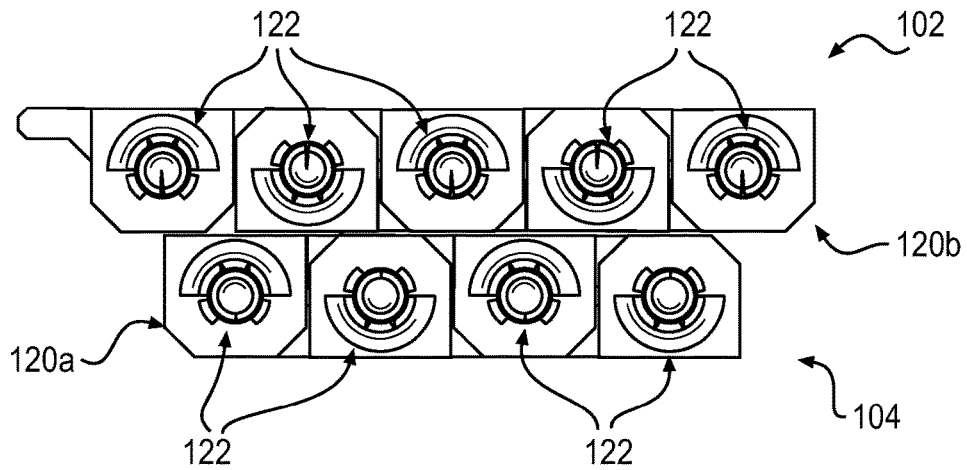


FIG. 7

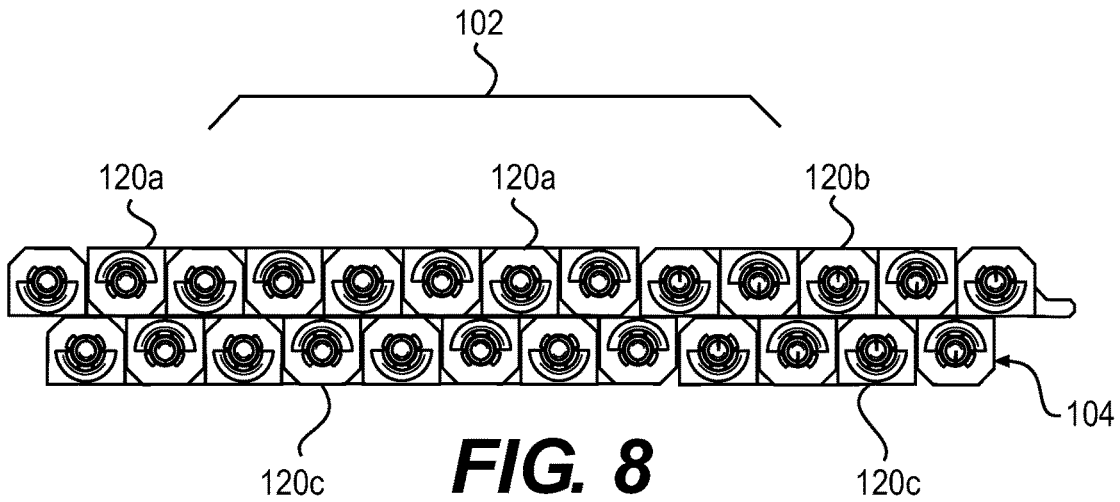


FIG. 8

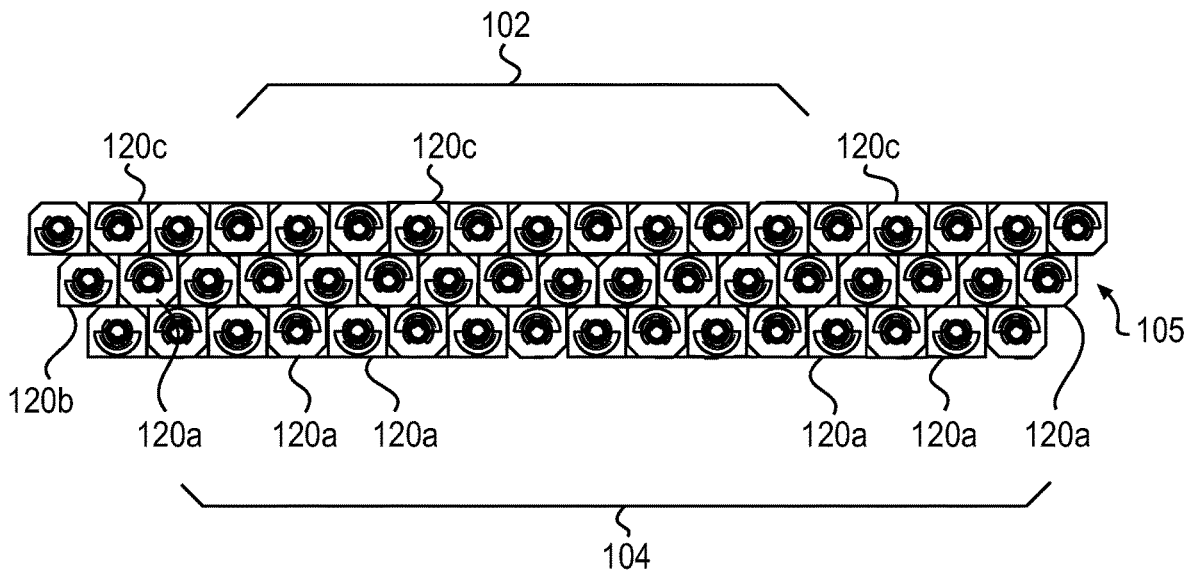


FIG. 9

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ASSEMBLY METHOD FOR A PRINTED CIRCUIT BOARD ELECTRICAL CONNECTOR

FIELD OF THE INVENTION

The present invention relates to a method for assembling an electrical connector of the type configured for a printed circuit board, such as a micro D or D-shaped electrical connector.

BACKGROUND

Manufacture and assembly of electrical connectors, such as those configured for use with a printed circuit board, like micro D and D-shaped connectors, is often time consuming and cumbersome. That is because when assembling a standard micro D electrical connector, for example, numerous steps are required. Those steps can include removing the individual contacts from a reel, crimping each of those contacts, installing each of the crimped contacts into a holder, inserting the holder with the crimped contacts into a shell, adding thin potting layer to the shell, arranging and managing the contact terminations, and then adding thicker potting layer to the shell. The terminations are arranged and managed to provide the correct termination position for installation onto the printed circuit board. The thin and thick potting layers are added to secure the contacts in position and prevent shorts after termination management. The steps of adding the thin potting layer, adding the thicker potting layer, and contact termination management, in particular, make the manufacturing and assembly process inefficient and burdensome.

Therefore, a need exists for a method of assembling an electrical connector to be installed on a printed circuit board, that is efficient and eliminates time consuming and cumbersome steps.

SUMMARY

The present invention may provide a method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, that comprises the steps of providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing; bending the tail ends of each contact wafer; interleaving the contact wafers to form one or more contact wafer assemblies; loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector; and inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector.

