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March 8, 2024

James J. Lukas, Jr.
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VIA EMAIL

Re: *Anderson Power Prods. v. BizLink Technology et al.*,
NDCA Case No. 3:23-cv-05436—Noninfringement & Invalidity of USPN
8,808,017

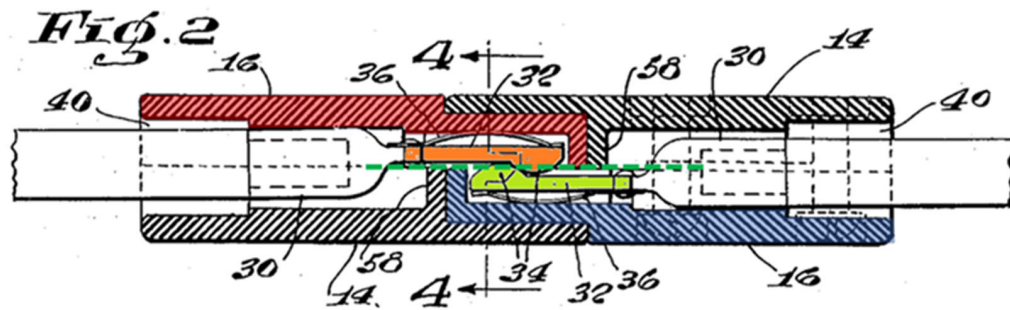
Dear Mr. Lukas:

We received no response from you to our letter dated December 22, 2023 regarding the non-infringement of the accused BizLink products as well as the clear invalidity of the asserted Anderson claims in light of several invalidating references, including U.S. Patent No. 8,182,278, U.S. Patent No. 3,648,219, and Anderson's own Saf-D-Grid connectors.

To follow up on our letter, we reiterate the unrefuted facts that Anderson's infringement assertion lacks any basis, and that Anderson's own reading of claim 1 renders the asserted '017 patent claims invalid by the anticipating prior art. BizLink, therefore, requests Anderson's voluntary dismissal of its action. However, if no dismissal or resolution occurs, BizLink is prepared to seek invalidation of Anderson's patent claims and seek the fees and costs incurred for having to respond to Anderson's unfounded assertions.

In addition to the invalid grounds BizLink identified in the letter dated December 22, 2023, many more prior art references similarly demonstrate that Anderson's patent claims are invalid and are unlikely to survive invalidity challenges. As examples, these invalidating prior art references include *Winkler*, U.S. Patent No. 2,838,739; *Davis*, U.S. Patent No. 5,785,557; *Kataoka*, U.S. Patent No. 8,182,278; and *Wu*, U.S. Patent No. 6,585,536.

Taking the '739 patent as a non-exclusive example, it discloses Anderson's claimed invention. Fig. 2, as reproduced below (annotated in color), and related descriptions anticipates the claims of the '739 patent.



Specifically, the '739 patent, including Figures 1-4, discloses a pair of electrical connectors (e.g., connectors 10, 12), including a first connector (e.g., connector 10) having a first insulating housing, and a first electrical contact (e.g., contact members 22, 24). As shown in FIGs. 1 and 2, the contact members 22, 24 have a connecting surface (e.g., elongated flat portion 32) that is substantially parallel with a longitudinal axis of the insulating housing and terminates in a leading end of the contact members 22, 24. A second connector (e.g., connector 12) has a second insulating housing and a second electrical contact (e.g., contact members 22, 24) supported within the second insulating housing. The '739 patent further discloses a first insulating barrier within the connector 10 extending beyond and covering the leading end of the contact members 22, 24, and a second insulating barrier extending beyond the contact members 22, 24 within the connector 12.

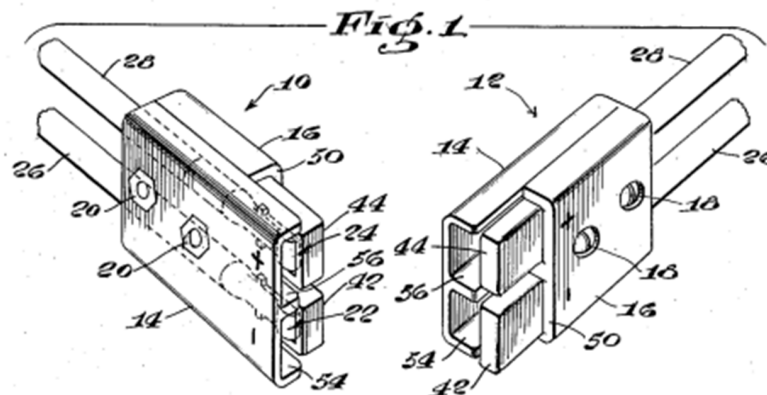
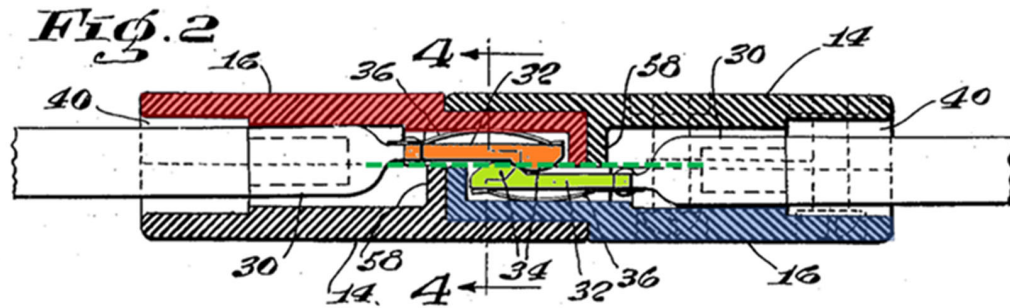


Figure 1 of the '739 patent



Annotated Figure 2 of the '739 patent

As shown in Figure 2 of the '739 patent, the contact members in the connector is configured to laterally engage with the elongated flat portion 32 of the contact members in the connector when it is mated with another connector. The protrusion of the second insulating member is configured to be in close proximity with the first insulating member when the connectors are partially disconnected and the first and second electrical contacts are separated by a short distance, thereby blocking substantially all through-air arcing paths between the contact members in connectors.

The '739 patent teaches all limitations of claim 1 of the '017 patent, including "*the second insulating barrier being configured so as to be in close proximity with the first insulating barrier when the first and second connectors are partially disconnected and the first and second electrical contacts are separated by a short distance, thereby blocking substantially all through-air arcing paths between the first and second electrical contacts.*"

The other identified prior art references similarly anticipate claim 1 and anticipate the other claims or render them obvious. The lack of any infringement aside, the clearly anticipating or invalidating disclosures of the prior art references identified in our December 22, 2023, letter and in this letter further demonstrate that Anderson should not continue this litigation. Continuing this action with no plausible infringement basis and with the demonstrated invalidity of Anderson's asserted patent makes this case exceptional under 35 U.S.C. § 285.

Please let us know by March 18, 2024, if Anderson will dismiss its action or will propose other resolutions,. If no resolution is reached, BizLink will proceed with taking actions to invalidate the '017 patent.

Mr. James J. Lukas, Jr.
March 8, 2024
Page 4

With Best Regards,



Ming-Tao Yang

MTY/jet

Enclosures: U.S. Patent Nos. 2,838,739, 5,785,557, 8,182,278, and 6,585,536.

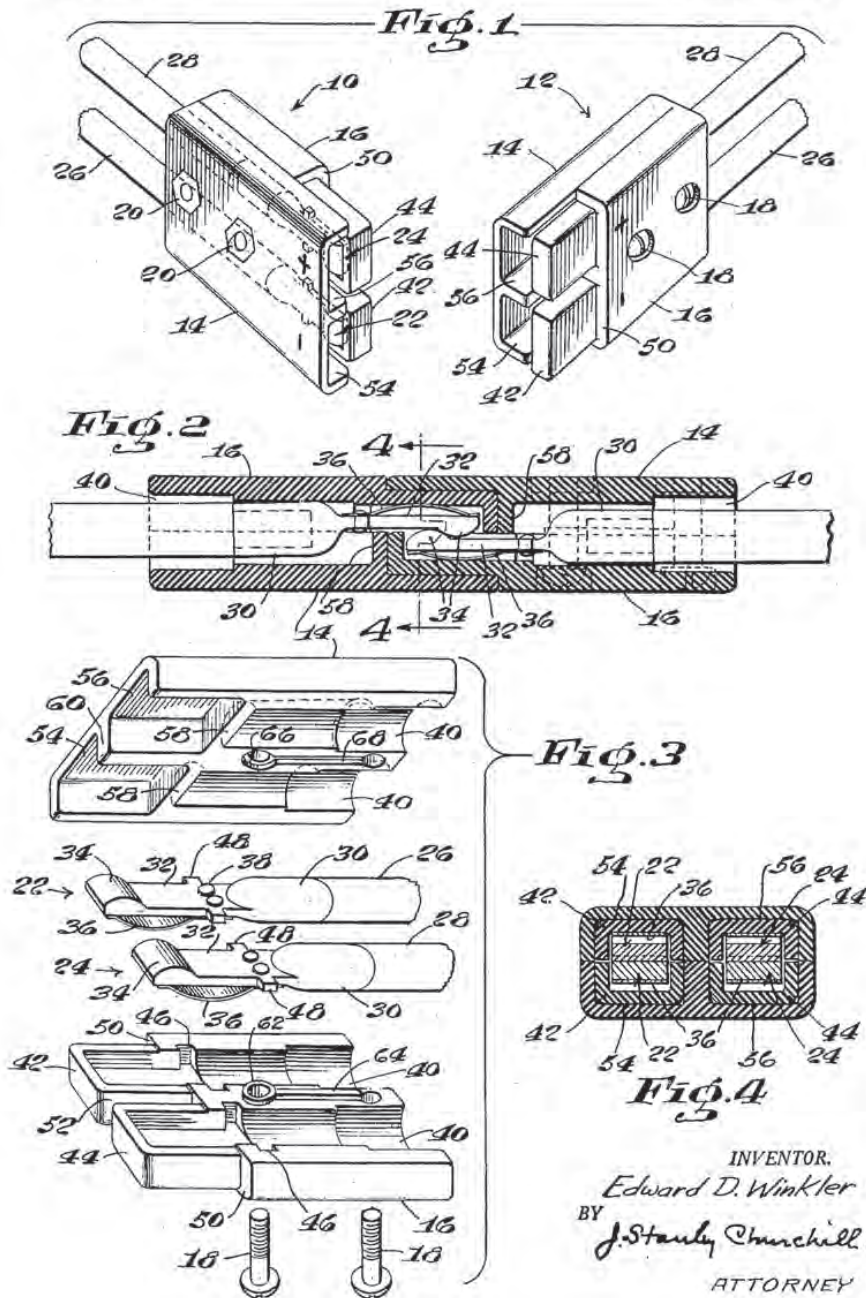
June 10, 1958

E. D. WINKLER
ELECTRICAL CONNECTOR

2,838,739

Filed Jan. 30, 1953

2 Sheets-Sheet 1



June 10, 1958

E. D. WINKLER
ELECTRICAL CONNECTOR

2,838,739

Filed Jan. 30, 1953

2 Sheets-Sheet 2

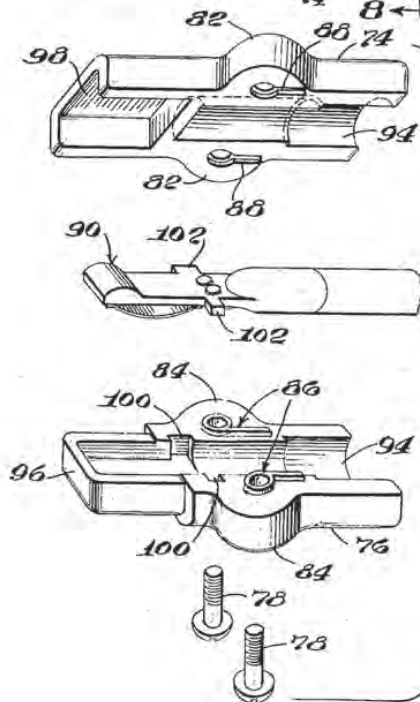
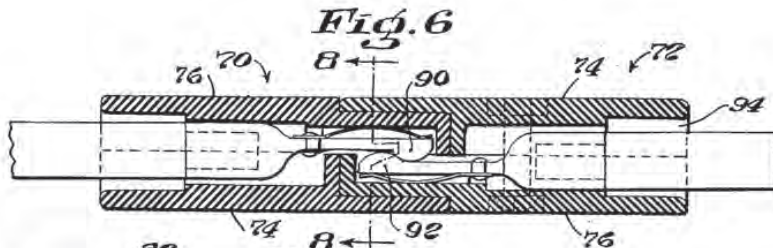
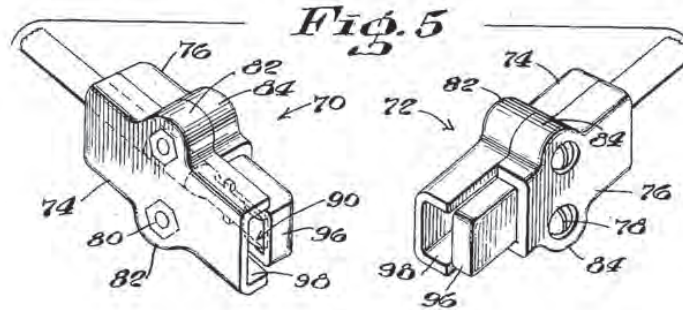


Fig. 7

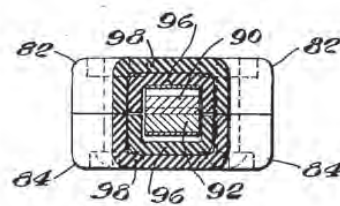


Fig. 8

INVENTOR,
Edward D. Winkler
BY *J. Stanley Churchill*
ATTORNEY

1

2,838,739

ELECTRICAL CONNECTOR

Edward D. Winkler, Reading, Mass., assignor to Albert & J. M. Anderson Manufacturing Company, Boston, Mass., a corporation of Massachusetts

Application January 30, 1953, Serial No. 334,145

7 Claims. (Cl. 339—47)

This invention relates to an electrical connector.

The invention has for an object to provide a novel and improved electrical connector which may be economically manufactured and used with advantage for general use and which is provided with electrical contacts adapted to be engaged by contacts of an identical connector.

With this general object in view and such others as may hereinafter appear, the invention consists in the electrical connector hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings illustrating the preferred embodiment of the invention:

Fig. 1 is a perspective view of a pair of identical two-pole connectors embodying the present invention;

Fig. 2 is a cross-sectional view of a pair of two-pole connectors joined together;

Fig. 3 is an exploded perspective view of a two-pole connector showing the relationship of the various parts;

Fig. 4 is a cross-sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is a perspective view of a pair of identical single-pole connectors;

Fig. 6 is a cross-sectional view of a pair of identical single-pole connectors joined together;

Fig. 7 is an exploded perspective view of the single-pole connector; and

Fig. 8 is a cross-sectional view taken on the line 8—8 of Fig. 6.

In general, the present invention contemplates an electrical connector of novel construction of the type having one or more identical contact or terminal members and which is adapted for longitudinal telescoping engagement with a second and identical connector. The present connector is provided with an insulating housing surrounding and enclosing the terminals for maximum insulating protection and in which provision is made for movably and yieldably mounting the terminals in a manner such that the terminals may be resiliently interlocked in their engaged position so as to prevent inadvertent disengagement thereof during normal usage. The present terminals are also adapted for self-cleaning during engagement and disengagement thereof and are shaped so that any pitting of the terminals caused by arcing at the extreme ends thereof during disengagement will not impair the efficiency of the terminals at the areas of contact in their engaged position. Also, with the present construction of connector, the connectors can be joined together in one position only so that when separate lines of fixed or non-changeable polarity are used, the same polarity may be maintained at all times. In practice, the polarity of the terminals may and preferably will be marked on the outer face of the insulating housing.

Referring now to the drawings, Fig. 1 illustrates a pair of two-pole electrical cable connectors indicated at 10, 12 comprising exact counterparts adapted for longitudinal telescoping engagement to form an electrical connection. As herein shown, each connector includes an insulating housing split longitudinally to form two half sections com-

2

prising an upper half section 14 and a lower half section 16, as viewed in Fig. 3, and which are detachably connected together by bolts 18 and nuts 20.

In the embodiment of the invention illustrated in Figs. 1 to 4, each insulating housing is arranged to support two identical contact members 22, 24 forming the terminals of electrical cables 26, 28 respectively, and as herein shown, each terminal is provided with a cylindrical end portion 30 bored to receive the end of the cable into which it may be soldered. The contacting end of each terminal comprises an elongated flat portion 32 substantially rectangular in cross section provided with a rounded or convex end portion 34 projecting from one surface thereof. On its opposite surface the contacting end of each terminal has attached thereto by rivets 38 an outwardly curved leaf spring 36, one end of the leaf spring being secured by the rivets and the other end being free.

The illustrated insulating housing is substantially rectangular in form, each half section 14, 16 shown in Fig. 3 having a main or rearwardly extended body portion hollowed out semi-circularly to form circular openings 40 in the assembled connector through which the cable ends of the terminals extend. The lower half section 16 of the housing is provided with two spaced forwardly extended terminal-receiving pockets 42, 44 substantially U-shaped in cross section and closed at their outer ends. The pockets 42, 44 are aligned with their respective cable openings 40, and the contacting end of each terminal is received in its pocket with the leaf spring 36 bearing against the bottom wall of the pocket and with the convex contacting portion 34 of the terminal extending above the side walls of the pocket, as shown.

In order to prevent longitudinal displacement of the terminals in the insulating housing, each lower half section is provided with grooved portions or slots 46 adjacent the inner ends of the pockets 42, 44 arranged to receive laterally extended ears 48 formed on the terminals, as illustrated.

As thus far described, it will be seen that the contacting end of each terminal is enclosed in its respective pocket except for the engaging face thereof which is resiliently urged by the leaf spring 36 toward the cooperating terminal. As herein shown, the side and bottom walls of the pockets 42, 44 are recessed or offset from the main body portion of the lower half section providing shouldered portions 50 thereabout, the spaced relationship of the pockets providing a slot 52 there between extending to the plane of the shouldered portions.

The upper half section 14 of the insulating housing, as viewed in Fig. 3, is provided with a corresponding forwardly extended portion coextensive with the body portion and shaped to provide two inverted U-shaped sockets 54, 56 open at their outer ends and closed at their inner ends by transversely extended wall portions 58 defining the adjacent end of the body portion, the two sockets being defined and separated by a longitudinally extended central partition wall 60. The socket-forming extension of the upper half section extends over the terminal-receiving pockets 42, 44 of the lower half section, and the sockets 54, 56 are of a size such as to snugly receive the pockets 42, 44 of a second and identical connector, the end of the socket-forming extension of one connector engaging the shouldered portion 50 of the second connector when the connectors are fully engaged. Also, when thus engaged, the central wall 60 of one connector fits into the slot 52 of the second connector, and the closed end walls of the pockets of one connector are engaged with the inner end walls 58 of the sockets of the second connector.

In order to align the two half sections 14, 16 in registered relation for assembly, the lower half section 16 is provided with a raised circular portion 62 about one

of the bolt openings and with a longitudinally extended raised portion 64 arranged to be fitted into correspondingly shaped recessed portions 66, 68 respectively formed in the upper half section 14. Also, the bolt openings in the half sections may be countersunk, as illustrated, to present the heads and nuts of the bolts below the outer surface of the insulating housing. It will also be observed that the terminals of each connector are enclosed in the pockets 42, 44 with only the upper contacting portions exposed, and that the socket-forming portions extending over the exposed portions of the terminals also provide a protective insulating wall above the terminals.

With this construction it will be seen that when two identical connectors are engaged by extending the pockets 42, 44 of one connector into their respective sockets 54, 56 of the second connector, the rounded contacting faces 34 of each spring-pressed terminal are slidably engaged by each other, initial inward movement of the connectors effecting downward movement of the terminals in their respective pockets against the springs 36. Upon continued inward movement the high points of the curved portions pass by each other, and as the connectors approach full engagement, the springs 36 effect upward movement of the terminals in their pockets to present the curved portions 34 in hooked or interlocked relation to each other, as illustrated. The cable openings 40 and the pockets 42, 44 are formed to provide ample clearance about the terminals movably supported therein to permit lateral movement of the terminals toward and away from each other, as described, and in practice, the terminals may effect a slight rocking movement about their respective curved leaf springs 36 as the terminals are engaged. It will also be observed that the transversely extended wall portions 58 serve to limit the upward movement of the terminals in their respective pockets when the contacts are disengaged. In practice, the metallic terminals may be coated with silver to provide an efficient contact.

From the above description it will be seen that in operation, any pitting of the terminals caused by arcing at the extreme ends thereof during disengagement will not impair the efficiency of the contacting surfaces when the terminals are in their fully engaged position, and that the sliding movement of the terminals against each other during engagement and disengagement will effect self-cleaning thereof. It will also be observed that the polarity of the terminals may be marked on the housing and that the connectors may be engaged in one position only such as to maintain the same polarity at all times.

Referring now to Figs. 5 to 8 illustrating a single-pole embodiment of the present invention, Fig. 1 shows a pair of single-pole connectors 70, 72 comprising exact counterparts adapted for longitudinal telescoping engagement to form an electrical connection. The construction of the single-pole connector may be similar to the construction of the connectors above described except that it has provision for supporting but one terminal, and as herein shown each connector includes an insulating housing split longitudinally to form upper and lower half sections 74, 76 respectively, as viewed in Fig. 7, and which are detachably connected together by bolts 78 and nuts 80 which are disposed in laterally extended ears 82, 84 of each half section. Raised portions 86 extending from the lower half section are arranged to engage similar recessed portions 88 formed in the upper half section to register the half sections in assembled relation. The single terminal in each connector, indicated at 90, 92 may be of the same construction as above described, and the insulating housing may be similarly provided with cut-out portions in each half section forming a cylindrical bore 94 through which the cable end of the terminal extends. The lower half section 76 is provided with a forwardly extended terminal-receiving pocket 96 recessed with relation to the main

body portion, and the upper half section 74 is provided with an extension coextensive with the main body portion forming an inverted U-shaped socket 98 extended over the terminal-receiving pocket similar in construction and mode of operation to the corresponding portions of the double-pole connector described. The lower half section 76 is also provided with similar grooves 100 arranged to receive the laterally extended ears 102 formed on the terminal to prevent longitudinal displacement of the same in its insulating housing.

With this construction it will be seen that when two identical single-pole connectors 70, 72 are engaged by extending the terminal-receiving pocket 96 of one connector into the socket 98 of the second connector, the spring-pressed terminals 90, 92 will be slidably engaged with each other, and that when the curved contacting portions of the terminals pass by each other they are resiliently engaged in hooked or interlocked relation, as above described and as illustrated in Fig. 6.

As illustrated in Fig. 7, the laterally extended retaining ear 102 on one side of the terminal may be of a different size than the ear on the opposite side, the mating grooves 100 being of corresponding sizes to receive the ear on one side only whereby to prevent installation of the terminal in its socket in any other position than with the contacting face directed upwardly during assembly of the connector.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. An electrical connector comprising a hollow insulating housing split longitudinally to form two half sections detachably connected together, one of said half sections having a terminal receiving pocket longitudinally extended therefrom, the other half section having a socket forming portion longitudinally extended therefrom, the pocket of one connector being adapted for longitudinal telescopic insertion into the socket of a second and identical connector when the connectors are engaged, a rigid terminal member provided with a substantially flat contacting portion, said contacting portion having a rounded projection in one of its surfaces adjacent the end thereof, said terminal member resiliently supported within one of the hollow insulating portions in detached relation to the walls thereof, a curved leaf spring carried by said terminal and in engagement with the forward portion of the bottom surface of the contacting portion of said terminal member, said rigid terminal being mounted to yield laterally when slidably engaged with an identical terminal in the second connector, said resiliently supported terminals being shaped to effect lateral depression of each other into their respective pockets during initial engagement and to effect interlocking engagement with each other when fully engaged, said insulating sockets enclosing said pockets when the connectors are engaged, said housing being formed to provide clearance to permit limited lateral movement of the rigid and resiliently mounted terminal member, and means carried by said contacting portion for preventing longitudinal displacement of the terminal in its insulating housing.

2. An electrical connector as defined in claim 1 wherein the insulating housing is provided with an opening in its rear end portion of a diameter greater than the sectional diameter of the terminal member to facilitate assembly and disassembly of the terminal with relation to the housing.

3. An electrical connector comprising a hollow insulating housing split longitudinally to form two half sections detachably connected together, one of said half sections having a plurality of individual spaced terminal-receiving pockets longitudinally extended therefrom, the other half section having a longitudinally extended portion forming a plurality of spaced sockets, the pockets of one con-

5

nector being adapted for longitudinal telescopic insertion into the sockets of a second and identical connector when the connectors are engaged, a rigid terminal member resiliently supported and mounted within each of said pockets in detached relation to the walls thereof, a curved leaf spring carried by the rigid terminal for urging the same outwardly from the pocket, said terminals being mounted to yield laterally when slidingly engaged with identical terminals in the second connector, said resiliently mounted terminals being shaped to effect lateral depression of each other in their respective pockets during initial engagement and to effect interlocking engagement with each other when fully engaged, said housing being formed to provide clearance to permit limited movement of the rigid and resiliently mounted terminal member laterally thereof, and means for preventing longitudinal displacement of the terminal in its insulating housing, said longitudinally extended portions of the insulating housing being U-shaped in cross section with the open sides thereof facing inwardly, the outer ends of said pockets being closed and the outer ends of said sockets being open, said sockets being defined by longitudinally extended rib portions disposed between the side walls of the U-shaped extension.

4. An electrical connector as defined in claim 1 wherein the resiliently mounted rigid terminal member is provided with a rounded projection on its contacting face arranged to cooperate with the rounded projection of the terminal member of the second connector, the rounded projections being arranged in hooked relationship when the connectors are engaged to effect said interlocking engagement.

6

5. An electrical connector as defined in claim 1 wherein the longitudinally extended portions of the insulating housing are U-shaped in cross section with the open sides thereof facing inwardly, the outer end of said pocket being closed and the outer end of said socket-forming portion being open.

6. An electrical connector as defined in claim 1 wherein projections are formed on one of said half sections for cooperation with depressions formed on the second half section to register the half sections in assembled relation.

7. An electrical connector as defined in claim 1 wherein the half sections of said hollow insulating housing form openings providing ample clearance to permit lateral movement of said rigid terminals toward and away from each other, one of said half sections having grooved portions for cooperation with laterally extended portions formed on said terminal contacting portion to prevent longitudinal displacement and to permit lateral movement of the terminal in said housing.

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US005785557A

United States Patent [19]

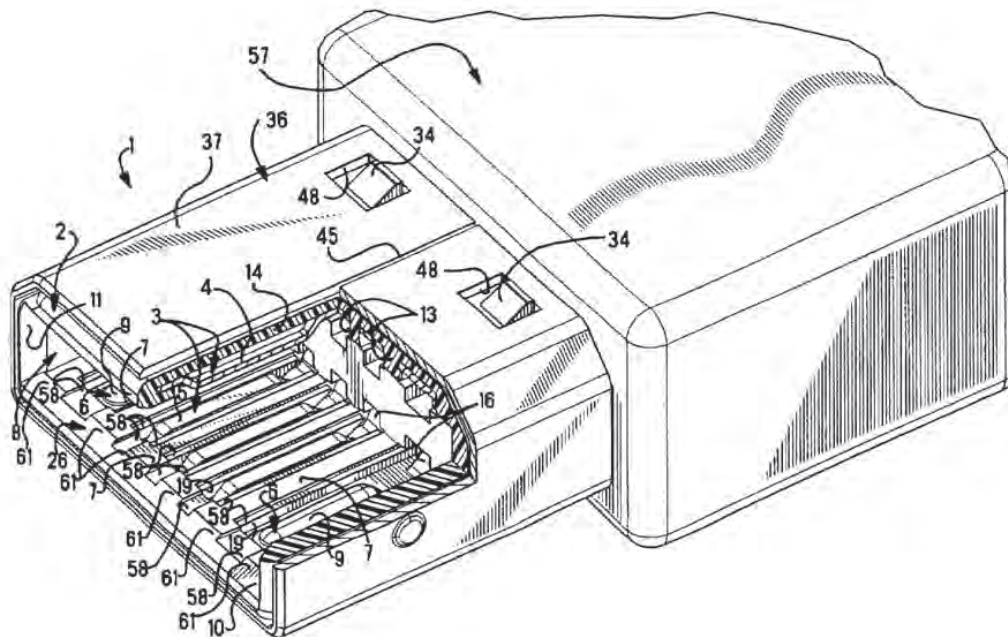
Davis

[11] **Patent Number:** 5,785,557[45] **Date of Patent:** Jul. 28, 1998[54] **ELECTRICAL CONNECTOR WITH PROTECTION FOR ELECTRICAL CONTACTS**[75] **Inventor:** Wayne Samuel Davis, Harrisburg, Pa.[73] **Assignee:** The Whitaker Corporation,
Wilmington, Del.[21] **Appl. No.:** 14,911[22] **Filed:** Feb. 8, 1993**Related U.S. Application Data**[63] **Continuation-in-part of Ser. No. 5,690, Jan. 19, 1993, Pat. No. 5,295,843.**[51] **Int. Cl.⁶** H01R 17/00[52] **U.S. Cl.** 439/660; 439/607; 439/108[58] **Field of Search** 439/607, 609, 439/610, 637, 660, 924, 62, 79, 108[56] **References Cited****U.S. PATENT DOCUMENTS**3,760,335 9/1973 Roberts
4,084,875 4/1978 Yamamoto 439/490 X

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Primary Examiner—Khiem Nguyen
Attorney, Agent, or Firm—Anton P. Ness[57] **ABSTRACT**

An electrical connector (1) comprising, an insulative housing (2), conductive contacts (4, 5) within an interior of the housing (2), insulative wiping surfaces (61) on a mating end (12) of the housing (2), and conductive surface areas (60) on the contacts (4, 5) being rearward of the wiping surfaces (61) and offset laterally of the wiping surfaces (61) to engage unwiped surface areas of mating contacts (4, 5) of another, mating connector (1).

18 Claims, 8 Drawing Sheets

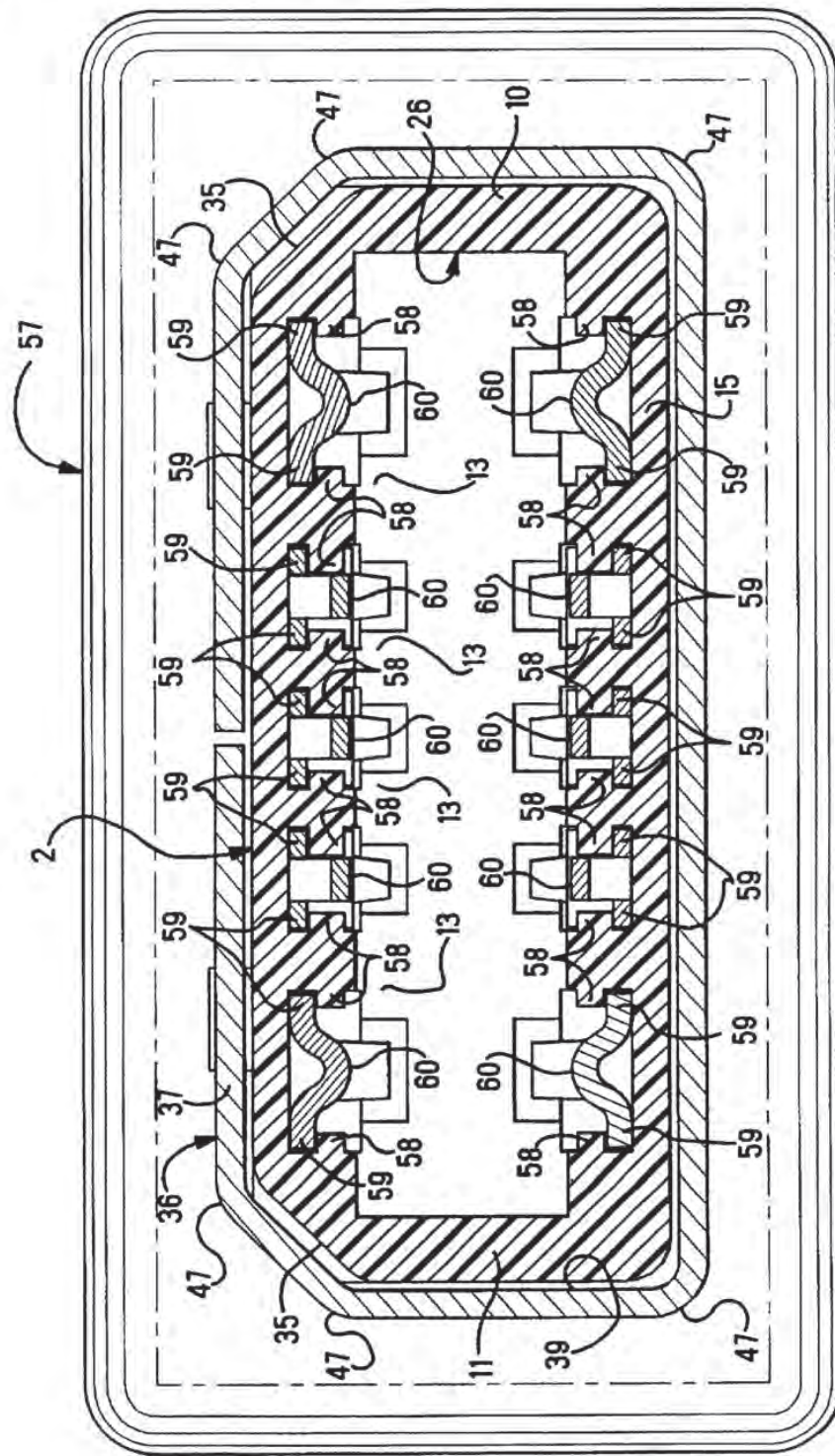
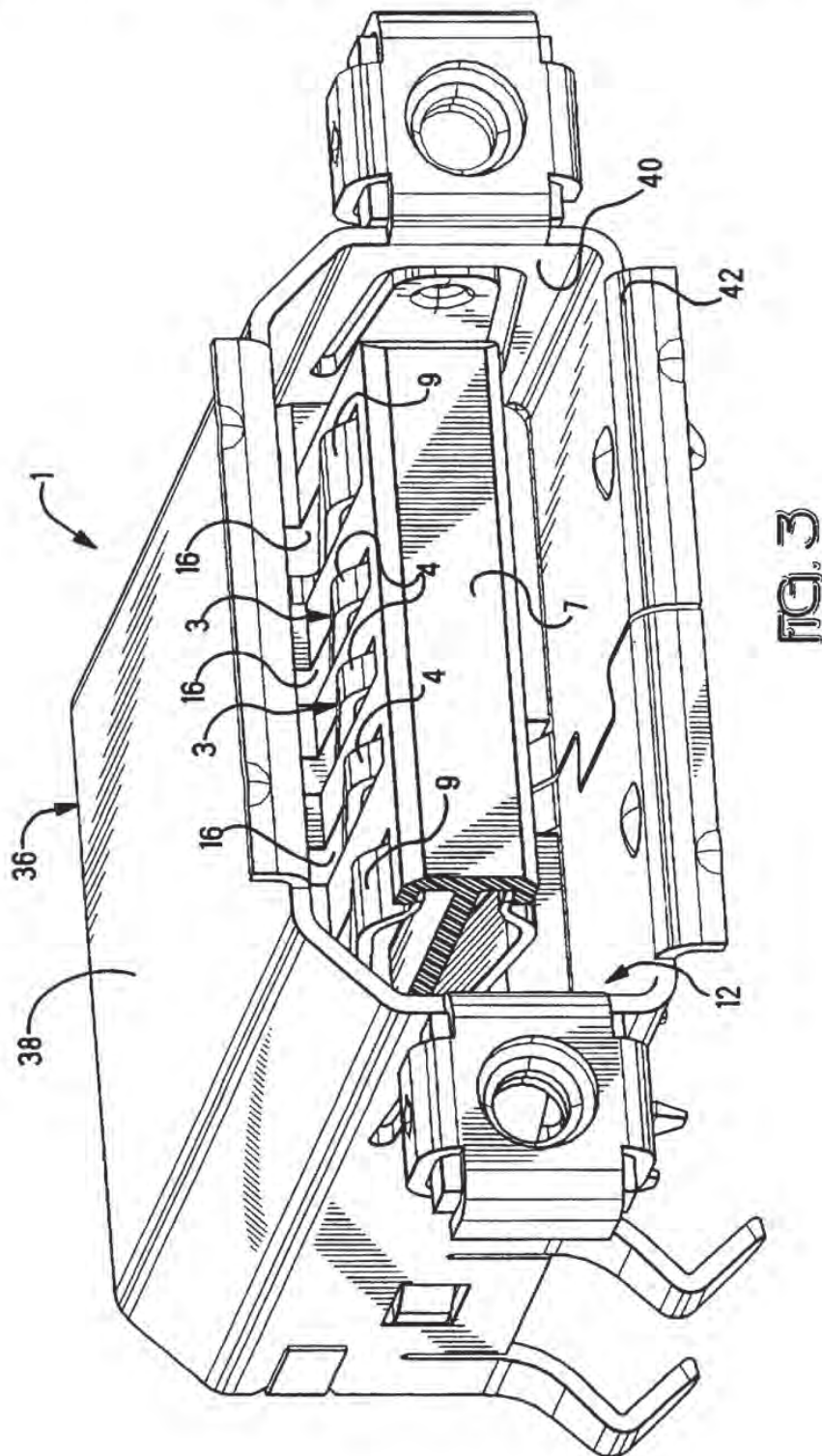
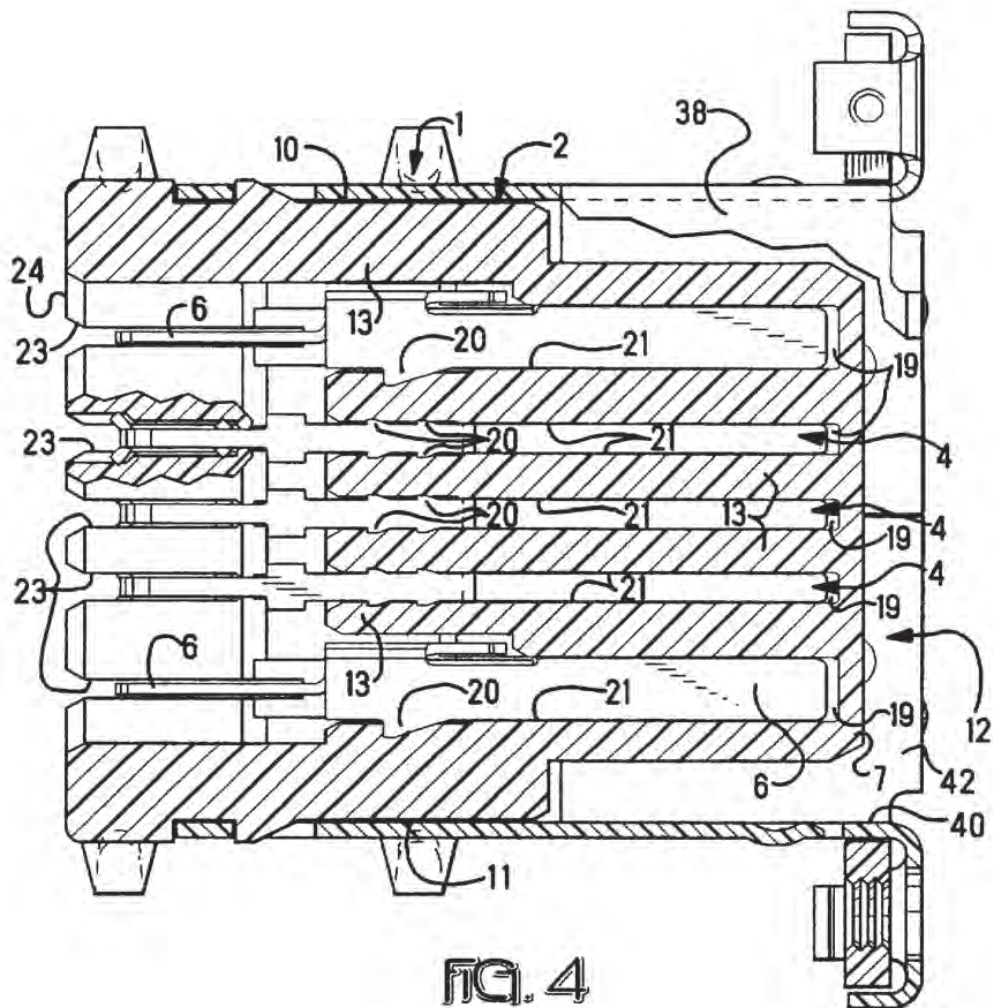
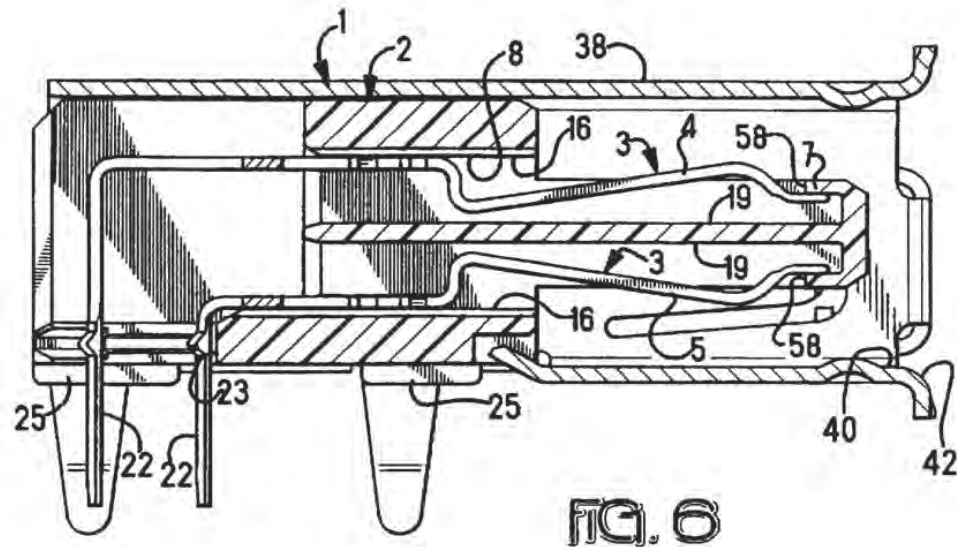
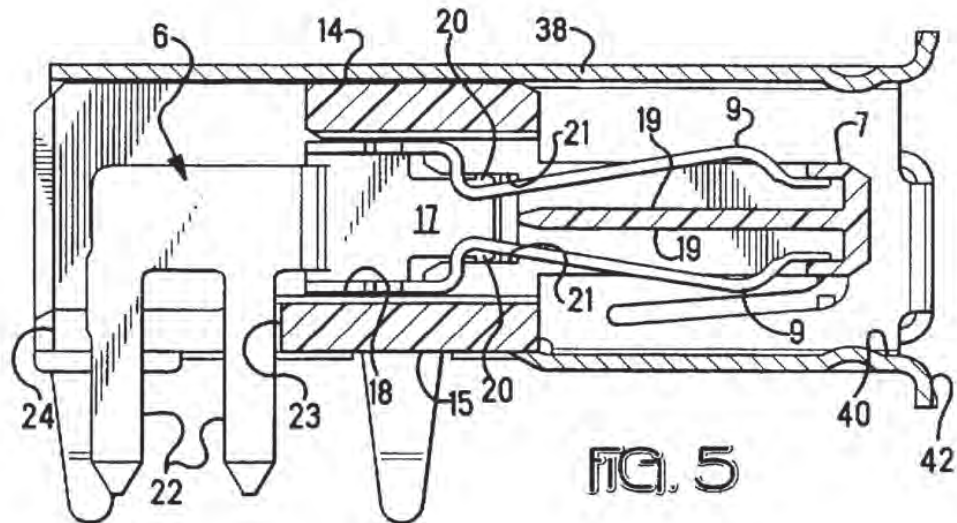
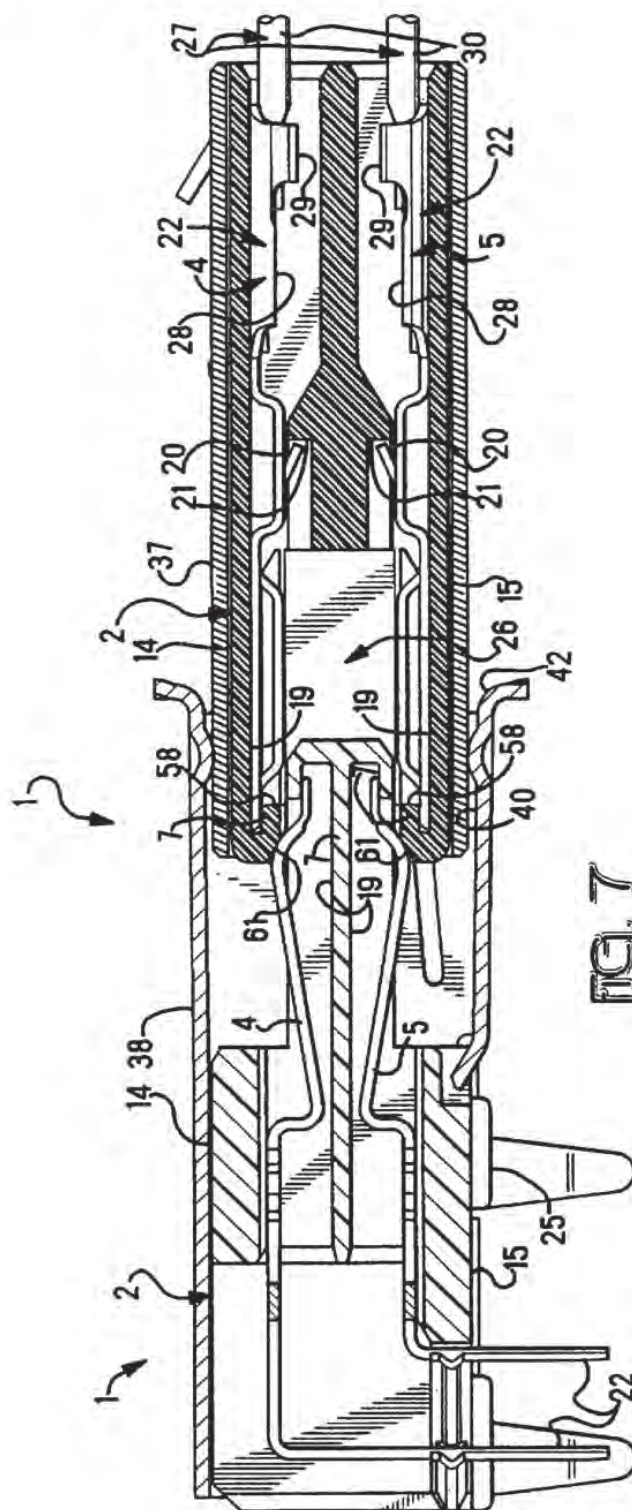