In one embodiment, the method further comprises the step of installing a contact support member at the tail ends of the contact wafers and the contact support member may include a plurality of conductive springs corresponding to each of the plurality of contacts. In some embodiments, the method may further comprise the step of coupling the insert, the shell, and the contact support together or the step of testing the electrical connector for electrical conductivity there-

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through after the step of coupling the insert, the shell, and the contact support together; the step of coupling may include inserting at least one fastener through each of the insert, the shell, and the contact support member, the fastener being configured to engage the printed circuit board for mounting the electrical connector thereto; and/or the fastener may be configured to engage the printed circuit board for mounting the electrical connector thereto such that the one or more contact wafer assemblies are electrically connected to the printed circuit board via the tail ends of the plurality of contacts.

In certain embodiments, the method further comprised the step of soldering the tail ends of the plurality of contacts to the printed circuit board; no potting material or layer is added to the electrical connector; neither the step of loading the one or more contact wafer assemblies in the insert nor the step of inserting the insert into the shell, includes the step of managing the plurality of terminations; the method further comprises the step of combining at least two contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts; the contact wafers of one of the two contact wafer assemblies may have a different or the same number of plurality of contacts from one another; the contact wafers of the other of the two contact wafer assemblies may have a different or the same number of plurality of contacts from one another.

In other embodiments, the method may further comprise the step of selecting from the plurality of contact wafers at least two contact wafers that may have a different or the same number of the plurality of contacts from one another to form at least one of the contact wafer assemblies; each of the contact wafers has a different number of contacts from the other contact wafers; and/or the method may further comprise the step of combining at least two of the contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts.

The present invention may also provide a method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, that comprises the steps of providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing, and wherein at least one contact wafer is formed with four contacts, at least one contact wafer is formed with five contacts, and at least one contact wafer is formed with six contacts; interleaving the contact wafers to form one or more contact wafer assemblies; loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector; and inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector.

In some embodiments, the step of interleaving includes interleaving one of the contact wafers with four, five, or six contacts with another of the contact wafers with four, five, or six contacts to form at least a first contact wafer assembly of the contact wafer assemblies; the step of interleaving includes interleaving one of the contact wafers with four, five, or six contacts with another of the contact wafers with four, five, or six contacts to form at least a second contact wafer assembly of the contact wafer assemblies; the method may further comprise the step of combining the first and the

second contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts; the step of loading the contact assemblies into the insert includes loading the combined first and second contact wafer assemblies; each of the contact wafers with four, five, and six contacts includes at least one weakened area between the contacts; the method may further comprise the step of breaking at least one of the contact wafers with four, five, and six contacts at the at least one weakened area, thereby forming multiple contact wafers therefrom; and/or the method may further comprise the step of bending the tail ends of each contact wafer prior to the step of interleaving the contact wafers. In one embodiment, the predetermined arrangement of the mating ends of the plurality contacts at the mating interface of the electrical connector is one of a 9-position, a 15-position, a 21-position, a 25-position, a 31-position, a 37-position, a 41-position, a 51-position, a 69-position, or a 100-position or any other varying number of contacts as desired.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is an exploded perspective view of an electrical connector of the method of assembling the same according to an exemplary embodiment of the present invention;

FIGS. 2A-2C are various cross-sectional views of the electrical connector illustrated in FIG. 1, once the electrical connector is assembled;

FIG. 3 is a perspective view of a contact wafer of the electrical connector illustrated in FIG. 1;

FIGS. 4A and 4B are perspective views of exemplary contact wafer assemblies of the electrical connector illustrated in FIG. 1;

FIG. 5 is a perspective view of combined contact wafer assemblies of the electrical connector illustrated in FIG. 1;

FIG. 6 are end views of exemplary contact wafers in accordance with an exemplary embodiment of the present invention; and

FIGS. 7-9 are an end views of an exemplary combinations of the contact wafers illustrated in FIG. 6, e.g. 9-position, 25-position, and 51-position, respectively, according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

Referring to the figures, the present invention generally relates to a method of assembling an electrical connector **100** configured for installation on a printed circuit board **10**, such as a micro D or D-shaped type connector. The method of the present invention eliminates time consuming and cumbersome assembly steps for a more efficient and faster assembly process of the connector.

Electrical connector **100** generally comprises one or more contact wafer assemblies **102** and **104** supported by an insert **106** which is received in a shell **108** of the connector. A support member **110** may be used to retain the contact wafers **102** and **104** in the insert **106** and shell **108**. The support member **110**, the insert **106**, and the shell **108** may be coupled together, such as by one or more fasteners **112**, as seen in FIGS. 2A-2C. The method of the present invention comprises the steps of assembling these components of electrical connector **100**.