FIG. 2









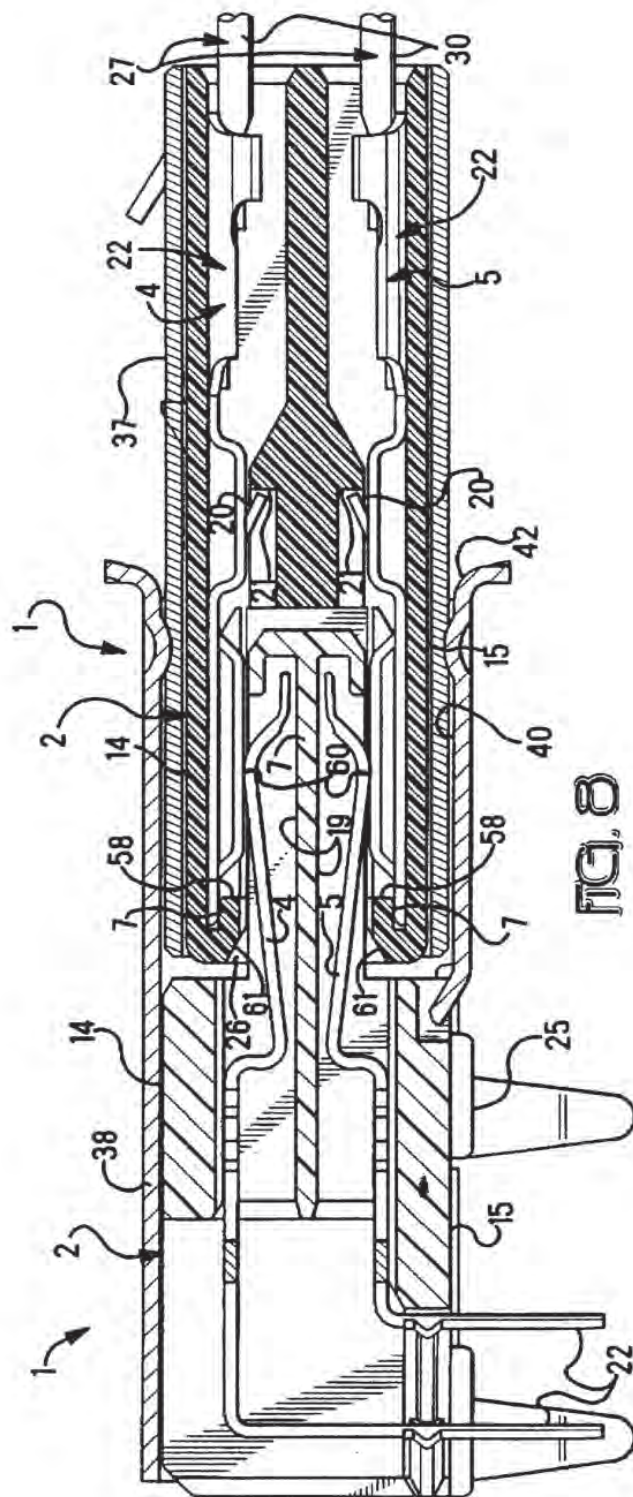


FIG. 8

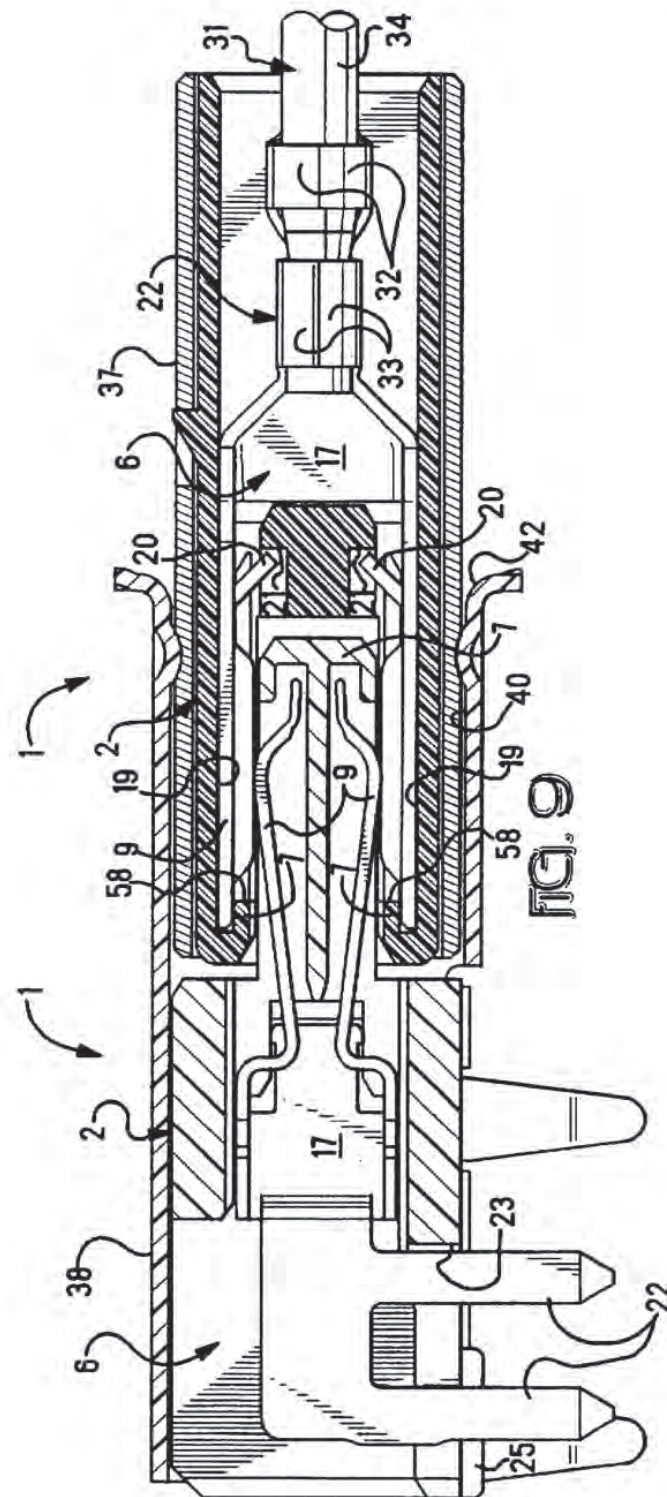


FIG. 9

ELECTRICAL CONNECTOR WITH PROTECTION FOR ELECTRICAL CONTACTS

RELATED APPLICATION INFORMATION

This is a Continuation-in-Part of U.S. patent application Ser. No. 08/005,690 filed Jan. 19, 1993, now U.S. Pat. No. 5,295,843.

FIELD OF THE INVENTION

The present invention relates to an electrical connector having electrical contacts, wherein the contacts are prevented from being wiped with insulation during mating connection with another, mating connector.

BACKGROUND OF THE INVENTION

An electrical connector, known from U.S. Pat. No. 3,760,335, comprises, an insulating housing and conductive signal contacts. The contacts are grouped in pairs, with an insulative divider of the housing separating one contact of the pair from the other contact of the pair. Multiple pairs of the contacts are distributed along the insulative divider. The pairs of contacts are especially suitable for connection to twisted pair wires used in the communications industry for data and voice transmission. Each pair of the twisted pair wires are connected to one pair of the contacts. To shield the connector from ESD, electrostatic discharge, a conductive metal shell surrounds the insulative housing of the connector. For example, a shielded connector is disclosed in U.S. Pat. No. 5,158,481.

A desirable shielded connector provides ESD protection for the electrical contacts of the connector during mating connection of the connector with another, mating connector. During mating connection of two mating connectors, an electrostatic voltage charge on one or both of the connectors should be discharged to ground electrical potential via the shield on one or both of the connectors, whereby the voltage charge is shunted away from electrical contacts in the connectors.

SUMMARY OF THE INVENTION

A feature of the invention resides in a shield covered connector with tips of electrical contacts being recessed from a mating end of the connector, and being covered by insulative material that provides ESD protection for the contacts.

Another feature of the invention resides in a connector with insulative wiping surfaces that provide ESD protection for electrical contacts, the wiping surfaces being offset from contact surfaces of the contacts, in the direction of mating insertion, to avoid insulative material being wiped onto the contact surfaces during mating connection with another, mating connector.

DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example with reference to the drawings according to which;

FIG. 1 is a fragmentary perspective view of an electrical connector;

FIG. 2 is a section view of the connector shown in FIG. 1;

FIG. 3 is a fragmentary perspective view of another, mating electrical connector for mating connection with the connector shown in FIG. 1;

FIG. 4 is a section view of the connector shown in FIG. 3;

FIG. 5 is an elevation view in section of the connector shown in FIG. 4;

FIG. 6 is a view similar to FIG. 5, illustrating signal contacts in the connector shown in FIG. 3;

FIG. 7 is an elevation view in section of the connectors shown in FIGS. 1 and 3 prior to mating engagement with each other;

FIG. 8 is a view similar to FIG. 7, illustrating the connectors in mating engagement with each other; and

FIG. 9 is a section view similar to FIG. 8, illustrating mating engagement of power contacts of the connectors.

With reference to FIGS. 1 through 6, each of two mating embodiments of an electrical connector 1 comprises, an insulative housing 2, multiple pairs 3 of conductive signal contacts 4, 5, accompanied by at least one power contact 6, in the housing 2. The pairs 3 of the signal contacts 4, 5 are distributed along an insulative divider 7 in an interior 8 of the housing 2. The signal contacts 4, 5 of each pair 3 are on opposite sides of the divider 7 that separates the signal contacts 4, 5 of each pair 3. The signal contacts 4, 5 are in rows, and are parallel to one another. A pair of contact fingers 9 on the power contact 6 are on opposite sides of the divider 7, and extend parallel to the signal contacts 4, 5. The surface area of each of the fingers 9 is larger than that of each of the signal contacts 4, 5, and is sufficiently broad to radiate heat from electrical power dissipation. In addition, each of the fingers 9 is of greater mass than each of the signal contacts 4, 5 to carry electrical current. When electrical current is transmitted by the power contact 6, dissipation of electrical power generates heat. The heat is radiated from the surface area of the power contact 6. A larger surface area and a higher mass of the power contact 6 will limit the temperature attained by the power contact 6.

The divider 7 bridges between, and is joined to side walls 10, 11 of the housing 2. The divider 7 extends from a front mating end 12 of the housing 2 and rearwardly in the interior 8 of the housing 2. Spaced apart partitions 13 in the interior 8 bridge between the divider 7 and a top wall 14 of the housing 2, and between the divider 7 and a bottom wall 15 of the housing 2. The partitions 13 join the divider 7 and the top and bottom walls 14, 15. The walls 14, 15 bridge between and join the side walls 10, 11 to form the exterior of the housing 2. Contact receiving cavities 16 in the housing 2 are defined between the partitions 13 and extend behind the divider 7 to receive the signal contacts 4, 5. With respect to the power contact 6, FIGS. 5 and 9, the fingers 9 are connected to a body portion 17 having a surface area sufficiently broad to radiate heat from electrical power dissipation. A pocket 18 in the housing 2, between a side wall 14, 15 and a partition 13, and behind the divider 7, receives the body portion 17. Each of the contact receiving cavities 16 is smaller than the pocket 18. The power contact 6 can be inserted in the housing 2 unmistakably in the pocket 18 that is larger than each of the smaller, contact receiving cavities 16 that is smaller than the body portion 17. The divider 7 extends forwardly of the partitions 13, and is provided with a series of grooves 19 on its opposite sides aligned with the contact receiving passages. The grooves 19 receive the signal contacts 4, 5 and the contact fingers 9. The grooves 19 that receive the contact fingers 9 are larger than the grooves 19 that receive the signal contacts 4, 5. Projecting lances 20 on each signal contact 4, 5, FIGS. 7 and 8, and on the power contact 6 impinge against walls 21 of the housing 2, and resist withdrawal of the contacts 4, 5 and 6

3

from the grooves 19. Each of the signal contacts 4, 5 and the power contact 6 is of unitary construction, stamped and formed from a strip of metal.

With respect to FIGS. 3-7, a circuit board connector 1, meaning a version of the connector 1 for mounting on a circuit board, not shown, will be described. The divider 7 is spaced apart from the top and bottom walls 14, 15 of the housing 2. The grooves 19 face toward the top and bottom walls 14, 15. The pairs 3 of signal contacts 4, 5 are adapted to be connected to a circuit board, not shown. An electrical termination 22 in the form of a post extends laterally downward from each of the signal contacts 4, 5 for connection to a circuit board, not shown, and more particularly, to a plated aperture, not shown, of the circuit board. The terminations 22 extend laterally downward by bending the signal contacts 4, 5 along their lengths, the signal contact 4 being longer in length than the signal contact 5.

With reference to FIGS. 5 and 9, the body portion 17 has a thickness that is the same thickness as each of the contact fingers 9. The fingers 9 are bent to extend outward from the body portion 17 such that the thickness of the body portion 17 is in a plane perpendicular to a plane of thickness of each of the contact fingers 9. A termination 22 in the form of a pair of posts extend laterally downward of each body portion 17 for connection to a circuit board, not shown, and more particularly, for connection in plated apertures, not shown, of the circuit board. Each of the terminations 22 is larger in surface area and mass than that of each of the terminations 22 on the signal contacts 4, 5, thereby to conduct electrical current, and to radiate heat resulting from dissipation of electrical power.

The terminations 22 are on the signal contacts 4, 5 where they emerge from a rear of the divider 7. The terminations 22 are on the power contact 6 where it emerges from a rear of the divider 7. A series of slots 23 in the bottom wall 15 of the housing 2 have open ends communicating with a rear end 24 of the bottom wall 15. The terminations 22 project through the slots 23, with the terminations 22 of each pair 3 of the contacts 4, 5 being spaced apart along the same slot 23. The bottom wall 15 of the housing 2 provides a base from which knob shaped feet 25, FIGS. 6-8, extend for resting against a circuit board, not shown.

With reference to FIGS. 1, 2 and 7-9, a cable connector 1, meaning a connector 1 for connection to an electrical cable, not shown, will be described. The cable connector 1 is adapted for mated connection with the version of the connector 1, FIGS. 3 and 4, for mounting on a circuit board, not shown. The divider 7 of the cable connector 1 is bifurcated by a passage 26 at the front mating end 12 for receiving the divider 7 of the version of the connector 1 for mounting on a circuit board, not shown. The grooves 19 face toward the passage 26, such that the contacts 4, 5 on opposite sides of the divider 7 face toward the passage 26. The pairs 3 of signal contacts 4, 5 are adapted to be connected to respective pairs 3 of signal wires 27 of a single electrical cable, not shown, or of multiple electrical cables, not shown. The signal wires 27 can be a twisted pair of signal wires 27. In FIG. 7, each of the signal contacts 4, 5 further comprises a termination 22 having arms 28 that extend outward laterally of each other, the arms being bendable into an open barrel configuration to encircle and connect with the signal wire 27. Another set of arms 29 extend laterally of each other, the arms 29 being bendable into an open barrel configuration to encircle and connect with insulation 30, FIG. 8, encircling the signal wire 27.

With reference to FIG. 9, the contact fingers 9 extend from a connection to an electrical power transmitting wire 31

4

larger in diameter than each of the signal wires 27. The wire 31 may comprise an electrical power cable. In particular, the body portion 17 comprises a termination 22 having sets of arms 32, 33 that extend outward laterally of each other, the arms 32 being bendable into an open barrel configuration to encircle and connect with the electrical power transmitting wire 31. The wire 31 is larger in diameter than each of the signal wires 27 to carry electrical current. The signal wires 27 are smaller in diameter, as they are required to transmit electrical signals of which the voltage, not the electrical power, is of paramount importance. The set of arms 33 extend laterally of each other, and are bendable into an open barrel configuration to encircle and connect with insulation encircling the wire 31.

With reference to FIG. 1, projecting locks 34 are on the exterior of the wall 14. The locks 34 are in the form of inclined wedge projections tapering toward the front mating end 12. The mating end 12 has a profile including chamfers 35, FIG. 2, that intersect the wall 14, making the wall 14 less wide than the wider wall 15, thereby providing the connector 1 with polarity for orienting the mating end 12.

With reference to FIGS. 1 and 2, shielding 36 for both electrical connectors 1, comprises; two conductive, telescopic shells 37, 38 that fit and slide one within the other. Each of the shells 37, 38 is of unitary construction, stamped and formed from a metal plate. The shells 37, 38 each are bent on themselves, forming wrapped sections, and forming telescopic first and second tubular enclosures 39, 40, with open front ends 41, 42 defining mating ends of the shells 37, 38.

A number of folds 47 in the tubular enclosure 39 conform to an exterior shape of the housing 2 of the connector 1. The folds 47 define the circumference of the profile on the mating end 41. Folds 47 in the enclosure 40 define the circumferences of the open ends 42, 44. The folds 47 conform the shell 38 with the shape of the first shell 37. A seam 45 extends along the tubular enclosure 39. Multiple locks 48, in the form of openings, located on both sides of the seam 45, lock to the connector 1 by locking to the projecting locks 34 on the housing 2. An overmold 57, FIG. 8, in the form of a molded insulation of desired shape, covers and adheres to the cable 25 and the strain relief portions 51, 52.

With reference to FIGS. 2 and 5-9 both connectors 1 will be described further. Flanges 58 on the divider 7 of the housing 2 overhang the front ends of the grooves 19 and overhang both lateral sides of each of the grooves 19. The flanges 58 overlap front tips on the contacts 4, 5 and front tips of the contact fingers 9 that are in respective grooves 19. The front tips of the contacts 4, 5 and of the contact fingers 9 are recessed from the mating end 12 of the housing 2.

With reference to the circuit board connector 1 shown in FIGS. 3 and 4, each of the contacts 4, 5, and the contact fingers 9, are inclined and bowed along their lengths to project outwardly bowed from the grooves 19. The bowed contacts 4, 5, and the bowed contact fingers 9, are resiliently deflectable by flattening their bowed configurations. For example, during mating connection of the connectors 1, one to the other, FIG. 8, the contacts 4, 5 and the contact fingers 9, of one connector 1, are matingly inserted into the other, mating connector 1. The bowed contacts 4, 5, and the bowed contact fingers 9, of the circuit board connector 1 engage respective contacts 4, 5, and contact fingers 9, of the cable connector 1, and are flattened somewhat to exert pressure engagement with the contacts 4, 5, and the contact finger 9, of the cable connector 1.

The cable connector 1 provides ESD protection, electrostatic discharge protection, for the signal contacts 4, 5. ESD protection is provided for the power contacts 6, as well. With reference to the cable connector 1 shown in FIGS. 1 and 2, the flanges 58, that overhang sides of the grooves 19, overlap lateral edge margins 59, FIG. 2, on each of the contacts 4, 5 on each of the contact fingers 9. The lateral edge margins 59 are received in respective grooves 19. On each signal contact 4, 5, and on each contact finger 9, a raised, conductive, contact surface 60 is allocated to a central section on each contact 4, 5 and on each contact finger 9 between the lateral edge margins 59. The conductive surface area 60 is raised with respect to the lateral edge margins 59. With respect to the contacts 4, 5, the conductive surface area 60 is separated from the lateral edge margins 59 by slits. With respect to the power contacts 9, the conductive surface area 60 is raised by bending the power contacts 9 lengthwise along the edge margins 59.

Within the passage 26 and on the mating end 12 of the housing 2, are multiple, insulative wiping surfaces 61 in the form of inclined ramps. The wiping surfaces 61 are spaced apart one from another, and appear as a castellated structure. The wiping surfaces 61 are interposed between the tips of the contacts 4, 5 and the mating end 12 of the housing 2. The wiping surfaces 61 are over the front tips of the contacts 4, 5 and of the contact fingers 9. The wiping surfaces 61 are in axial alignment with the edge margins 59 on the contacts 4, 5, and on the contact fingers 9, and are offset laterally from the contact surfaces 60 on the contacts 4, 5 and on the contact fingers 9. The wiping surfaces 61 project along paths of mating insertion of the contacts 4, 5, and the contact fingers 9, and are interposed between the mating end 12 of the housing 2 and the exposed contacts 4, 5 and the exposed contact fingers 9.

With reference to FIG. 7, with the conductive shells 37, 38 engaged, the contacts 4, 5 and the contact fingers 9, of the circuit board connector 1, will engage the insulative wiping surfaces 61, prior to engagement with the respective contacts 4, 5 and contact fingers 9, of the cable connector 1. At least the shell 38 of the circuit board connector 1 will be referenced to ground electrical potential, by virtue of being connected to a ground plane of a circuit board, not shown. The engaged conductive shells 37, 38 discharge electrostatic voltages to ground before the contacts 4, 5 and the contact fingers 9 of the connectors 1 engage one another. The engaged conductive shells 37, 38 are engaged while the insulative wiping surfaces 61 are interposed between the contacts 4, 5 of the two connectors 1, and between the contact fingers 9 the two connectors 1. To mate the connectors 1, the contacts 4, 5 and the contact fingers 9, of the circuit board connector 1 will wipe against, and ride over, the insulative wiping surfaces 61 as mating connection of the connectors 1 takes place.

During mating engagement of one connector 1 and the other connector 1, the contacts 4, 5 of the circuit board connector 1 will wipe, or stroke against, the contacts 4, 5 of the cable connector 1, as shown in FIG. 8. It is desired to avoid wiping of the contacts 4, 5 and the contact fingers 9 against the insulative material 61 of the housings 2, particularly at the same places where the contacts 4, 5 engage one another, and where the contact fingers 9 engage one another. Such wiping against the insulative material 61 would tend to apply insulative material on the contacts 4, 5 and on the contact fingers 9. The presence of insulative material on the contacts 4, 5 and on the contact fingers 9, where they engage one another during mating connection, would reduce electrical conductivity, undesirably. The contact surfaces 60 on

respective contacts 4, 5 are rearward of the insulative wiping surfaces 61 in the passage 26. The contacts 4, 5 of the circuit board connector 1 wipe against the insulative wiping surfaces 61 prior to engagement with the contacts 4, 5 of the cable connector 1. However, the insulative wiping surfaces 61 are offset laterally from the contact surfaces 60 of the contacts 4, 5 in the cable connector 1. The mating contacts 4, 5 of the circuit board connector 1 are axially aligned in the direction of mating insertion with the contacts 4, 5 of the cable connector 1. The wiping surfaces 61 are aligned with the side margins 59 of the contacts 4, 5 and the contact fingers 9, of the circuit board connector 1, in the direction of mating insertion. The middle surface areas, between the lateral side margins 59, of the contacts 4, 5 and the contact fingers 9, of the circuit board connector 1, are offset laterally of the wiping surfaces 61, during mating insertion into the cable connector 1. These middle surface areas pass between the insulative wiping surfaces 61, and are unwiped by the insulative wiping surfaces 61 during passage of the side margins of the contacts 4, 5 and the contact fingers 9 over the wiping surfaces 61. The contact surfaces of the contacts 4, 5 and the contact fingers 9, of the cable connector 1, engage these unwiped, middle surface areas of the mating contacts 4, 5 and contact fingers 9, of the circuit board connector 1. Thereby, the presence of insulative material is avoided on the contacts 4, 5 and on the contact fingers 9, at the locations where they engage one another during mating connection of the connectors 1.

An advantage of the invention resides in a connector 1 with tips of contacts 4, 5 being recessed from a mating end 12 of the connector 1 and covered by insulative material that provides ESD protection for the contacts 4, 5.

Another advantage of the invention resides in a connector 1 with insulative wiping surfaces 61 that provide ESD protection for electrical contacts 4, 5, the wiping surfaces 61 being offset from the contacts 4, 5 in the direction of mating insertion to avoid insulative material being wiped onto contact surfaces of the contacts 4, 5 during mating connection with another, mating connector 1.

Other advantages, and other embodiments and modifications of the invention are intended to be covered by the spirit and scope of the accompanying claims.

I claim:

1. An electrical connector comprising: an insulative housing, conductive contacts within an interior of the housing, wiping surfaces on a mating end of the housing, conductive surfaces on the contacts being rearward of the wiping surfaces and offset laterally of the wiping surfaces to engage unwiped surface areas of mating contacts of another, mating connector, which mating contacts wipe against the wiping surfaces prior to engagement of the unwiped surface areas of the mating contacts with the conductive surface areas of the contacts, the wiping surfaces projecting along paths of mating insertion of the contacts, and being interposed between the contacts and a front edge of the housing.

2. An electrical connector as recited in claim 1, wherein, an insulative divider separates one of the contacts from another of the contacts of each pair of the contacts.

3. An electrical connector as recited in claim 1, further comprising: an insulative divider separating one of the contacts from another of the contacts of each pair of the contacts, at least one conductive power contact having a pair of contact fingers on opposite sides of the divider, the contact fingers having a surface area sufficiently broad to radiate heat from electrical power dissipation, and the fingers extending parallel to the contacts.

4. An electrical connector as recited in claim 1, wherein, the wiping surfaces are interposed between the contacts and

a front edge of the housing, and conductive shielding encircles the housing, a front edge of the shielding being closer to the front edge of the housing than the contacts.

5. An electrical connector as recited in claim 1, wherein, front tips of the contacts are recessed from a front edge of the housing, and the wiping surfaces are interposed between the tips of the contacts and the front edge of the housing.

6. An electrical connector as recited in claim 1, wherein, the wiping surfaces cover front tips of the contacts.

7. An electrical connector as recited in claim 1, wherein, the wiping surfaces are ramps.

8. An electrical connector comprising: an insulative housing, conductive contacts within an interior of the housing, wiping surfaces on a mating end of the housing, conductive surfaces on the contacts being rearward of the wiping surfaces and offset laterally of the wiping surfaces to engage unwiped surface areas of mating contacts of another, mating connector, which mating contacts wipe against the wiping surfaces prior to engagement of the unwiped surface areas of the mating contacts with the conductive surface areas of the contacts, and the conductive surfaces being raised with respect to edge margins of the contacts received in grooves in the housing.

9. An electrical connector comprising:

an insulative housing, conductive contacts within an interior of the housing, wiping surfaces on a mating end of the housing and interposed between the contacts and a front edge of the housing, with the wiping surfaces projecting along paths of mating insertion of mating contacts of another, mating connector, conductive surfaces on the contacts being offset laterally of the wiping surfaces and being rearward of the wiping surfaces to engage said mating contacts of said another, mating connector, which mating contacts pass the wiping surfaces prior to engagement with the conductive surfaces, and a conductive shield surrounding the mating end of the housing, the wiping surfaces being closer to the shield than the contacts.

10. An electrical connector as recited in claim 9, wherein, an insulative divider separates one of the contacts from another of the contacts of each pair of the contacts.

11. An electrical connector as recited in claim 9, further comprising: an insulative divider separating one of the

contacts from another of the contacts of each pair of the contacts, at least one conductive power contact having a pair of contact fingers on opposite sides of the divider, the contact fingers having a surface area sufficiently broad to radiate heat from electrical power dissipation, and the fingers extending parallel to the contacts.

12. An electrical connector as recited in claim 9, wherein, the wiping surfaces are interposed between the contacts and a front edge of the housing, and conductive shielding encircles the housing, a front edge of the shielding being closer to the front edge of the housing than the contacts.

13. An electrical connector as recited in claim 9, wherein, front tips of the contacts are recessed from a front edge of the housing, and the wiping surfaces are interposed between the tips of the contacts and the front edge of the housing.

14. An electrical connector as recited in claim 9, wherein, the wiping surfaces cover front tips of the contacts.

15. An electrical connector as recited in claim 9, wherein, the wiping surfaces are ramps.

16. An electrical connector comprising: an insulative housing, conductive contacts within an interior of the housing, wiping surfaces on a mating end of the housing, conductive surfaces on the contacts being offset laterally of the wiping surfaces and being rearward of the wiping surfaces to engage mating contacts of another, mating connector which mating contacts pass the wiping surfaces prior to engagement with the conductive surfaces, and a conductive shield surrounding the mating end of the housing, the wiping surfaces being closer to the shield than the contacts, and the conductive surfaces being raised with respect to edge margins of the contacts received in grooves in the housing.

17. An electrical connector as recited in claim 9 wherein, the conductive surfaces on each contact are between edge margins on each contact, and the wiping surfaces are offset from the conductive surface areas on the contacts, and are in alignment with the edge margins on the contacts.

18. An electrical connector as recited in claim 1 wherein, the conductive surfaces on each contact are between edge margins on each contact, and the wiping surfaces are offset from the conductive surfaces on the contacts, and are in alignment with the edge margins on the contacts.

* * * * *



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(12) **United States Patent**
Kataoka et al.

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(45) **Date of Patent:** **May 22, 2012**

(54) **CONNECTOR**

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(51) **Int. Cl.**
H01R 11/22 (2006.01)

(52) **U.S. Cl.** **439/266**

(58) **Field of Classification Search** 439/259,
439/262, 263, 265, 266, 268, 269.1
See application file for complete search history.

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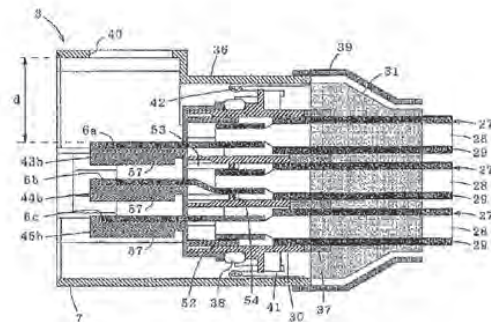
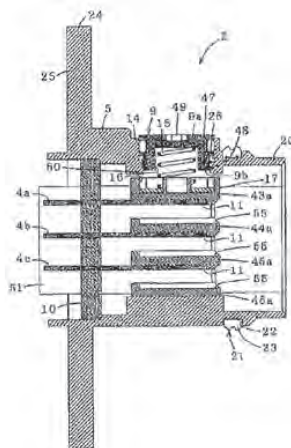
Primary Examiner — Ross Gushi

(74) *Attorney, Agent, or Firm* — Scully, Scott, Murphy & Presser, P.C.

(57) **ABSTRACT**

A connector includes a first terminal housing for housing a plurality of aligned first connecting terminals, a second terminal housing for housing a plurality of aligned second connecting terminals, and a connecting member for collectively fixing and electrically connecting the plurality of first connecting terminals and the plurality of second connecting terminals. The insulator includes a first insulating member that is one of two divided insulators formed by dividing the insulator, and a second insulating member that is another of the divided insulators. The two divided insulators overlap when the first terminal housing is fitted to the second terminal housing, thereby forming the insulator having a predetermined thickness. A fitting groove is formed on a facing surface of one of the first and second insulating members, and a convex portion fitting to the fitting groove is formed on a facing surface of the other.

8 Claims, 7 Drawing Sheets



US 8,182,278 B2

Page 2

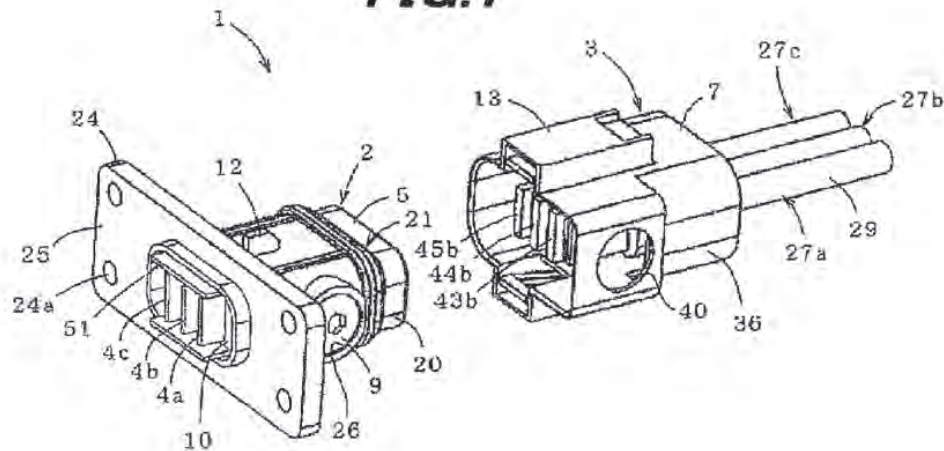
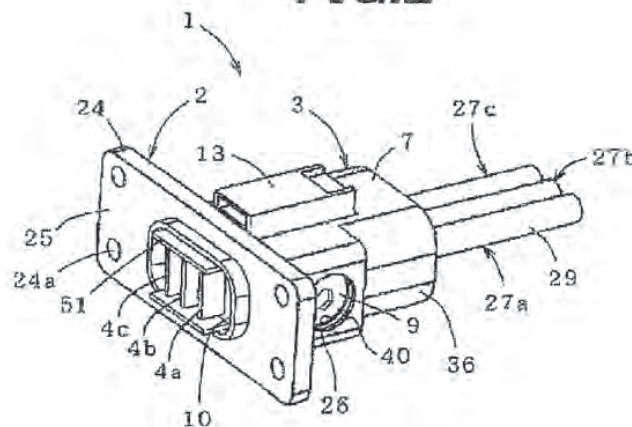
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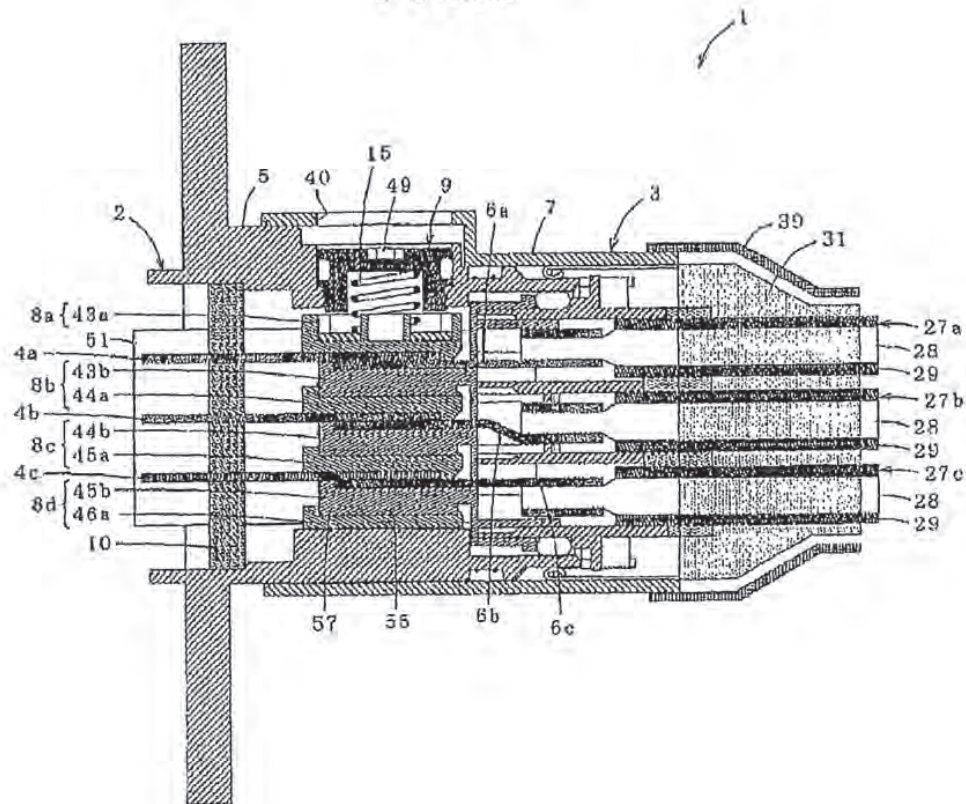
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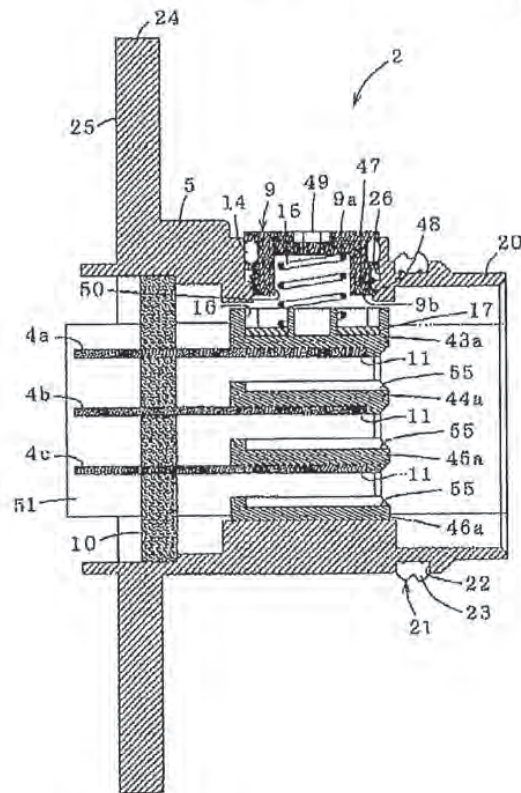
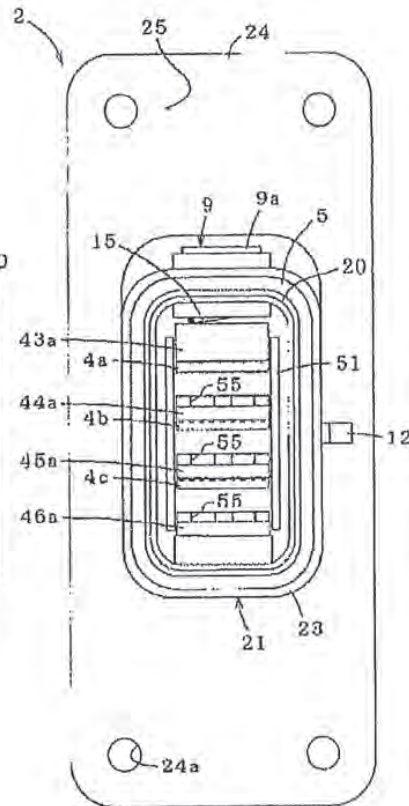
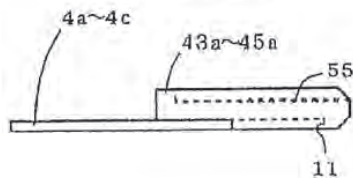
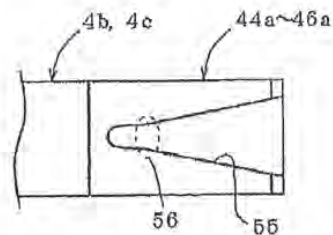
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FIG. 1**FIG. 2**

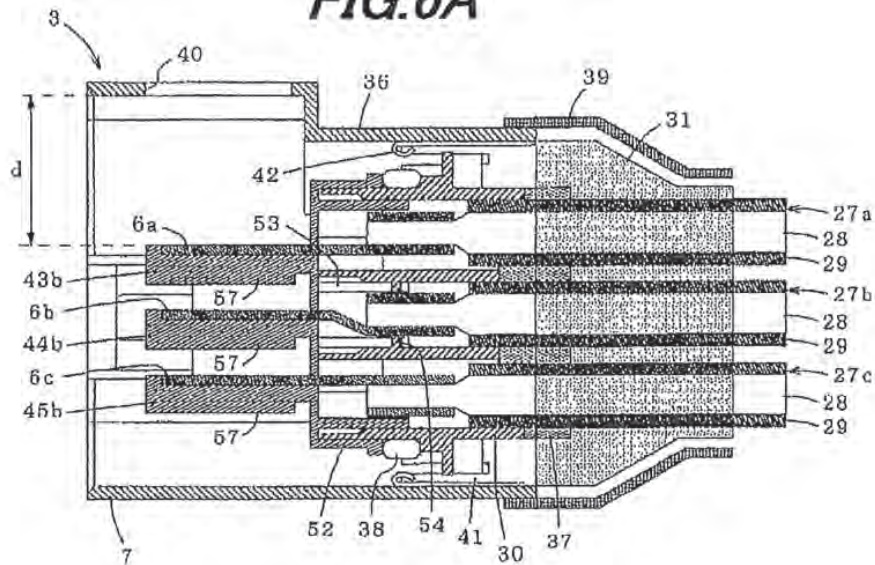
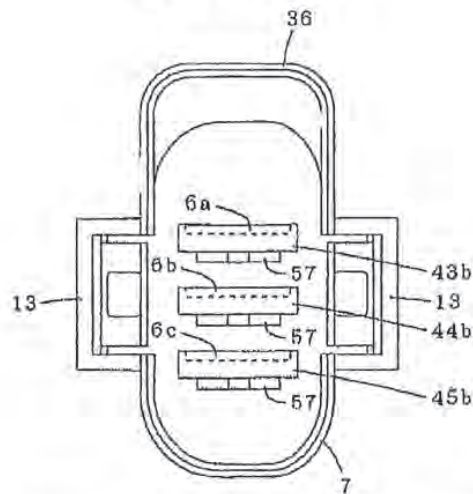
5 FIRST TERMINAL HOUSING
7 SECOND TERMINAL HOUSING
9 CONNECTING MEMBER
43b-45b SECOND INSULATING MEMBER

FIG. 3

5 FIRST TERMINAL HOUSING
 7 SECOND TERMINAL HOUSING
 9 CONNECTING MEMBER
 43a-46a FIRST INSULATING MEMBER
 43b-46b SECOND INSULATING MEMBER
 55 FITTING GROOVE
 57 CONVEX PORTION