Each contact wafer assembly **102** and **104** is preferably formed by interleaving at least two contact wafers **120**. Each contact wafer **120** supports a plurality of contacts **122** in a housing **130** where each contact **122** has a mating end **124** and an opposite tail end **126** extending and being exposed outside of the housing **130**, as best seen in FIG. 3. Housing **130** may, for example, be overmolded onto the contacts **122** in a manner similar to that disclosed in commonly owned U.S. Pat. No. 9,362,638, the subject matter of which is herein incorporated by reference. The housing **130** may have one or more recessed surfaces **132** on at least one side **134** thereof where each recessed surface **132** is designed to receive a corresponding portion of another housing, as seen in FIGS. 4A and 4B, when interleaving the contact wafers **120** to form the contact wafers assemblies **102** and **104**. Once the contact wafers **120** are interlocked, the contacts **122** of the contact wafers **120** alternate and are substantially in axial alignment. That is, the mating ends **124** of the contacts **122** of both wafers **120** may be aligned and likewise the tail ends **126** of the contacts of both wafers may be aligned.

Insert **106** may have a contact receiving portion **140**, designed to receive the contact wafer assemblies **102** and **104**, and a flange portion **142**, designed to couple with the support member **110**, as best seen in FIGS. 1 and 2A-2C. Alternatively, support member **110** may be eliminated such that flange portion **142** of insert **106** is mounted directly to the printed circuit board **10**. Contact receiving portion **140** may include a housing section **144** that accommodates the housings **130** of the contact wafer assemblies **102** and **104** and a contact section **146** that accommodates the contacts **122**. In a preferred embodiment, the contact section **146** includes a plurality of open ended passageways **148** that receive the individual contacts **122**. Flange portion **142** may include one or more holes **149** to receive the one or more fasteners **112**.

Shell **108** has an insert receiving portion **150** and a flange portion **152**. The insert receiving portion **150** is sized to receive the contact receiving portion **140** of insert **106**. An open end **156** of the insert receiving portion **150** exposes the mating ends **124** of the contacts **122** and defines a mating interface for connecting to a mating connector (not shown). Flange portion **152** may abut flange portion **142** of insert **106** and also has one or more holes **158** that align with the one or more holes **149** of insert **106** for receiving the fasteners **112**. Support member **110** may also include one or more holes **160** that align with the holes **149** and **158** of insert **106** and shell **108**, respectively, to receive the fasteners **112** and the fasteners **112** may engage the printed circuit board **10**, thereby mounting the connector **100** to the board **10**. In one embodiment, support member **110** may include conductive springs **162**, such as c-clips, that correspond to each of the contacts **122** and engage their tails ends **126**, to establish an electrical connection between the contacts **122** and the printed circuit board **10**. Alternatively, the support member **110** may be eliminated and the tail ends **126** of the contacts **122** may directly engage the printed board **10**, such as by soldering, to establish the electrical connection therebetween.

The method of the present invention preferably includes the step of bending the tail ends of each contact **122** of each contact wafer **120**. The tails ends **126** may be bent about 90 degrees, for example, as seen in FIGS. 3, 4A, and 4B, to assist with engagement with either the conductive springs **162** of the support member **110** or with direct engagement with the printed circuit board. The tails ends **126** are

preferably bent before the contact wafers **120** are interleaved to form the contact wafer assemblies **102** and **104**.

A least two of the contact wafers **120** may be interleaved to form a contact wafer assembly, such as contact wafer assembly **102** (FIG. 4A) or contact wafer assembly **104** (FIG. 4B). Once the contact wafer assemblies **102** and **104** are formed, they can be easily loaded into the contact receiving portion **140** of the insert **106** such that the mating ends **124** of the contacts **122** are receiving in the individual passageways **148**. When loading the contact wafer assemblies **102** and **104**, they may be combined, as seen in FIG. 5, for loading into insert **106** such that the contact wafer assemblies **102** and **104** form a predetermined arrangement of the mating ends **124** of the plurality of contacts **122**. As such, no contact or wire management is required during assembly of the connector **100**.

The insert **106** with the contact wafer assemblies **102** and **104** loaded therein, can then be inserted into the insert receiving portion **150** of shell **108** such that the contact mating ends **124** are in the predetermined arrangement at the mating interface of the electrical connector, that is at the open end **156** of shell **108**. Because the contacts **122** are fully supported in their predetermined arrangement by insert **106**, no potting or epoxy material or layer needs to be added to the connector **100** during assembly. The predetermined arrangement of the mating ends **124** of the contacts **122** may be selected based on the desired connector type, e.g. 9-position, a 15-position, a 21-position, a 25-position, a 31-position, a 37-position, a 41-position, a 51-position, a 69-position, or a 100-position or any other varying number of contacts, as desired. FIG. 7, for example, illustrates a 9-position arrangement of the contacts **122** in which one contact wafer assembly **102** includes five contacts and the other contact wafer assembly **104** includes four contacts. Once the loaded insert **106**, shell **108**, and support member **110** are coupled together, the connector **100** may then be tested for electrical conductivity therethrough prior to shipping to a customer.