FIG. 4A**FIG. 4B****FIG. 5A****FIG. 5B**

4a-4c FIRST CONNECTING TERMINAL
 5 FIRST TERMINAL HOUSING
 43a-46a FIRST INSULATING MEMBER
 55 FITTING GROOVE

FIG. 6A**FIG. 6B**

6a-6c SECOND CONNECTING TERMINAL
 7 SECOND TERMINAL HOUSING
 43b-45b SECOND INSULATING MEMBER
 57 CONVEX PORTION

FIG. 7A

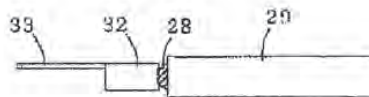


FIG. 7B

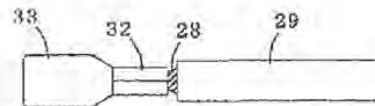


FIG. 8A

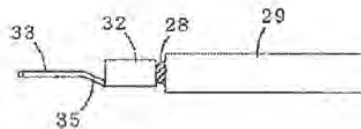


FIG. 8B

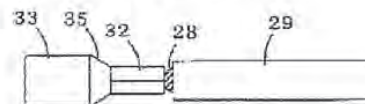


FIG. 9A

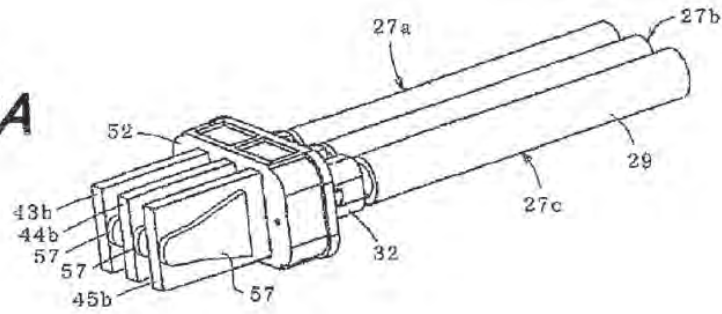


FIG. 9B

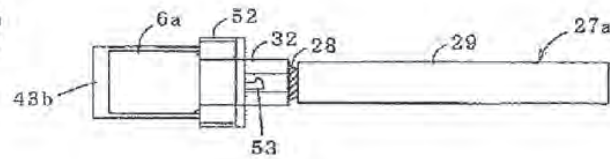


FIG. 9C

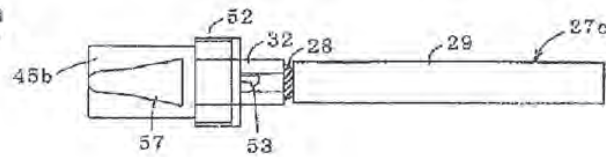
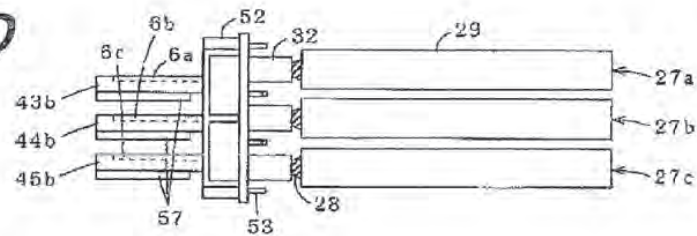
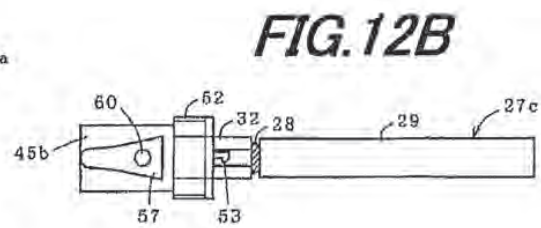
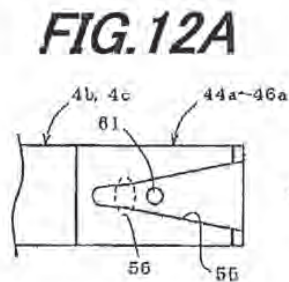
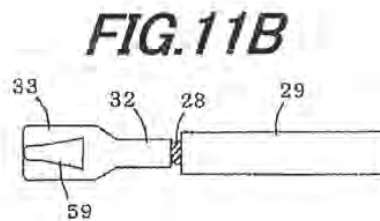
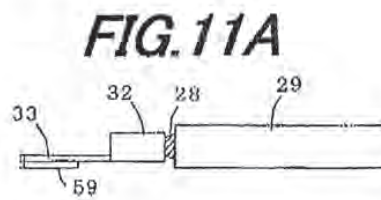
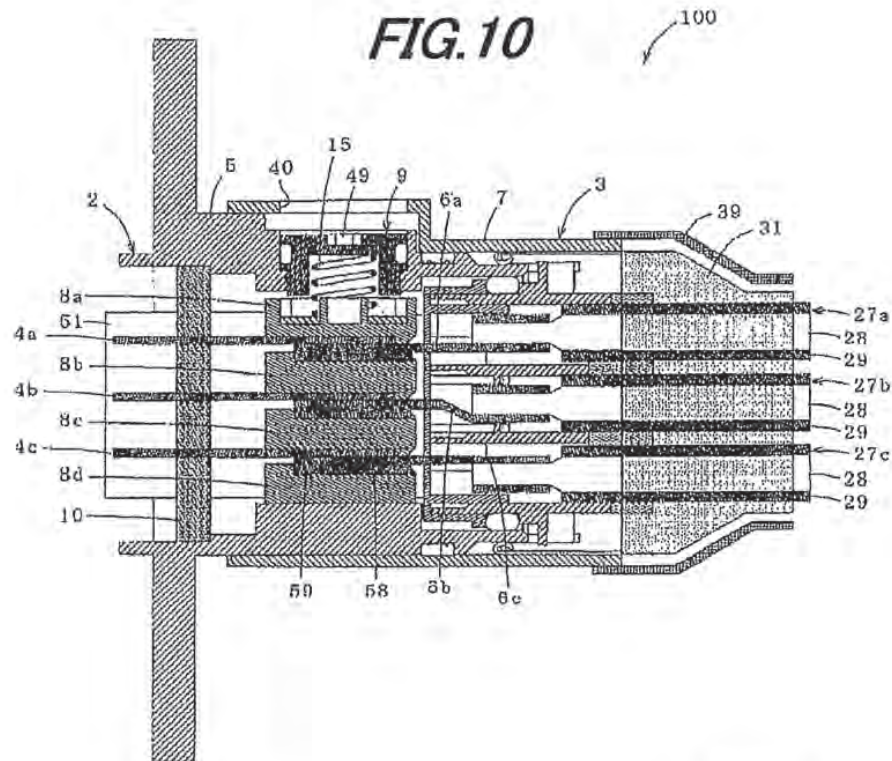


FIG. 9D





1

CONNECTOR

The present application is based on Japanese Patent Application No. 2010-091579 filed on Apr. 12, 2010, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a connector which is used for, e.g., an eco-friendly car such as a hybrid car and an electric car, in particular, to a connector which may be potentially employed for a connection of a power harness used for transmitting a large amount of power.

2. Description of the Related Art

A power harness has made significant progress in recent years and is used for connecting between devices such as between a motor and an inverter or between an inverter and a battery in, e.g., a hybrid car or an electric car for transmitting a large amount of power, and a connector in a two-divided structure composed of, e.g., a male connector portion provided with a male terminal as well as a first terminal housing for housing the male terminal and a female connector portion provided with a female terminal connected to the male terminal as well as a second terminal housing for housing the female terminal is provided to one end of the power harness (see, e.g., JP-A-2009-070754).

In recent years, all components in such an eco-friendly car have been lightened in weight in order to improve energy saving performance, and size reduction is desired as one of effective means of reducing weight.

A technique of Japanese patent No. 4037199 is an example of a known technique.

The technique described in Japanese patent No. 4037199 is an electric connection structure for vehicle in which connecting terminals of plural phases of a conductive member led from a vehicle driving motor are connected to connecting terminals of plural phases of a power line cable led from an inverter for driving the motor, a connecting terminal of each phase of the conductive member overlaps a corresponding connecting terminal of each phase of the power line cable, an insulating member is arranged on a surface opposite to an overlapping surface of the connecting terminals, and the overlapped terminals of each phase are tightened and fixed to the insulating member in an overlapping direction by a single bolt provided at a position to penetrate therethrough.

In other words, the technique of Japanese patent No. 4037199 is a connection structure in which plural connecting terminals and insulating members compose a laminated structure and the connecting terminals are fixed and electrically connected all together at contact points by tightening in an overlapping direction (or a lamination direction) using a single bolt while plural contact points between the connecting terminals as an overlapping surface thereof are sandwiched, and this kind of configuration is more effective than the technique of JP-A-2009-070754 in that downsizing is easy.

SUMMARY OF THE INVENTION

In the technique of Japanese patent No. 4037199, the connecting terminals are fixed and electrically connected by a bolt, i.e., a through type connecting member (a stem portion and ahead portion), as mentioned above. Since the through-type connecting member is formed of metal in light of strength, it is necessary to ensure insulation at a stem portion which penetrates contact points and a collar is thus separately provided to cover a periphery of the stem portion, however,

2

this configuration has a problem that the number of components used for the connecting member increases, resulting in high cost.

Therefore, in order to decrease the number of components used for the connecting member and to reduce the cost, the inventors designed a configuration such that a connecting member is formed not in a through-type but in a non-through type by using only a head portion and that an adjacent insulating member is pushed from one direction by the head portion of the connecting member to fix and electrically connect connecting terminals at each contact point.

However, a power harness used for a vehicle is used in an environment such as in a vehicle where vibration is likely to occur, and when the above-mentioned non-through type connecting member is used, connecting terminals move relatively easily due to fine sliding as compared to the case of using a through-type connecting member, and thus, a problem of abrasion at a contact point arises. For example, although tin plating, etc., is applied to a surface of the connecting terminal in order to stably obtain low contact resistance, when the connecting terminal is abraded due to fine sliding, the tin plating on the surface of the connecting terminal is peeled off, abrasion powder is generated, is oxidized and is deposited, and the connecting terminal climes on the oxidized abrasion powder, resulting in an increase in contact resistance.

Therefore, when the non-through type connecting member is employed, there is a new problem that it is necessary to take measures to prevent abrasion at the contact point.

The invention is made in view of the above-mentioned circumstances, and it is an object of the invention to provide a connector in which plural first connecting terminals, plural second terminals and plural insulators are arranged in a laminated state, and it is possible to suppress abrasion at a contact point due to fine sliding.

(1) According to one embodiment of the invention, a connector comprises:

a first terminal housing for housing a plurality of aligned first connecting terminals;

a second terminal housing for housing a plurality of aligned second connecting terminals;

a laminated structure that one surface of each of the plurality of first connecting terminals is paired with one surface of each of the plurality of second connecting terminals to form a plurality of contact points when the first terminal housing is fitted to the second terminal housing and each contact point is arranged so as to be sandwiched by insulators having a predetermined thickness; and

a connecting member for collectively fixing and electrically connecting the plurality of first connecting terminals and the plurality of second connecting terminals at each contact point by pressing the insulator adjacent thereto,

wherein the insulator comprises a first insulating member that is one of two divided insulators formed by dividing the insulator, the first insulating member being formed so as to be fixed to another surface of the first connecting terminal adjacent thereto and to cover at least an end surface of the adjacent first connecting terminal on a front end side in a fitting direction, and a second insulating member that is another of the divided insulators, the second insulating member being formed so as to be fixed to another surface of the second connecting terminal adjacent thereto and to cover at least an end surface of the adjacent second connecting terminal on a front end side in a fitting direction,

the two divided insulators overlap when the first terminal housing is fitted to the second terminal housing, thereby forming the insulator having a predetermined thickness, and

3

a fitting groove is formed on a facing surface of one of the first and second insulating members that face each other by the overlap of the two divided insulators, and a convex portion fitting to the fitting groove is formed on a facing surface of the other.

(2) According to another embodiment of the invention, a connector comprises:

a first terminal housing for housing a plurality of aligned first connecting terminals;

a second terminal housing for housing a plurality of aligned second connecting terminals;

a plurality of aligned insulators housed in the first terminal housing;

a laminated state that one surface of each of the plurality of first connecting terminals faces one surface of each of the plurality of second connecting terminals so as to be paired when the first terminal housing is fitted to the second terminal housing and the plurality of insulators are arranged so that each of a plurality of contact points formed by a plurality of facing first and second connecting terminals are sandwiched therebetween; and

a connecting member for collectively fixing and electrically connecting the plurality of first connecting terminals and the plurality of second connecting terminals at each contact point by pressing the insulator adjacent thereto is included,

wherein each of the plurality of first connecting terminals is integrally fixed to an insulator that is adjacently arranged on another surface, and

a fitting groove is formed on one of another surface of the second connecting terminal and a surface of the insulator that face each other at the time of fitting the first terminal housing to the second terminal housing, and a convex portion fitting to the fitting groove is formed on the other.

In the above embodiment (1) or (2) of the invention, the following modifications and changes can be made.

(i) The fitting groove is formed in a triangular shape such that a groove width increases toward a front end side in a fitting direction,

the convex portion is formed such that a width decreases toward the front end side in the fitting direction so as to be fitted to the triangular fitting groove, and

the fitting groove is gradually fitted into the convex portion as the first terminal housing is being fitted to the second terminal housing.

(ii) A protruding engaging portion is formed on a surface of the convex portion, and

an engaging hole to be engaged with the engaging portion is formed on a bottom surface of the fitting groove.

Points of the Invention

According to one embodiment of the invention, a connector is constructed such that a fitting groove is formed on one of facing surfaces of a first insulating member and a second insulating member which face each other when two divided insulators (i.e., a first insulating member and a second insulating member) are overlapped, and a convex portion fitted to the fitting groove is formed on the another facing surface. Thereby, it is possible to restrict movement of each insulating member and to suppress abrasion due to fine sliding at the contact points while ensuring insertability between connecting terminals when the connector is fitted even if a non-through type connecting member is employed.

BRIEF DESCRIPTION OF THE DRAWINGS

Next, the present invention will be explained in more detail in conjunction with appended drawings, wherein:

4

FIG. 1 is a perspective view showing first and second connector portions which compose a connector in an embodiment of the present invention;

FIG. 2 is a perspective view showing the connector after the first connector portion is fitted to the second connector;

FIG. 3 is a cross sectional view showing the connector after the first connector portion is fitted to the second connector;

FIGS. 4A and 4B show the first connector portion, wherein FIG. 4A is a cross sectional view thereof and FIG. 4B is a schematic view thereof when viewed from a front end side in a fitting direction;

FIGS. 5A and 5B show a first connecting terminal, wherein FIG. 5A is a side view thereof and FIG. 5B is a top view thereof;

FIGS. 6A and 6B show the second connector portion, wherein FIG. 6A is a cross sectional view thereof and FIG. 6B is a schematic view thereof;

FIGS. 7A and 7B show a second connecting terminal, wherein FIG. 7A is a side view thereof and FIG. 7B is a bottom view thereof;

FIGS. 8A and 8B show the second connecting terminal, wherein FIG. 8A is a side view and FIG. 8B is a top view;

FIGS. 9A to 9D show the second connecting terminals which are aligned and held in a second inner housing, wherein FIG. 9A is a perspective view thereof, FIG. 9B is a top view thereof, FIG. 9C is a bottom view thereof and FIG. 9D is a side view thereof;

FIG. 10 is a perspective view showing first and second connector portions which compose a connector in a modification;

FIGS. 11A and 11B show a second connecting terminal in the connector of FIG. 10, wherein FIG. 11A is a side view thereof and FIG. 11B is a bottom view thereof; and

FIGS. 12A and 12B are top views showing shapes of a fitting groove and a convex portion in the modification of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the invention will be described below in conjunction with the appended drawings.

FIG. 1 is a perspective view showing first and second connector portions of a connector in the present embodiment, FIG. 2 is a perspective view showing the connector when the first connector portion is fitted to the second connector, and FIG. 3 is a cross sectional view thereof.

As shown in FIGS. 1-3, a connector 1 of the present embodiment is composed of a first connector portion 2 and a second connector portion 3, and plural power lines are connected at a time by fitting the connector portions 2 and 3 together.

More specifically, the connector 1 is provided with the first connector portion 2 having a first terminal housing 5 which houses plural (three) aligned first connecting terminals (male terminals) 4a-4c, the second connector portion 3 having a second terminal housing 7 which houses plural (three) aligned second connecting terminals (female terminals) 6a-6c, plural insulators 8a-8d for insulating between contact points, and a connecting member 9 for collectively fixing and electrically connecting the plural first connecting terminals 4a-4c to the plural second connecting terminals 6a-6c at each contact point by pressing the insulator 8a adjacent thereto. In the connector 1, when the first terminal housing 5 of the first connector portion 2 is fitted to the second terminal housing 7 of the second connector portion 3, one surface of each of the plural first connecting terminals 4a-4c is paired with one

5

surface of each of the plural second connecting terminals 6a-6c (a pair of the first connecting terminal 4a and the second connecting terminal 6a, that of the first connecting terminal 4b and the second connecting terminal 6b, and that of the first connecting terminal 4c and the second connecting terminal 6c) to compose plural contact points and each contact point is arranged so as to be sandwiched by the insulators 8a-8d formed of a non-conductive resin with a predetermined thickness, thereby forming a laminated structure.

The insulators 8a-8d are composed of two divided insulators, first insulating members 43a-46a and second insulating members 43b-45b. More precisely, the insulator 8a has the same thickness as the first insulating member 43a and is not divided in the present embodiment, but may have a thickness of the first insulating members 44a-46a which are divided. The insulator 8a as a divided insulator is explained below.

The first insulating members 43a-46a are one of the two divided insulators which are formed by dividing the insulators 8a-8d. When the first connecting terminal 4a (or 4b or 4c) is adjacent thereto, the first insulating members 43a-46a are fixed to another surface of the adjacent first connecting terminal 4a (or 4b or 4c) so as to cover at least an end surface thereof on a front end side in a fitting direction. The first insulating member 46a not having the adjacent first connecting terminal 4a (or 4b or 4c) is integrally fixed to an inner surface of the first terminal housing 5.

The second insulating members 43b-45b are another of the divided insulators. When the second connecting terminal 6a (or 6b or 6c) is adjacent thereto, the second insulating members 43b-45b are fixed to another surface of the adjacent second connecting terminal 6a (or 6b or 6c) so as to cover at least an end surface thereof on a front end side in a fitting direction.

The first insulating member 44a (or 45a or 46a, or alternatively 43a) and the second insulating member 43b (or 44b or 45b) are formed so that the total thickness thereof is necessary and sufficient to ensure insulation between the contact points (or between a contact point and the first terminal housing). In other words, the insulation between the contact points (or between a contact point and the first terminal housing) can be ensured only by overlapping the first insulating members 43a-46a with the second insulating members 43b-45b.

As described above, the reason why the insulators 8a-8d are composed of two divided insulators, the first insulating members 43a-46a and the second insulating members 43b-45b, is to obtain a structure, so-called touch protection, for preventing a foreign object such as a hand or a finger from touching the first connecting terminals 4a-4c and the second connecting terminals 6a-6c when the first terminal housing 5 is not fitted to the second terminal housing 7.

The insulator 8a pressed by the connecting member 9 is actually formed of only the first insulating member 43a, however, from the viewpoint of the idea of the present invention, it may be said that the insulator 8a is formed by overlapping the first insulating member 43a having a predetermined thickness with a second insulating member having a thickness of zero.

The connector 1 is used for connecting, e.g., a motor for driving a vehicle to an inverter for driving the motor.

More specifically, the first terminal housing 5 of the first connector portion 2 (on the left side in FIG. 1) is fitted to a shield case of the motor, and portions of the first connecting terminals 4a-4c exposed from the first terminal housing 5 are connected to each terminal of a terminal block which is installed in the shield case of the motor. The second connector portion 3 electrically connected to the inverter is fitted to the first connector portion 2, thereby electrically connecting the

6

motor to the inverter. The above is the connection on the motor side, and the connection on the inverter side is the same.

Each configuration of the connector portions 2 and 3 will be described in detail below.

As shown in FIG. 4, in the first connector portion 2, three first connecting terminals 4a-4c are aligned and held at predetermined intervals, and the first terminal housing 5 housing the three aligned first connecting terminals 4a-4c and the connecting member 9 for collectively fixing and electrically connecting the plural first connecting terminals 4a-4c to the plural second connecting terminals 6a-6c at each contact point by pressing the adjacent insulator 8a are provided.

As a terminal housing, the first terminal housing 5 may be either male (a male terminal housing) or female (a female terminal housing). Here, the case where the first terminal housing 5 is a male terminal housing will be explained as an example.

The first connecting terminals 4a-4c are plate-like terminals, are formed of non-conductive resin (e.g., PPS (polyphenylene sulfide) resin, PPA (polyphthalamide) resin, PA (polyamide) resin, PBT (polybutylene terephthalate) and epoxy-based resin), and are aligned and held at predetermined intervals in a first inner housing 10 which is housed in the first terminal housing 5 and is formed of a resin molded body. The method of holding the first connecting terminals 4a-4c in the first inner housing 10 includes a holding method in which the first connecting terminals 4a-4c are inserted at the time of forming the first inner housing 10 and a resin is subsequently cured, and a holding method in which the first connecting terminals 4a-4c are pressed into the preliminarily formed first inner housing 10.

In addition, each of the first connecting terminals 4a-4c is integrally fixed to the first insulating members 43a-45a which are adjacently arranged on the other surface side (a surface opposite to the surface connected to the second connecting terminals 6a-6c). That is, as mentioned above, the first inner housing 10 holds the first connecting terminals 4a-4c aligned at predetermined intervals and the first insulating members 43a-45a are integrally fixed at the end of the held first connecting terminals 4a-4c, and as a result, the first insulating members 43a-45a are also aligned at predetermined intervals. Such a configuration ensures insulation between each contact point and insertability of the second connecting terminals 6a-6c for the fitting.

Note that, it is not necessary to physically fix the first insulating members 43a-45a to the first connecting terminals 4a-4c, and it is enough if a positional relationship between the first insulating members 43a-45a and the first connecting terminals 4a-4c is fixed. The positional relationship between the first insulating members 43a-45a and the first connecting terminals 4a-4c is fixed by, e.g., integrally forming the first insulating members 43a-45a with the first inner housing 10. As described above, it is possible to cut the number of components and processes for forming the components by integrally forming the first insulating members 43a-45a with the first inner housing 10, thereby further reducing the manufacturing cost.

Electricity of different voltage and/or current is fed to each of the first connecting terminals 4a-4c. For example, the present invention assumes the use of a three-phase AC power line between a motor and an inverter, and alternate current different by 120 degrees in phase is fed to each of the first connecting terminals 4a-4c. Each of the first connecting terminals 4a-4c should be formed of a highly conductive metal such as silver, copper or aluminum for reducing the electric

power transmission loss, etc., in the connector 1. In addition, each of the first connecting terminals 4a-4c has little flexibility.

The first insulating members 43a-45a are positioned and fixed so as to protrude on the front end side of the first connecting terminals 4a-4c. A corner of each of the first insulating members 43a-45a on a side to insert and extract the second connecting terminals 6a-6c is chamfered. In addition, a fitting groove 11 for fitting the first connecting terminals 4a-4c to be fixed is formed on the first insulating members 43a-45a as shown in FIG. 5A. The first connecting terminals 4a-4c to be fixed are fitted and integrally fixed to the fitting groove 11. As a result, the end surface of the first connecting terminals 4a-4c on the front end side in the fixing direction is covered, a level difference between the first insulating members 43a-45a and the first connecting terminals 4a-4c is filled, and a back surface of the first insulating members 43a-45a (a lower surface in the drawing) is thereby flush with the back surface of the first connecting terminals 4a-4c (a lower surface in the drawing). These configurations improve the insertion and extraction properties of the second connecting terminals 6a-6c into and from the first connecting terminals 4a-4c since the second connecting terminals 6a-6c do not contact with the end surface of the first connecting terminals 4a-4c when the first connector portion 2 is fitted to the second connector portion 3. It should be noted that, in FIG. 5A, the structure of the first insulating member 43a is simplified and the first insulating members 43a-45a are illustrated in the same figure.

Meanwhile, a fitting groove 55 is formed on the upper surfaces of the first insulating members 44a-46a as shown in FIG. 5B. The fitting groove 55 is formed in a substantially triangular shape of which groove width increases toward the front end side in the fitting direction. Furthermore, a necked portion 56, at which a groove width increase rate changes, is formed on a rear end side of the fitting groove 55 in the fitting direction. In detail, it is formed such that the groove width increase rate on the front end side in the fitting direction is larger than the rear end side in the fitting direction across the necked portion 56. In other words, the fitting groove 55 has a shape which is narrowed on the rear end side in the fitting direction. It should be noted that the first insulating members 44a-46a are illustrated in the same figure in FIG. 5B for convenience of explaining the fitting groove 55 even though a second connecting terminal is not to be connected to the first insulating member 46a.

Referring once again to FIG. 4, the connecting member 9 is metal (e.g., SUS, iron and a copper alloy, etc.), and is a non-through type connecting member formed of a head portion which has a large diameter portion 9a and a small diameter portion 9b integrally formed with the large diameter portion 9a.

A packing 14 for preventing water from entering into the first terminal housing 5 is provided on the outer periphery of the large diameter portion 9a.

A male screw 48, which is joined together with a female screw 47 formed on an inner peripheral surface of a connecting member insertion hole 26 of the first terminal housing 5, is formed on an outer periphery of the small diameter portion 9b. Such a configuration makes the connecting member 9 press the insulator 8a adjacent thereto by screwing together with the first terminal housing 5.

An irregular shaped hole 49 (a hexagonal hole in FIG. 4A) is formed on the upper surface of the large diameter portion 9a, and the connecting member 9 can be rotated and tightened by fitting a tightening tool such as a spanner to the irregular shaped hole 49.

Meanwhile, the connecting member 9 is formed in a shape having two outer diameter dimensions, one of which is the large diameter portion 9a provided with the packing 14 and another of which is the small diameter portion 9b having the male screw 48 formed thereon, and the connecting member insertion hole 26 is formed in a shape which matches the shape having two outer diameter dimensions. An effective waterproof structure can be realized by such a configuration, i.e., by not arranging the male screw 48 at a portion facing the packing 14 when the connecting member 9 is tightened against the connecting member insertion hole 26.

In addition, the connecting member 9 has a hollow portion 50 which opens in the first terminal housing 5 and houses an elastic member 15 for imparting a predetermined pressing force to the insulator 8a. The elastic member 15 is composed of, e.g., a spring formed of metal (e.g., SUS, etc.). The elastic member 15 is regarded as a portion of the connecting member 9 in the present embodiment.

A concave portion 16 for covering (housing) a portion of the elastic member 15 is formed on the upper surface of the insulator 8a with which the elastic member 15 is partially in contact, and a receiving member 17 formed of metal (e.g., SUS, etc.) for preventing the insulator 8a formed of a non-conductive resin from being damaged by receiving the elastic member 15 is provided on a bottom of the concave portion 16 (i.e., a seat portion with which the elastic member 15 is partially in contact).

The receiving member 17 prevents damage of the insulator 8a by dispersing stress applied from the elastic member 15 to the upper surface of the insulator 8a. Therefore, a contact area between the receiving member 17 and the insulator 8a is preferably as large as possible. The receiving member 17 having a shape in contact throughout the entire surface of the bottom of the concave portion 16 is provided in the present embodiment in order to increase the contact surface between the receiving member 17 and the insulator 8a.

The connecting member 9 is inserted into the first terminal housing 5 from a side of the surfaces of the first connecting terminals 4a-4c on which the first insulating members 43a-45a are fixed (from an upper side in FIG. 4) and the male screw 48 formed on the small diameter portion 9b is then joined together with the female screw 47 formed on the connecting member insertion hole 26, which results in that the plural first connecting terminals 4a-4c and the plural second connecting terminals 6a-6c are collectively fixed and electrically connected at each contact point by pressure in an insertion direction of the connecting member 9 (from the upper side to the lower side in FIG. 4).

The first terminal housing 5 is formed of a hollow cylindrical body 20 having a substantially rectangular shaped horizontal cross-section. An outer periphery of one side (on the right side in the drawing) of the cylindrical body 20 which is fitted to the second terminal housing 7 is formed in a tapered shape in light of fitting properties to the second connector portion 3. Meanwhile, a rib 12 for stabilizing the fitting direction when fitted to the second terminal housing 7 as well as for fixation and stabilization after fitting is formed on the outer peripheral portion of the cylindrical body 20. In addition, a terminal housing waterproof structure 21 for sealing between the first connector portion 2 and the second connector portion 3 is provided on the outer peripheral portion of the one side of the cylindrical body 20. The terminal housing waterproof structure 21 is composed of a concave portion 22 formed on the outer peripheral portion of the cylindrical body 20 on the opening side and a packing 23 such as an O-ring provided on the concave portion 22.

The first inner housing 10 in which the first connecting terminals 4a-4c are each aligned and held is housed in the cylindrical body 20 on the other side (on the left side in the drawing). A flange 24 for fixing the first connector portion 2 to a housing of a device, etc., (e.g., a shield case of a motor) is formed on an outer periphery of the other side of the cylindrical body 20. A packing, etc., for sealing between the housing of the device, etc., and the first connector portion 2 may be provided on a peripheral edge portion 25 of the flange 24 which is used for fixation to the housing of the device, etc., by inserting a bolt into a mounting hole 24a. The configuration of the flange 24 is not based on the premise that the first connector portion 2 is fixed to a housing of a device, etc., and the flange 24 may be alternatively provided on the second connector portion 3 or on both of the first connector portion 2 and the second connector portion 3. In addition, it may be in a free state in which neither the first connector portion 2 nor the second connector portion 3 is fixed to a housing of a device, etc.

Meanwhile, the flange 24 is effective to improve heat dissipation. That is, a surface area of the first terminal housing 5 can be increased by forming the flange 24, and it is thus possible to improve the heat dissipation when heat generated inside the first connector portion 2 (e.g., heat generated at each contact point) is released to the outside through the first terminal housing 5.

The connecting member insertion hole 26 for inserting the connecting member 9 therethrough is formed on the upper portion (on the upper side in the drawing) of the cylindrical body 20. The connecting member insertion hole 26 is formed in a cylindrical shape and a diameter of a lower end portion thereof (on the lower side in the drawing) is reduced so as to match the shape of the connecting member 9. The reduced diameter portion contacts with the peripheral edge portion on the lower surface of the large diameter portion 9a of the connecting member 9, thereby restricting a stroke of the connecting member 9.

For shielding performance, heat dissipation and weight saving of the connector 1, the cylindrical body 20 is preferably formed of light metal having high electrical and thermal conductivity such as aluminum, but may be formed of resin. When the first terminal housing 5 is formed of a non-conductive resin, the first insulating member 46a and the first terminal housing 5 may be integrally molded by the non-conductive resin. In the present embodiment, the cylindrical body 20 is formed of aluminum. By forming the cylindrical body 20 from aluminum as just described, there is an effect that the connecting member 9 can be tightened firmly to the connecting member insertion hole 26 when joined together as compared to the case where the cylindrical body 20 is formed of an insulating resin.

In the present embodiment, since a clearance between the laminated structure and the first terminal housing 5 is designed to be as small as possible in order to downsize the connector 1, it is necessary to ensure insulation between the first terminal housing 5 and the first connecting terminals 4a-4c to prevent electrical short circuit of the first connecting terminals 4a-4c via the metallic first terminal housing 5.

Therefore, in the present embodiment, electricity shields 51 are provided on both sides of the first inner housing 10 in which the first connecting terminals 4a-4c are aligned and held.

Besides the effect of ensuring the insulation, the electricity shield 51 has a function of touch protection for preventing a foreign object such as a hand or a finger from touching the side surfaces of the first connecting terminals 4a-4c. In other words, the electricity shield 51 provides the effect of ensuring

the insulation between the first terminal housing 5 and the first connecting terminals 4a-4c when the clearance between the laminated structure and the first terminal housing 5 is configured to be small in the extent that a hand or finger does not get in, and provides the effect of preventing the hand or finger from touching the side surfaces of the first connecting terminals 4a-4c in a non-fitted state while still having some function of ensuring the insulation when the clearance is configured to be large such that a hand or a finger gets in.

Alternatively, the first insulating members 43a-45a may be formed so as to cover also the side surfaces of the first connecting terminals 4a-4c, instead of providing the electricity shield 51.

Since it is considered that most of workers who manipulate the connector are adult men, a standard size of a hand or finger of a worker in the present embodiment is that of adult man. In this regard, however, this standard can be, of course, appropriately changes depending on the assumed worker.

As shown in FIG. 6, the second connector portion 3 has the second terminal housing 7 in which plural (three) aligned second connecting terminals (female terminals) 6a-6c are housed. Here, a connector portion on a side having female terminals is referred to as the second connector portion 3. In other words, as a terminal housing, the second terminal housing 7 may be either male (a male terminal housing) or female (a female terminal housing). The case where the second terminal housing 7 is a female terminal housing which corresponds to the first terminal housing 5 as a male terminal housing will be explained here.

As shown in FIGS. 7 and 8, the second connecting terminals 6a-6c each have a caulking portion 32 for caulking a conductor 28 which is exposed at an end portion of cables 27a-27c and a plate-like contact point 33 integrally formed with the caulking portion 32. The end portion of the plate-like contact point 33 may be formed in a tapered shape in order to improve insertability.

The present embodiment is configured such that the cables 27a-27c are aligned and held with as little clearance as possible in order to downsize the connector 1. Therefore, a trunk portion 35 of the second connecting terminal 6b connected to the cable 27b which is arranged at the middle when aligned is bent as shown in FIG. 8 so that the second connecting terminals 6a-6c are arranged at equal intervals.

Each of the second connecting terminals 6a-6c should be formed of a highly conductive metal such as silver, copper or aluminum for transmission loss reduction, etc., in the connector 1. In addition, each of the second connecting terminals 6a-6c has little flexibility.

The cables 27a-27c extending from the inverter side are respectively connected to edges of the second connecting terminals 6a-6c. The cables 27a-27c are respectively electrically connected to the first connecting terminals 4a-4c via the second connecting terminals 6a-6c, and electricity of different voltage and/or current corresponding to each of the first connecting terminals 4a-4c is transmitted. The cables 27a-27c are each composed of the conductor 28 and an insulation layer 29 formed on the outer periphery thereof. The conductor 28 having a cross-sectional area of 20 mm² is used in the present embodiment.

The cables 27a-27c are each held by a cable supporting member 30 which is in a multi-cylindrical shape (contiguous plural cylinders). The cable supporting member 30 is formed of a non-conductive resin, etc., to prevent short circuit by insulating the second connecting terminals 6a-6c from each other. The cable supporting member 30 allows the second connecting terminals 6a-6c to be held at respective predetermined positions even though each of the cables 27a-27c

11

respectively connected to the second connecting terminals 6a-6c is very flexible. In other words, since a cable excellent in flexibility can be used as the cables 27a-27c in the present embodiment, it is possible to improve the wiring flexibility for laying the cables 27a-27c.

As shown in FIG. 9, a second inner housing 52 formed of a resin molded body in which the second connecting terminals 6a-6c connected to the cables 27a-27c are held so as to be arranged at predetermined intervals is fitted to the end of the cable supporting member 30 in the fitting direction. By the second inner housing 52, the second connecting terminals 6a-6c are respectively positioned and held under the first connecting terminals 4a-4c (i.e., objects to be connected) respectively facing the second connecting terminals 6a-6c so as to be respectively paired therewith when the first connector portion 2 is fitted to the second connector portion 3.

A holding method using insert molding, in the same manner as holding the first connecting terminals 4a-4c in the first inner housing 10, can be employed as a method of holding the second connecting terminals 6a-6c in the second inner housing 52.

However, unlike the case of first connecting terminals 4a-4c, the second connecting terminals 6a-6c are connected to the long cables 27a-27c and if the method in which the second connecting terminals 6a-6c are preliminarily held in the second inner housing 52 by the insert molding is employed, it is necessary to insert the second inner housing 52 from the rear end side of the cables 27a-27c to fit to the cable supporting member 30, which is cumbersome.

Therefore, in the present embodiment, after the ends of the cables 27a-27c are inserted into and held in the cable supporting member 30, the second inner housing 52 formed in a cap-like shape is fitted to the cable supporting member 30 so as to cover the second connecting terminals 6a-6c, thereby aligning and holding the second connecting terminals 6a-6c.

Meanwhile, a pawl portion 53 to be engaged with the cable supporting member 30 is formed on the second inner housing 52. The pawl portion 53 is engaged with an engaging portion 54 formed on the cable supporting member 30, and the second inner housing 52 is thereby fitted and subsequently fixed to the cable supporting member 30.

The second inner housing 52 is formed of a non-conductive resin, etc., and insulates the second connecting terminals 6a-6c from each other to prevent short-circuit.

Meanwhile, the second connecting terminals 6a-6c are integrally fixed to the respective second insulating members 43b-45b which are adjacently arranged on another surface thereof (a surface opposite to the surface connected to first connecting terminals 4a-4c). Fixation here means that a positional relationship between the second insulating members 43b-45b and the second connecting terminals 6a-6c is fixed, as mentioned previously. The second insulating members 43b-45b are integrally formed with the second inner housing 52 in the present embodiment. This allows the manufacturing cost to be reduced.

Meanwhile, the second insulating members 43b-45b are formed so as to cover not only the end surface of the second connecting terminals 6a-6c on the front end side in the fixing direction but also the side surface thereof. As a result, it is possible to ensure the insulation between the second connecting terminals 6a-6c and the metallic first terminal housing 5 when the first terminal housing 5 is fitted to the second terminal housing 7. The effect of touch protection is also obtained by covering the side surfaces of the second connecting terminals 6a-6c in the same manner as the electricity shield 51.

12

A convex portion 57 fitting to the fitting groove 55 is formed on the lower surfaces (surfaces on the lower side in FIG. 6) of the second insulating members 43b-45b. The convex portion 57 is formed so that a width thereof is reduced toward the front end side in the fitting direction to be fitted to the fitting groove 55 with substantially no clearance and that the shape of the convex portion 57 is substantially the same as that of the fitting groove 55.

A braided shield 31 is wound around portions of the cables 27a-27c which are pulled out from the second terminal housing 7 in order to improve the shielding performance. The braided shield 31 is in contact with the below-described cylindrical shield body 41, and is electrically connected to the first terminal housing 5 via the cylindrical shield body 41 (the same potential (GND)). It should be noted that the braided shield 31 is not shown in FIGS. 1 and 2 for simplification.

Referring once again to FIG. 6, the second terminal housing 7 is composed of a hollow cylindrical body 36 having a substantially rectangular horizontal cross section. Since the first terminal housing 5 is fitted in the second terminal housing 7, an inner peripheral portion of the cylindrical body 36 on one side (on the left side in the drawing) to be fitted to the first terminal housing 5 is formed in a tapered shape in light of fitting properties to the first terminal housing 5. Meanwhile, a fixing guide portion 13, by which the rib 12 formed on the cylindrical body 20 composing the first terminal housing 5 is received and guided to be fitted and fixed, is formed on the outer peripheral portion of the cylindrical body 36. The first terminal housing 5 is housed in and fitted to the second terminal housing 7 while the rib 12 is guided by the fixing guide portion 13, which allows smooth fitting, firm fixation after the fitting and prevention of looseness in fitting due to vibration.

Alternatively, the second terminal housing 7 may be configured to be fixed in the first terminal housing 5 in an opposite manner. In this case, the inner peripheral portion of one end of the cylindrical body 20 composing the first terminal housing 5 is formed in a tapered shape, the outer peripheral portion of one end of the cylindrical body 36 composing the second terminal housing 7 is formed in a tapered shape, and the terminal housing waterproof structure 21 is formed on the outer peripheral portion of the one end of the cylindrical body 36.

The cable supporting member 30 having cables 27a-27c aligned and held therein is housed in the cylindrical body 36 on the other end side (on the right side in the drawing). A non-packing airtight portion 37 is formed on the cable supporting member 30 on a cable insertion side to prevent water from trickling down through the cables 27a-27c and entering into the second terminal housing 7. A packing 38 in contact with an inner peripheral surface of the first terminal housing 5 is provided between the cable supporting member 30 and the second inner housing 52 on the outer peripheral portion of the cable supporting member 30. That is, the connector 1 has a double waterproof structure composed of the packing 23 of the terminal housing waterproof structure 21 and the packing 38 provided on the outer peripheral portion of the cable supporting member 30.

Furthermore, the outer periphery of the cylindrical body 36 on the other end side from where the cables 27a-27c are led out is covered by a rubber boot 39 for preventing water from entering into the cylindrical body 36. It should be noted that the rubber boot 39 is not shown in FIGS. 1 and 2 for simplification.

A connecting member manipulating hole 40, through which the connecting member 9 provided on the first connector portion 2 is manipulated when the second connector por-

13

tion 3 is fitted to the first connector portion 2, is formed on an upper portion of the cylindrical body 36 (on the upper side in the drawing). The connecting member manipulating hole 40 also serves as a through-hole for making the connecting member 9 insertable into and extractable from the first terminal housing 5 after the first terminal housing 5 is fitted to the second terminal housing 7. The function as the through-hole allows easy assembly and maintenance of the connector 1, and provides an effect of good usability. The connecting member 9 can be pulled out through the connecting member manipulating hole 40 to repair or replace the packing 14 without detaching the second connector portion 3 from the first connector portion 2 even if, e.g., the packing 14 provided on the connecting member 9 has to be replaced due to corrosion caused by deterioration with time.

For shielding performance, heat dissipation and weight saving of the connector 1, the cylindrical body 36 is preferably formed of light metal having high electrical and thermal conductivity such as aluminum, but may be formed of resin. Since the cylindrical body 36 is formed of a non-conductive resin in the present embodiment, the aluminum cylindrical shield body 41 is provided on an inner peripheral surface of the cylindrical body 36 on the other end side in order to improve the shielding performance and the heat dissipation.

The cylindrical shield body 41 has a contact portion 42 which comes in contact with an outer periphery of the aluminum first terminal housing 5 when the first connector portion 2 is fitted to the second connector portion 3, and the cylindrical shield body 41 and the first terminal housing 5 are thermally and electrically connected via the contact portion 42. This improves the shielding performance and the heat dissipation. Significant improvement is expected particularly in the heat dissipation by actively releasing heat to the first terminal housing 5 which is excellent in heat dissipation.

Connection between the first connecting terminals 4a-4c and the second connecting terminals 6a-6c using the connector 1 of the present embodiment will be described below.

When the first connector portion 2 is fitted to the second connector portion 3, the second connecting terminals 6a-6c and the second insulating members 43b-45b are respectively inserted into gaps between the first connecting terminals 4a-4c and the first insulating members 43a-46a which are paired therewith. The insertion provides a laminated structure in which one surface of each of the plural first connecting terminals 4a-4c faces one surface of each of the plural second connecting terminals 6a-6c so as to be paired, and the first connecting terminals 4a-4c and the second connecting terminals 6a-6c and the insulators 8a-8d formed by overlapping the first insulating members 43a-46a with the second insulating members 43b-45b are alternately arranged.

Since both of the fitting groove 55 and the convex portion 57 are formed in a substantially triangular shape, the fitting groove 55 is gradually fitted into the convex portion 57 in this process as the first terminal housing 5 is being fitted to the second terminal housing 7. That is, at an early stage of the fitting operation, a small width portion of the convex portion 57 on the front end side in the fitting direction thereof is inserted into a large groove width portion of the fitting groove 55 on the front end side in the fitting direction thereof and a clearance between the fitting groove 55 and the convex portion 57 is large, which allows the first insulating members 44a-46a and the second insulating members 43b-45b to move freely with respect to one another, and at a late stage of the fitting operation, the clearance between the fitting groove 55 and the convex portion 57 is gradually reduced which results

14

in that the first insulating members 44a-46a and the second insulating members 43b-45b cannot move with respect to one another and are being fixed.

In the present embodiment, particularly, since the necked portion 56 is formed in the fitting groove 55 on the rear end side in the fitting direction so that the convex portion 57 is fitted to the fitting groove 55 without clearance, a width difference between the fitting groove 55 on the front end side in the fitting direction thereof and the convex portion 57 on the front end side in the fitting direction thereof can be increased at the early stage of the fitting operation as compared to the case where the fitting groove 55 and the convex portion 57 are formed in a simple triangular shape without necked portion. As a result, the first insulating members 44a-46a and the second insulating members 43b-45b can move more freely at the early stage of the fitting operation and it is possible to ensure sufficient insertability of the first connecting terminals 4a-4c into the second connecting terminals 6a-6c. At the late stage of the fitting operation, the convex portion 57 can be securely held at the necked portion 56 of the fitting groove 55 and the first insulating members 44a-46a are firmly fixed to the second insulating members 43b-45b.

At this time, in the first connector portion 2, the first insulating members 43a-46a and the second insulating members 43b-45b which compose the insulators 8a-8d are respectively fixed to the ends of the first connecting terminals 4a-4c and the second connecting terminals 6a-6c aligned and held at predetermined intervals and to the first terminal housing 5, each gap between the insulators 8a-8d can be kept without additionally providing a retention jig for keeping gaps between the insulators 8a-8d. This makes easy to respectively insert the second connecting terminals 6a-6c and the second insulating members 43b-45b into gaps between first connecting terminals 4a-4c and first insulating members 43a-46a which are respectively paired therewith. In other words, the insertion and extraction properties of the second connecting terminals 6a-6c are not degraded. In addition, it is very effective in that it is possible to realize further downsizing as compared to the conventional art since it is not necessary to provide a retaining jig for keeping the gaps between the insulators 8a-8d.

Meanwhile, a contact point between the first connecting terminal 4a (or 4b) and the second connecting terminal 6a (or 6b) is sandwiched between the insulator 8a (or 8b) and the insulator 8b (or 8c). Likewise, a contact point between the first connecting terminal 4c and the second connecting terminal 6c is sandwiched between the insulator 8c and the insulator 8d.

After that, as shown in FIG. 3, when the male screw 48 of the connecting member 9 and the female screw 47 of the first terminal housing 5 are joined together and tightened by manipulating the connecting member 9 through the connecting member manipulating hole 40, the connecting member 9 is turned and pushed into the first terminal housing 5, and then, the insulator 8a, the insulator 8b, the insulator 8c and the insulator 8d are pressed in this order by the elastic member 15 so that any two of the insulators 8a-8d sandwich each contact point and come in contact therewith in a state that the contact points are insulated from each other. At this time, the first connecting terminals 4a-4c and the second connecting terminals 6a-6c are bent in some degree due to pressure from the insulators 8a-8d and respectively make contact in a large area. As a result, it is possible to realize a connector which is effective particularly for a vehicle in which vibration is likely to occur.

In sum, as described above, in the connector 1 of the present embodiment, since the fitting groove 55 is formed on

15

one of facing surfaces of the first insulating member 44a (or 45a or 46a) and the second insulating member 43b (or 44b or 45b) which face each other when the two divided insulators (the first insulating members 44a-46a and the second insulating members 43b-45b) are overlapped and the convex portion 57 fitted to the fitting groove 55 is formed on the another facing surface, it is possible to restrict movement of each insulating member and to suppress abrasion due to fine sliding at the contact points while ensuring insertability between connecting terminals when the connector is fitted even if a non-through type connecting member is employed.

Additionally, in the connector 1, since the insulators 8a-8d for insulating each contact point are composed of two divided insulators, the first insulating members 43a-46a and the second insulating members 43b-45b, which are respectively fixed to the other surfaces of the first connecting terminals 4a-4c and the second connecting terminals 6a-6c, not only the first connecting terminals 4a-4c but also the second connecting terminals 6a-6c are not exposed in the non-fitted state and it is thereby possible to prevent unintentional contact and electric shock to a foreign object such as a hand or finger of a worker, etc.