In a preferred embodiment, the contact wafers **120** may have a different number of contacts **122** from one another. For example, each contact wafer **120** may be one of three types, that is a 4-contact type wafer **120a**, a 5-contact type wafer **120b**, and 6-contact type wafer **120c**, as seen in FIG. 6. Each of the 4, 5 and 6-contact type wafers **120a**, **120b**, and **120c** has 4, 5, and 6 contacts **122**, respectively, supported in the housing **130**. Each housing **130** of 4, 5 and 6-contact type wafers **120a**, **120b**, and **120c** may have one or more weakened areas **170** allowing the wafers to be broken apart into more than one wafer. Using the breakable 4, 5 and 6-contact type wafers **120a**, **120b**, and **120c**, any of the connector positions (e.g. 9-position, 15-position, 21-position, 25-position, 31-position, 37-position, 41-position, 51-position, 69-position, or 100-position) can be arranged. For example, the 9-position contact arrangement illustrated in FIG. 7 is formed by combining contact wafer assembly **102** with five contacts and contact wafer assembly **104** with four contacts. Contact wafer assembly **102** may be created, for example, by interleaving two of the contact wafers **120** which are formed by breaking the 5-contact type wafer **120b** into two the wafers via weakened area **170** with one wafer have two contacts and the other wafer having the remaining three contacts. Similarly, the other contact wafer assembly **104** may be created, for example, by interleaving two of the contact wafers formed by breaking the 4-position type wafer **120a** into the two wafers each having two contacts. When these contact wafer assemblies **102** and **104** are combined and loaded into insert **106** and shell **108**, the result is a

9-position contact arrangement ready for connection to a corresponding mating connector at open end **156**.

Similarly, the 25-position contact arrangement illustrated in FIG. 8, for may be formed by interleaving two 4-contact type wafers **120a** plus one 5-contact type wafer **120b** that is broken into two and three contacts interleaved for contact wafer assembly **102**; and interleaving two 6-contact type wafers **120c** for the other contact wafer assembly **104**. Another example is the 51-position contact arrangement shown in FIG. 9, which is formed in a similar manner. That is contact wafer assembly **102** is formed by interleaving two 6-contact type wafers **120c** plus one 6-contact type wafer **120c** broken in half and interleaved. The other contact wafer assembly **104** may be formed by interleaving four of the 4-contact type wafers **120a**. Yet another contact wafer assembly **105** is provided between the contact wafer assemblies **102** and **104** to complete the 51-position contact arrangement. The middle contact wafer assembly **105** may be formed by one 4-contact type wafer **120a** interleaved with one 5-contact type wafer **120b** plus two 4-contact wafers **120a** interleaved with one another.

While particular embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, comprising the steps of:

providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing;

bending the tail ends of each contact wafer;

interleaving the contact wafers to form one or more contact wafer assemblies;

loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector;

inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector; and installing a contact support member at the tail ends of the contact wafers, wherein the contact support member includes a plurality of conductive springs corresponding to each of the plurality of contacts.

2. The method of claim 1, further comprising the step of coupling the insert, the shell, and the contact support together.

3. The method of claim 2, further comprising the step of testing the electrical connector for electrical conductivity therethrough after the step of coupling the insert, the shell, and the contact support together.

4. The method of claim 2, wherein the step of coupling includes inserting at least one fastener through each of the insert, the shell, and the contact support member, the fastener being configured to engage the printed circuit board for mounting the electrical connector thereto.

5. The method of claim 4, wherein the fastener is configured to engage the printed circuit board for mounting the electrical connector thereto such that the one or more contact

wafer assemblies are electrically connected to the printed circuit board via the tail ends of the plurality of contacts.