In addition, in the connector 1 of the present embodiment, the insulators 8a-8d having a predetermined thickness are formed by the overlap of the first insulating members 43a-46a and the second insulating members 43b-45b when the first terminal housing 5 is fitted to the second terminal housing 7. In other words, the insulators 8a-8d are formed in a thickness necessary and sufficient for insulation between terminals or between each terminal and the first terminal housing 5. Therefore, a lamination thickness of the laminated structure composed of the respective contact point and the insulators 8a-8d does not become unintentionally large.

Although the thicknesses of the first insulating members 43a-46a are substantially the same as those of the second insulating members 43b-45b in the present embodiment, the thicknesses may be different. That is, for example, the second insulating members 43b-45b may be formed thinner than the first insulating members 43a-46a to improve flexibility of the second connecting terminals 6a-6c to which the second insulating members 43b-45b are fixed. In other words, the invention is applicable not only to a connector aiming to downsize but also to a conventional connector.

It should be noted that the present invention is not intended to be limited to the above-mentioned embodiments, and the various kinds of embodiments can be implemented without departing from the gist of the present invention.

In the present embodiment, for example, the fitting groove 55 is formed on the first insulating members 44a-46a and the convex portion 57 is formed on the second insulating members 43b-45b, however, it may be configured such that the convex portion 57 is formed on the first insulating members 44a-46a and the fitting groove 55 is formed on the second insulating members 43b-45b.

In addition, although the insulators 8a-8d are each divided in the present embodiment, the invention is applicable to a connector 100 using insulators 8a-8d which are each one-piece and not divided, as shown in FIG. 10. In this case, for example, the insulators 8a-8d are fixed to the first connecting terminals 4a-4c and to the inner surface of the first terminal housing 5, a fitting groove 58 is formed on each of the insulators 8a-8d, a convex portion 59 is formed on another surface of each of the second connecting terminals 6a-6c which faces the fitting groove 58, and the same effect as the connector 1 is thereby obtained.

In addition, as shown in FIG. 12, a protruding engaging portion 60 may be formed on a surface of the convex portion

16

57 while an engaging hole 61 to be engaged with the engaging portion 60 is formed on a bottom surface of the fitting groove 55. This prevents fine sliding in the fitting direction.

Meanwhile, the present embodiment assumes the use of a three-phase AC power line, however, according to the technical idea of the invention, it may be, e.g., a connector for a vehicle which is configured to collectively connect lines used for different purposes such as a three-phase AC power line between a motor and a vehicle and a two-phase DC power line for air conditioner. Since the configuration described above allows one connector to collectively connect power lines used for different purposes, it is not necessary to prepare different connectors for each intended purpose and it is thus possible to contribute to space saving and cost reduction.

In addition, although the first connecting terminals 4a-4c are respectively in surface-to-surface contact with the second connecting terminals 6a-6c in the present embodiment, it may be configured that a protruding portion is each formed on surfaces of the first connecting terminals 4a-4c which are the contact side surface and are in contact with the second connecting terminals 6a-6c, and the protruding portion is fitted to the plate-like contact point 33 of the second connecting terminals 6a-6c. Each combining force between the first connecting terminals 4a-4c and the second connecting terminals 6a-6c can be more stabilized by the above-mentioned configuration. That is, it is particularly effective against vibration in a direction perpendicular to the connecting member 9.

Alternatively, terminal surfaces of the first connecting terminals 4a-4c and the second connecting terminals 6a-6c may be each roughened by a knurling process to increase frictional force so as to make the terminals difficult to move, thereby strengthening the fixation at each contact point.

Meanwhile, although the first connecting terminals 4a-4c are linearly in contact with the second connecting terminals 6a-6c when viewed from the large diameter portion 9a side of the connecting member 9 in the present embodiment, the first terminal housing 5 and the second terminal housing 7 may be configured so that the first connecting terminals 4a-4c of the first connector portion 2 respectively in contact with the second connecting terminals 6a-6c of the second connector portion 3 are crossed at a right angle when viewed from the large diameter portion 9a side of the connecting member 9. In other words, the first connector portion 2 and the second connector portion 3 may be fitted in an L-shaped manner. Likewise, it is possible to configure so that the second terminal housing 7 and the second connecting terminals 6a-6c are arranged obliquely with respect to the first terminal housing 5 and the first connecting terminals 4a-4c. By applying the aspect of the invention as described above, the insertion and extraction direction of the second connector portion 3 into and from the first connector portion 2 can be diversified. In other words, a direction of leading a cable from a connector can be adjusted to a desired direction, thereby contributing to space saving.

In addition, the case where a cable is not connected to one end of the first connecting terminals 4a-4c, unlike the second connecting terminals 6a-6c, has been described in the present embodiment, it is not limited to such a structure. That is, the connector of the present embodiment can be used for connecting between cables.

In addition, although a cable excellent in flexibility is used as the cables 27a-27c in the present embodiment, a rigid cable may be used.

In addition, the connecting member 9 having the irregular shaped hole 49 has been explained as an example in the present embodiment, the configuration of the connecting member 9 is not intended to be limited to the form in which the irregular shaped hole 49 is formed, and, for example, a

17

stem of a CPA (Connector Position Assurance) lever for securing the fitting of the first connector portion 2 and the second connector portion 3 may be configured as the connecting member 9 so that the fitting is secured by rotating the CPA lever and the connecting member 9 is pressed (or tightened) toward the first terminal housing 5.

In addition, although the connecting member 9 in which the irregular shaped hole 49 for fitting a hexagonal wrench (also called hexagonal spanner) is formed on the upper surface of the large diameter portion 9a is used in the present embodiment under an assumption of using a commercially available hexagonal wrench, it may be configured such that an irregular shaped hole 49 in a shape corresponding to that of a specialized tool is formed on the upper surface of the large diameter portion 9a under an assumption of using a specialized tool of which shape is not commercially available.

In addition, in the present embodiment, a direction of the connecting member 9 may be either horizontal or vertical when the connector is in use. In other words, a direction in a usage state is not a requirement in the use conditions of the connector of the present embodiment.

In addition, although the connecting member 9 presses the insulator 8a adjacent thereto via the elastic member 15 which is a portion of the connecting member 9 in the present embodiment, the adjacent insulator 8a may be pressed directly, not via the elastic member 15.

Note that, although it is mentioned that use of the connecting member 9 which is not the through type provides an effect of reducing the cost as compared to the case of using the through type connecting member 9, employing the non-through type connecting member 9 leads to weight saving of the connecting member 9, which can contribute to weight saving of the entire connector 1 as a result.

Although the invention has been described with respect to the specific embodiment for complete and clear disclosure, the appended claims are not to be therefore limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art which fairly fall within the basic teaching herein set forth.

What is claimed is:

1. A connector, comprising:

a first terminal housing for housing a plurality of aligned first connecting terminals;

a second terminal housing for housing a plurality of aligned second connecting terminals;

a laminated structure that one surface of each of the plurality of first connecting terminals is paired with one surface of each of the plurality of second connecting terminals to form a plurality of contact points when the first terminal housing is fitted to the second terminal housing and each contact point is arranged so as to be sandwiched by insulators having a predetermined thickness; and

a connecting member for collectively fixing and electrically connecting the plurality of first connecting terminals and the plurality of second connecting terminals at each contact point by pressing the insulator adjacent thereto,

wherein the insulator comprises a first insulating member that is one of two divided insulators formed by dividing the insulator, the first insulating member being formed so as to be fixed to another surface of the first connecting terminal adjacent thereto and to cover at least an end surface of the adjacent first connecting terminal on a front end side in a fitting direction, and a second insulating member that is another of the divided insulators, the second insulating member being formed so as to be

18

fixed to another surface of the second connecting terminal adjacent thereto and to cover at least an end surface of the adjacent second connecting terminal on a front end side in a fitting direction,

the two divided insulators overlap when the first terminal housing is fitted to the second terminal housing, thereby forming the insulator having a predetermined thickness, and

a fitting groove is formed on a facing surface of one of the first and second insulating members that face each other by the overlap of the two divided insulators, and a convex portion fitting to the fitting groove is formed on a facing surface of the other.

2. The connector according to claim 1, wherein a protruding engaging portion is formed on a surface of the convex portion, and

an engaging hole to be engaged with the engaging portion is formed on a bottom surface of the fitting groove.

3. The connector according to claim 1, wherein the fitting groove is formed in a triangular shape such that a groove width increases toward a front end side in a fitting direction, the convex portion is formed such that a width decreases toward the front end side in the fitting direction so as to be fitted to the triangular fitting groove, and the fitting groove is gradually fitted into the convex portion as the first terminal housing is being fitted to the second terminal housing.

4. The connector according to claim 3, wherein a protruding engaging portion is formed on a surface of the convex portion, and

an engaging hole to be engaged with the engaging portion is formed on a bottom surface of the fitting groove.

5. A connector, comprising:

a first terminal housing for housing a plurality of aligned first connecting terminals;

a second terminal housing for housing a plurality of aligned second connecting terminals;

a plurality of aligned insulators housed in the first terminal housing;

a laminated state that one surface of each of the plurality of first connecting terminals faces one surface of each of the plurality of second connecting terminals so as to be paired when the first terminal housing is fitted to the second terminal housing and the plurality of insulators are arranged so that each of a plurality of contact points formed by a plurality of facing first and second connecting terminals are sandwiched therebetween; and

a connecting member for collectively fixing and electrically connecting the plurality of first connecting terminals and the plurality of second connecting terminals at each contact point by pressing the insulator adjacent thereto is included,

wherein each of the plurality of first connecting terminals is integrally fixed to an insulator that is adjacently arranged on another surface, and

a fitting groove is formed on one of another surface of the second connecting terminal and a surface of the insulator that face each other at the time of fitting the first terminal housing to the second terminal housing, and a convex portion fitting to the fitting groove is formed on the other.

6. The connector according to claim 5, wherein a protruding engaging portion is formed on a surface of the convex portion, and

an engaging hole to be engaged with the engaging portion is formed on a bottom surface of the fitting groove.

19

7. The connector according to claim 5, wherein the fitting groove is formed in a triangular shape such that a groove width increases toward a front end side in a fitting direction, the convex portion is formed such that a width decreases toward the front end side in the fitting direction so as to be fitted to the triangular fitting groove, and the fitting groove is gradually fitted into the convex portion as the first terminal housing is being fitted to the second terminal housing.

20

8. The connector according to claim 7, wherein a protruding engaging portion is formed on a surface of the convex portion, and

an engaging hole to be engaged with the engaging portion is formed on a bottom surface of the fitting groove.

* * * * *



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(12) **United States Patent**
Wu

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(45) **Date of Patent:** **Jul. 1, 2003**

(54) **CABLE END CONNECTOR WITH LOCKING MEMBER**

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Taipei Hsien (TW)**

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(52) **U.S. Cl.** **439/358**

(58) **Field of Search** 439/358, 357,
439/352, 353, 606

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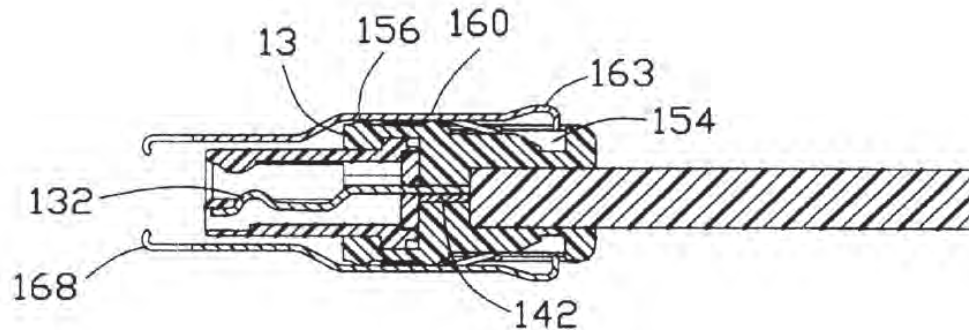
Primary Examiner—Tulsidas Patel

(74) *Attorney, Agent, or Firm*—Wei Te Chung

(57) **ABSTRACT**

A cable end connector (10) for mating with a complementary connector (20) comprises a housing (12), a plurality of contacts (132) mounted in the housing, a cable (14) having a plurality of conductors (142) electrically connecting the contacts, a cover (15) over-molded with and enclosing a rear end of the housing, and a locking member (16) mounted to the housing and the cover. The housing defines a retention portion (121) on an upper surface of the housing. The locking member has a main portion (160) abutting against a top surface of the cover, a latch portion (162) extending from the main portion and latching with the retention portion of the housing, and a locking portion (166) extending forwardly from the main portion to lock with the complementary connector for providing a mechanical connection therebetween.

22 Claims, 12 Drawing Sheets



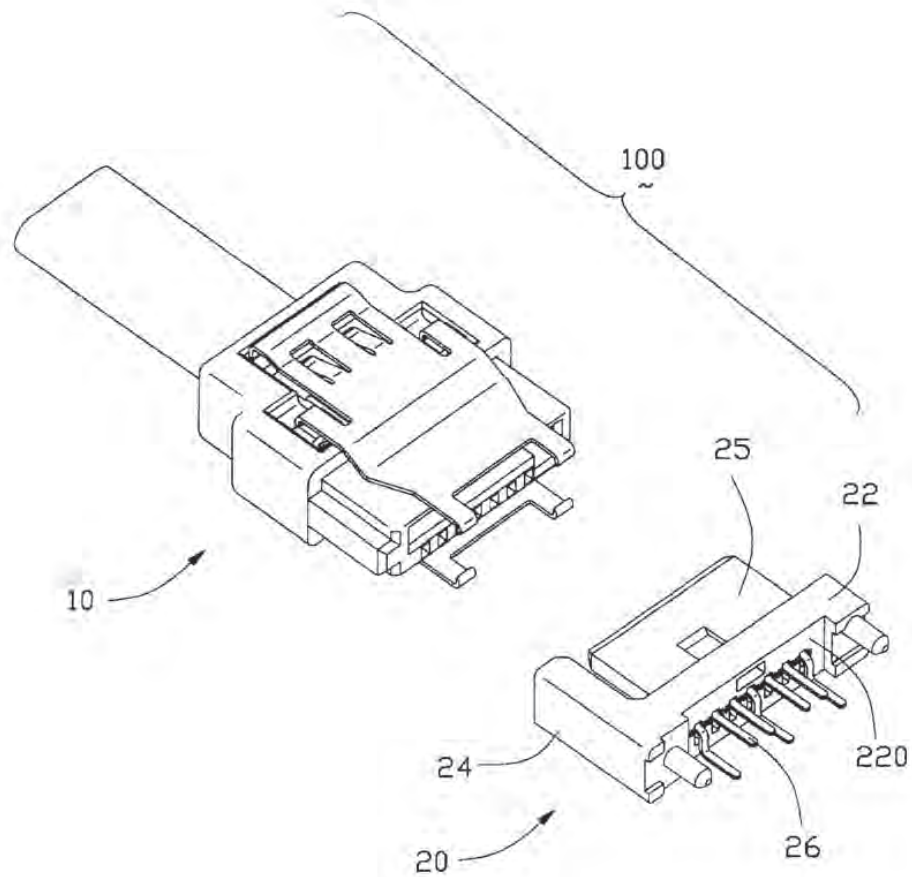
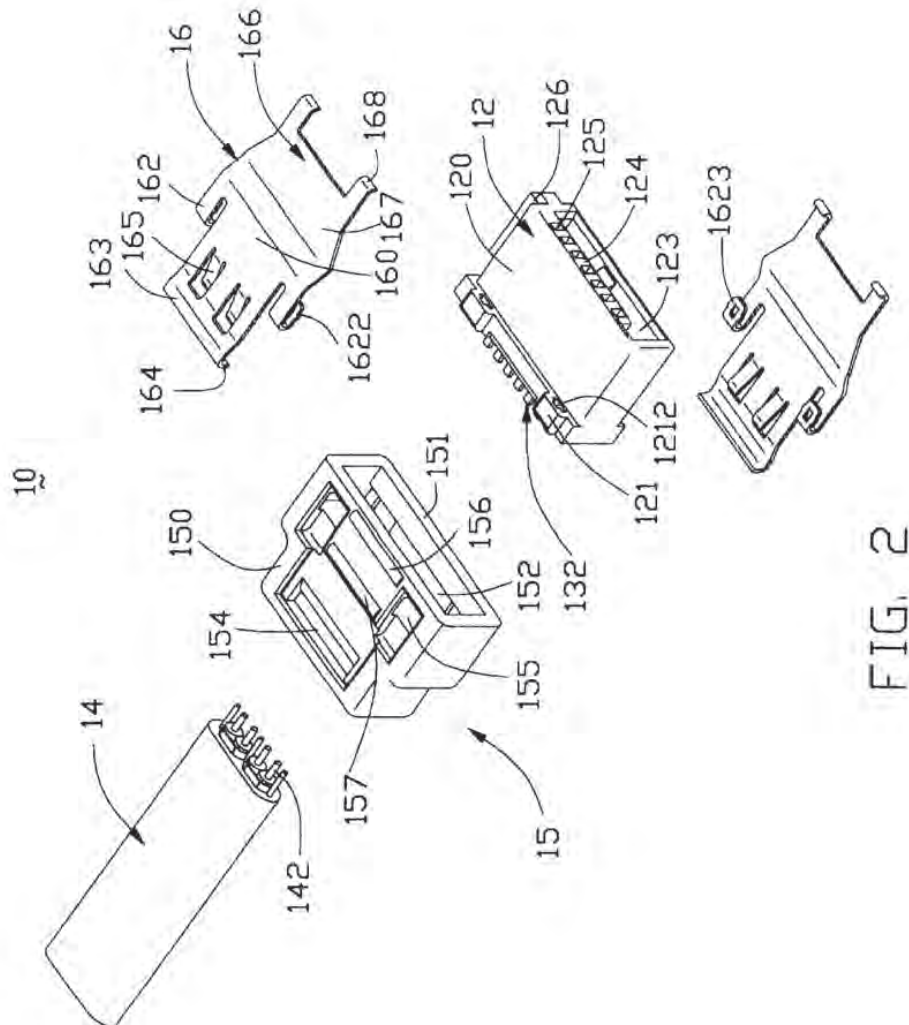