6. The method of claim 1, further comprising the step of soldering the tail ends of the plurality of contacts to the printed circuit board.

7. The method of claim 1, wherein no potting material is added to the electrical connector.

8. The method of claim 1, wherein neither the step of loading the one or more contact wafer assemblies in the insert nor the step of inserting the insert into the shell, includes the step of managing terminations of the plurality of contacts.

9. The method of claim 1, further comprising the step of combining at least two contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts.

10. The method of claim 9, wherein the contact wafers of one of the two contact wafer assemblies have a different number of plurality of contacts from one another.

11. The method of claim 10, wherein the contact wafers of the other of the two contact wafer assemblies have a different number of plurality of contacts from one another.

12. The method of claim 1, further comprising the step of selecting from the plurality of contact wafers at least two contact wafers that have a different number of the plurality of contacts from one another to form at least one of the contact wafer assemblies.

13. The method of claim 1, wherein each of the contact wafers has a different number of contacts from the other contact wafers.

14. The method of claim 13, further comprising the step of combining at least two of the contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts.

15. A method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, comprising the steps of:

providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing, and wherein at least one contact wafer is formed with four contacts, at least one contact wafer is formed with five contacts, and at least one contact wafer is formed with six contacts;

interleaving the contact wafers to form one or more contact wafer assemblies;

loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector; and

inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector.

16. The method of claim 15, wherein the step of interleaving includes interleaving one of the contact wafers with four, five, or six contacts with another of the contact wafers with four, five, or six contacts to form at least a first contact wafer assembly of the contact wafer assemblies.

17. The method of claim 16, wherein the step of interleaving includes interleaving one of the contact wafers with four, five, or six contacts with another of the contact wafers with four, five, or six contacts to form at least a second contact wafer assembly of the contact wafer assemblies.

18. The method of claim 17, further comprising the step of combining the first and the second contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts.

19. The method of claim 18, wherein the step of loading the contact assemblies into the insert includes loading the combined first and second contact wafer assemblies.

20. The method of claim 15, wherein each of the contact wafers with four, five, and six contacts includes at least one weakened area between the contacts.

21. The method of claim 20, further comprising the step of breaking at least one of the contact wafers with four, five, and six contacts at the at least one weakened area, thereby forming multiple contact wafers therefrom.

22. The method of claim 15, further comprising the step of bending the tail ends of each contact wafer prior to the step of interleaving the contact wafers.

23. The method of claim 15, wherein the predetermined arrangement of the mating ends of the plurality of contacts at the mating interface of the electrical connector is one of a 9-position, a 15-position, a 21-position, a 25-position, a 31-position, a 37-position, a 41-position, a 51-position, a 69-position, or a 100-position.

24. A method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, comprising the steps of:

providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing;

bending the tail ends of each contact wafer;

interleaving the contact wafers to form one or more contact wafer assemblies;

loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector, and the contact wafers of one of the two contact wafer assemblies have a different number of plurality of contacts from one another;

combining at least two contact wafer assemblies to form the predetermined arrangement of the mating ends of the plurality of contacts; and

inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector.

25. A method of assembling an electrical connector, the electrical connector being configured for mounting to a printed circuit board, comprising the steps of:

providing a plurality of contact wafers, each contact wafer including a plurality of contacts supported by a housing, wherein each of the plurality of contacts includes a mating end for engaging a mating connector and a tail end for electrically connecting to the printed circuit board, the mating and tail ends being exposed outside of the housing;

bending the tail ends of each contact wafer;

interleaving the contact wafers to form one or more contact wafer assemblies;

loading the one or more contact wafer assemblies into an insert of the electrical connector, such that the one or more contact wafer assemblies form a predetermined

arrangement of the mating ends of the plurality of contacts at a mating interface of the electrical connector;
selecting from the plurality of contact wafers at least two contact wafers that have a different number of the plurality of contacts from one another to form at least one of the contact wafer assemblies; and
inserting the insert, with the one or more contact wafer assemblies, into a shell of the electrical connector.

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