FIG. 1



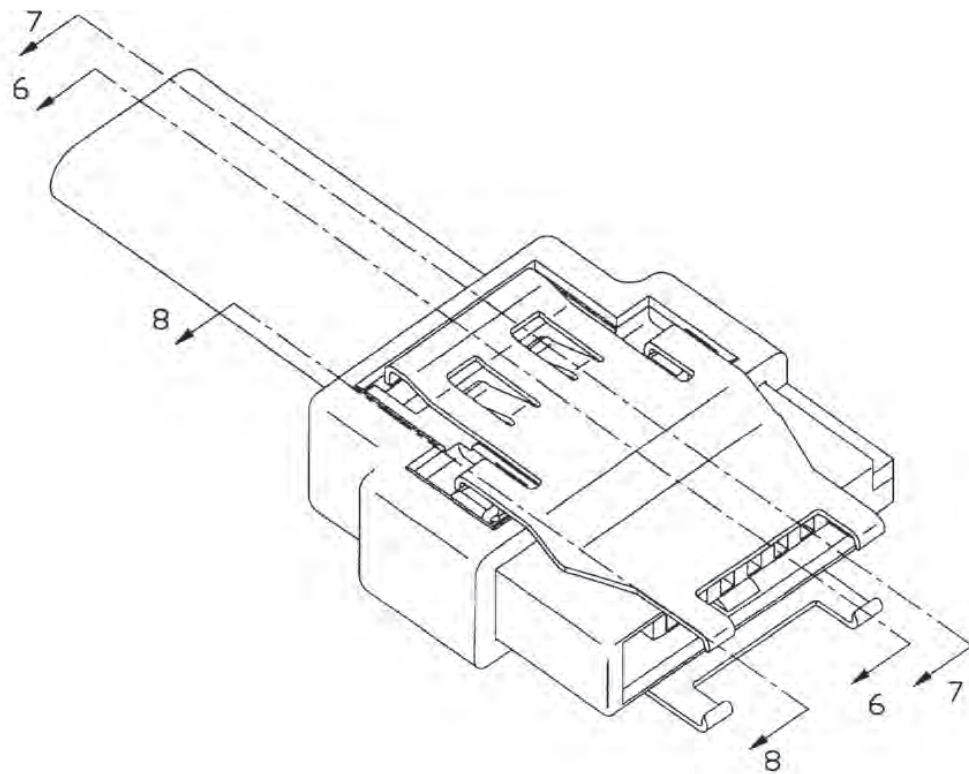


FIG. 4

10

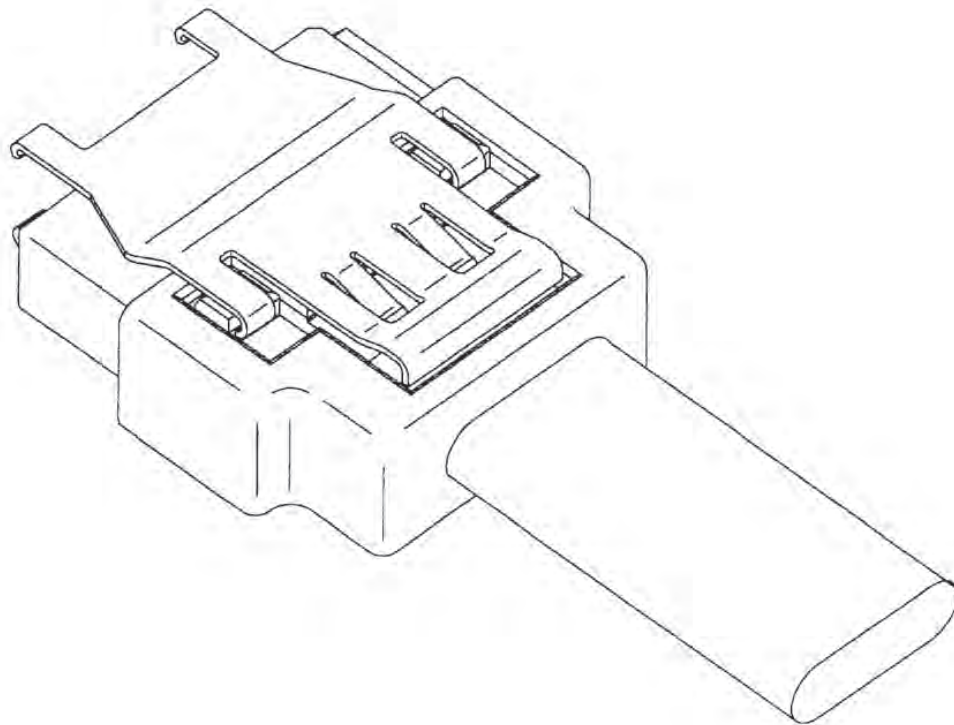


FIG. 5

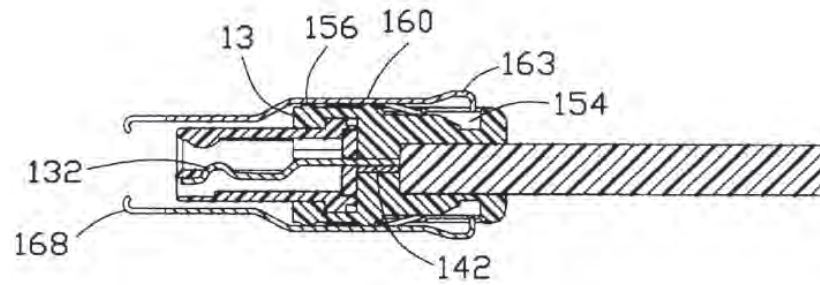


FIG. 6

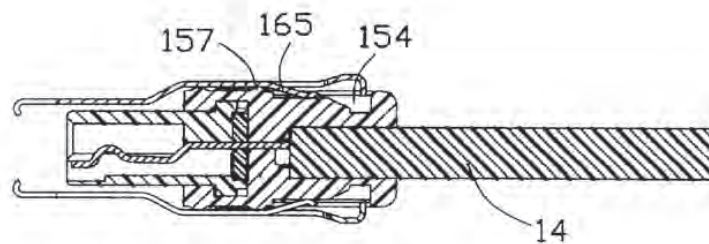


FIG. 7

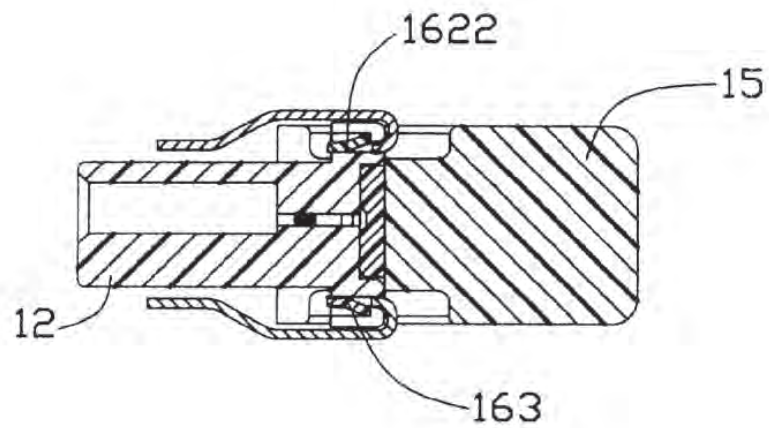


FIG. 8

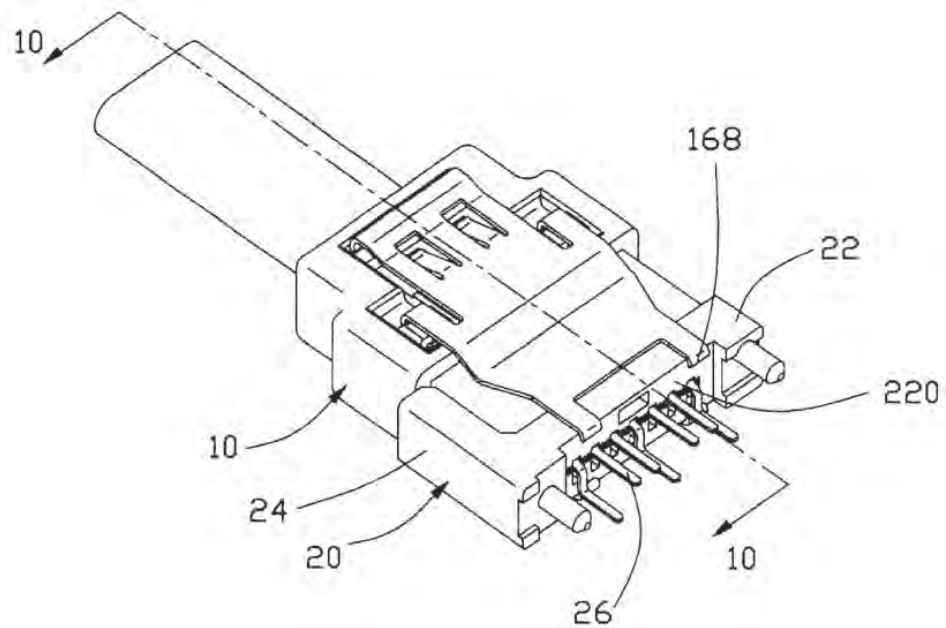


FIG. 9

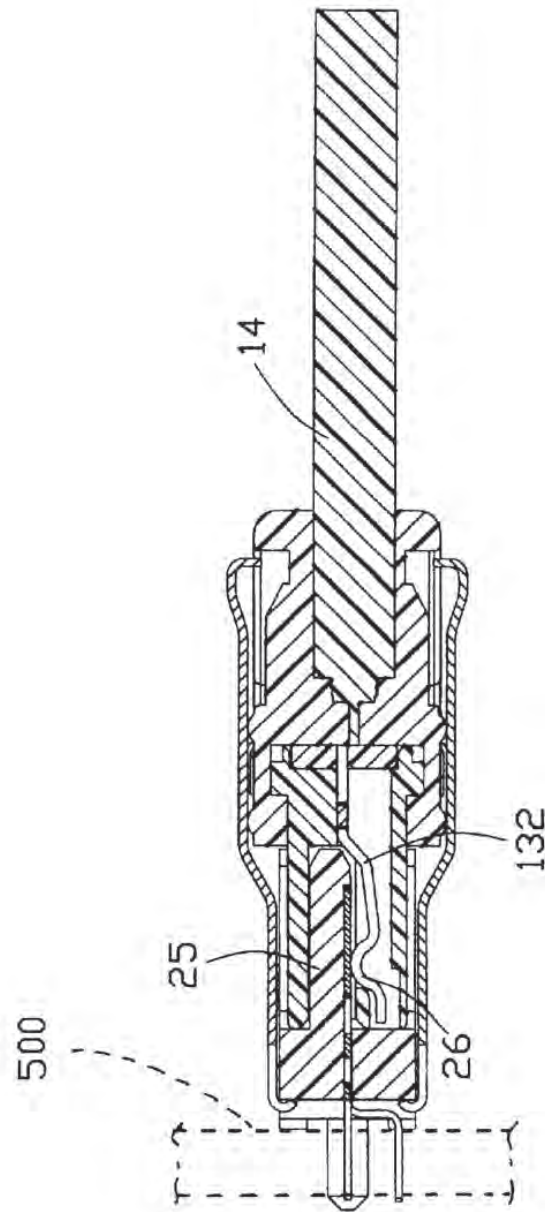


FIG. 10

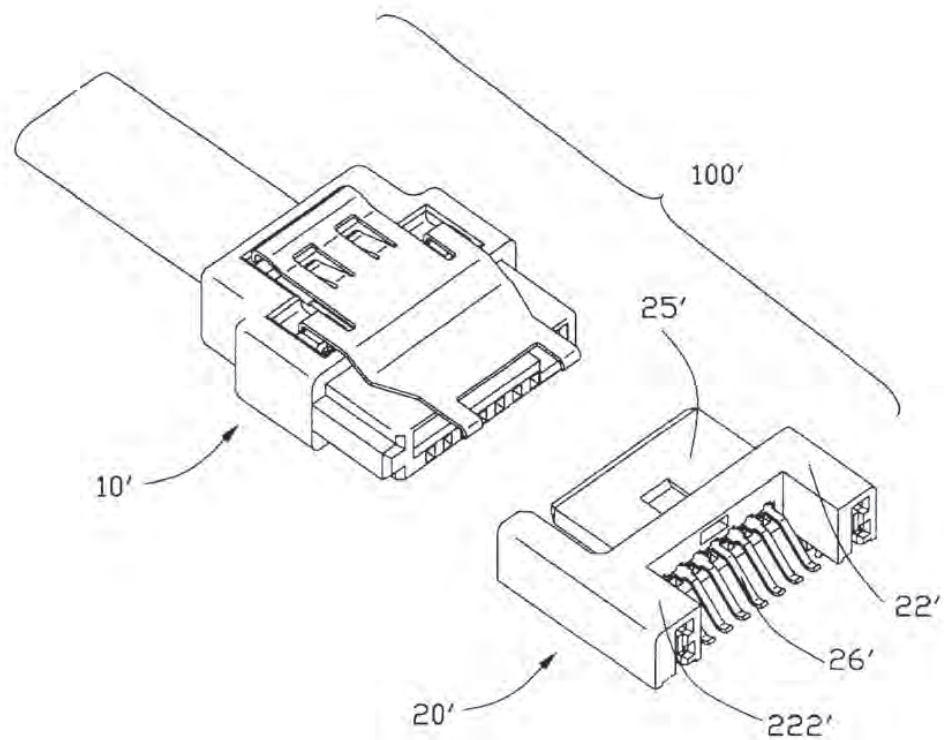


FIG. 11

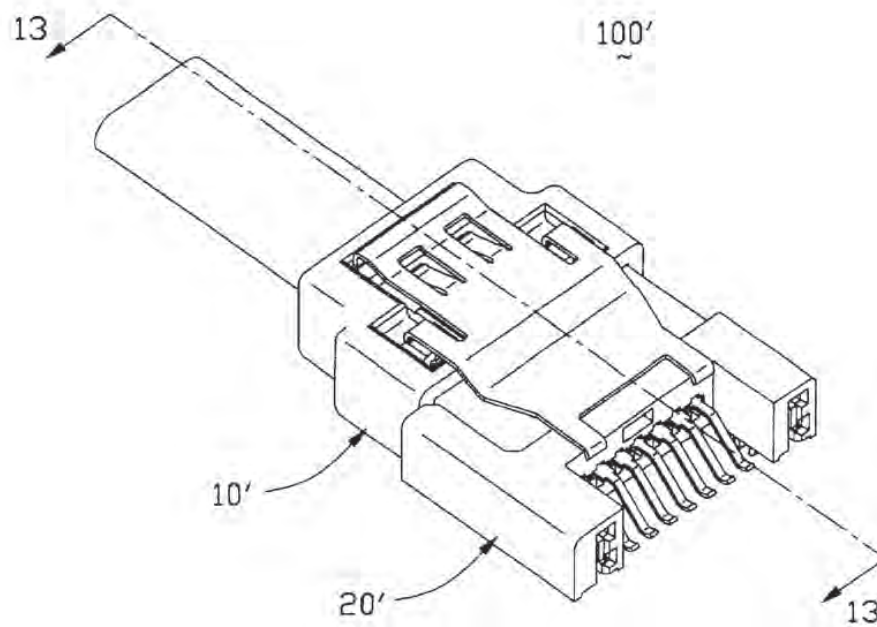


FIG. 12

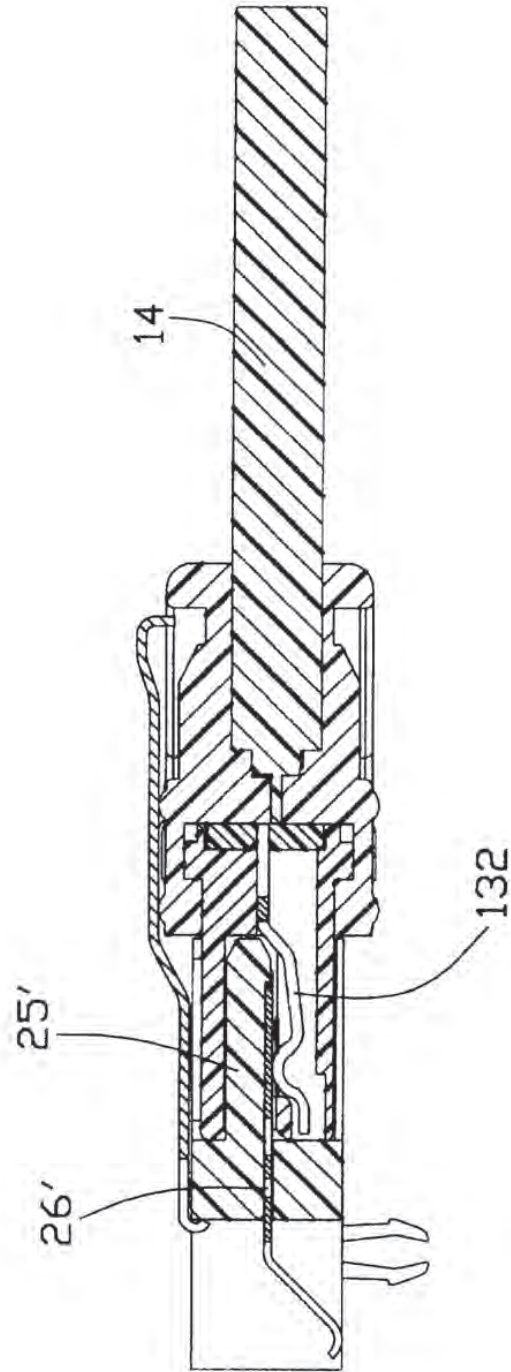


FIG. 13

1

CABLE END CONNECTOR WITH LOCKING MEMBER

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is a co-pending application of the U.S. patent application with an known serial number filed on the same day and by the same inventor, entitled "ELECTRICAL CONNECTOR WITH LOCKING MEMBER" and assigned to the same assignee of this patent application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a cable end connector with a locking member for locking with a complementary connector.

2. Description of Related Art

Complementary electrical connectors typically include dielectric housings respectively receiving a plurality of terminals or contacts which, when the connectors are mated, establish an electrical interconnection therebetween. The complementary connectors may be male and female connectors or plug and socket connectors for electrically connecting the terminals or contacts received therein. In some instances, the connectors have complementary latches for locking the connectors together when mated. U.S. Pat. Nos. 5,445,534, 5,775,931, and 5,924,886 disclose different forms of latch structures to provide reliable mechanical connection therebetween.

There exists in the art an electrical connector known as a Serial Advanced Technology Attachment (Serial ATA) connector which is generally used for disk drives and storage peripherals. Especially, the Serial ATA connectors according to the Serial ATA standard are featured in fewer electrical contacts than other conventional electrical connectors and are relatively tiny in configurations, and it is more desirable for the Serial ATA connector to have a locking member for providing a reliable mechanical connection with a complementary connector.

Hence, an electrical connector with a locking member for locking the connector with a complementary connector is required to overcome the disadvantages of the related art.

SUMMARY OF THE INVENTION

An object, therefore, of the present invention is to provide a cable end connector with a locking member for locking the connector with a complementary connector.

Another object of the present invention is to provide a cable end connector with a locking member adapted to easily lock/release with/from a complementary connector.

In order to achieve the objects set forth, a cable end connector for mating with a complementary connector comprises a housing, a plurality of contacts mounted in the housing, a cable having a plurality of conductors electrically connecting the contacts, a cover over-molded with and enclosing a rear end of the housing, and a locking member mounted to the housing and the cover for locking with the complementary connector. The housing forms a retention portion on an upper surface of the housing. The locking member has a main portion abutting against a top surface of the cover, a latch portion extending from the main portion and latching with the retention portion of the housing, and a portion extending forwardly from the main portion in order to lock with the complementary connector for providing a mechanical connection therebetween.

2

Other objects, advantages and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an assembled view of an electrical connector assembly to cable end connector and a complementary connector in accordance with the invention;

FIG. 2 is an exploded, perspective view of the cable end connector in accordance with the present invention;

FIG. 3 is a view similar to FIG. 2, but taken from rear and bottom aspects;

FIG. 4 is an assembly, perspective view of the cable end connector of FIG. 2;

FIG. 5 is a view similar to FIG. 4, but taken from rear and bottom aspects;

FIG. 6 is a cross-sectional view taken along line 6—6 of FIG. 4;

FIG. 7 is a cross-sectional view taken along line 7—7 of FIG. 4;

FIG. 8 is a cross-sectional view taken along line 8—8 of FIG. 4;

FIG. 9 is an assembled view of FIG. 1;

FIG. 10 is a cross-sectional view taken along line 10—10 of FIG. 9;

FIG. 11 is an assembled view of an electrical connector assembly of a second embodiment of the present invention to show the cable end connector and a second complementary connector;

FIG. 12 is an assembled view of FIG. 1; and

FIG. 13 is a cross-sectional view taken along line 13—13 of FIG. 12.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, an electrical connector assembly 100 in accordance with the present invention comprises a cable end connector 10 and a complementary connector 20. In the embodiment shown, the cable end connector 10 and the complementary connector 20 are typical standard Serial ATA connectors. However, in alternative embodiments, the electrical connectors could be provided as other than Serial ATA electrical connectors.

Referring to FIGS. 2 and 3, the cable end connector 10 comprises an insulative housing 12, a contact insert 13, a cable 14, a cover 15, and a pair of locking members 16.

The housing 12 comprises an L-shaped receiving space 123 defined in a front end thereof and a block 124 protruding into the receiving space 123. The block 124 comprises a plurality of passageways 125 defined in the block 124. Two pairs of retention portions 121 protrude upwardly and downwardly from an upper surface and a lower surface of the housing 12 and adjacent to a rear end of the housing 12. A retention hole is defined in each retention portion 121 in a front to rear direction. A guiding projection 126 protrudes sidewardly from a side surface of the housing 12.

The contact insert 13 is insert-molded with a plurality of contacts 132 and is mounted into a rear end of the housing 12 with the contacts received into the passageways 125 and partly exposed into the receiving space 123.

The cable 14 comprises a plurality of conductors 142 extending beyond a front end thereof.

3

The cover 15 is over-molded with the housing 12. The cover 15 comprises an upper plate 150 and an opposite lower plate 151 which together defines a receiving cavity at a front end thereof, an opening 153 at a rear end of the cover 15. A recess 154 is defined in the upper plate 150 adjacent to the rear end thereof. A pair of through holes 155 is defined in the upper plate adjacent to the front end of the cover 15 and a pair opposite sides of the cover 15. A first rib 156 is formed on the upper plate 150 adjacent to the front end of the cover 15, and a second rib 157 is formed on the upper plate 150 at a middle of the cover 15. The lower plate 151 of the cover 15 has a same construction with the upper plate 150.

Each locking member 16 comprises a main portion 160, a pair of latching portions formed on a pair of opposite ends of the main portion 160, a push portion 163 extending rearwardly from the main portion 160, and a locking portion extending forwardly from the main portion 160.

Each latching portion 162 extends rearwardly from the main portion 160 and comprises an engaging portion 1622 extending downwardly and forwardly therefrom. A resilient tab 1623 extends downwardly from the engaging portion 1622. A pair of tabs 165 extends downwardly from the main portion 160. The push portion 163 extends upwardly from the main portion and comprises a contact portion 164 extending downwardly from the push portion 163. The locking portion 166 comprises a plate portion 167 extending from the main portion 160 and a pair of locking sections 168 extending forwardly from the plate portion 167. The locking section has a claw construction.

Referring to FIGS. 4-8, in assembly, the conductors 142 of the cable 14 are first soldered to the contacts 132 exposed outside the housing 12. The cover 15 is over-molded with the rear end of the housing 12 with the conductors 142 received into the opening 153, the retention portions 121 entering into the through holes 155 of the upper and lower plates 150 and 151. The pair of locking members 16 are assembled to the housing 12 and the cover 15 with each engaging portion 1622 received into the retention holes 1212 of the retention portion 121, the resilient tab 1623 abuts against an inner wall of the retention hole 1212 of the retention portion 121, the main portion 160 abutting against the first and second ribs 156 and 157, the tabs 165 abutting against the upper and lower plates 150 and 151, the plate portions 167 covering the front end of the housing and the locking sections extending beyond a front surface of the housing 12.

Referring to FIGS. 1, 9 and 10, the complementary connector 20 comprises a base portion 22, a guiding post 24 extends forwardly from one end of the base portion 22, a tongue portion 25 extending forwardly from a middle of the base portion 22. A plurality of terminals 26 is assembled to the tongue portion and each terminal has a tail portion extending beyond a rear surface 220 of the base portion 22 for extending through and soldered with a through hole of a printed circuit board 500 (FIG. 10).

When the cable end connector 10 is mated with the complementary connector 20, the guiding projection 126 is received into the guiding post 24 of the base portion 22, the tongue portion 25 is received into the receiving space 123 with the terminals 26 electrically contacting the contacts 132, the latching sections 168 locking and abutting against the rear surface 220 of the base portion to securely locking the complementary connector 20 with the cable end connector 10. When the cable end connector is separated from the complementary connector 20, the push portions 163 is pushed toward the cover with the tabs 165 resiliently

4

deformed, the contact portions 164 are received into the recesses 154 of the cover, the second ribs 157 support the main portion 160 and functioning as a fulcrum, at a same time, the locking sections 168 move upwardly and downwardly and are separated from the rear surface of the base portion 22. When the push portions are released, the resilient deform is disappeared, the first ribs 156 support the main portion 160 and functioning as a fulcrum, and at the same time, the push portions and the locking sections return to original positions.

Referring to FIGS. 11, 12 and 13, an electrical connector assembly in accordance with a second embodiment comprises a second cable end connector and a second complementary connector 20'. The second cable end connector 10' has a same construction as that of the cable end connector 10 described in the first embodiment except that the second cable end connector 10' only has one locking member. The second complementary connector 20' has a same construction as that of the complementary connector 20 in the first embodiment except the base portion 22' and the terminals 26'. The base portion 22' has a pair of rear portion extending rearwardly from a rear surface of the base portion 22'. Each terminal 26' has a tail portion extending beyond the rear surface of the base and bent downwardly for being surface mounted to the printed circuit board.

It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the distal end of the locking section 168 may be further equipped with an oblique guiding section for easy assembling between the mated connectors.

What is claimed is:

1. A cable end connector for mating with a complementary connector, comprising:

- a housing defining a retention portion on an upper surface thereof;
- a plurality of contacts mounted in the housing;
- a cable having a plurality of conductors electrically connecting the contacts;
- a cover over-molded with and enclosing a rear end of the housing; and
- a locking member having a main portion abutting against a plate of the cover, a latch portion extending from the main portion and latching with the retention portion of the housing, and a locking portion extending forwardly from the main portion and adapted to lock with the complementary connector for providing a mechanical connection therebetween.

2. The cable end connector as claimed in claim 1, wherein the locking member comprises a push portion extending rearwardly and upwardly from the main portion thereof, the push portion has a contact portion extending downwardly therefrom.

3. The cable end connector as claimed in claim 2, wherein a recess is defined in the plate of the cover to receive the contact portion of the locking member when the push portion is pushed downwardly.

4. The cable end connector as claimed in claim 2, wherein a pair of tabs extends downwardly from the main portion of the locking member and abuts against the plate of the cover

5

for providing spring force to the push portion of the locking member to resume to an original position.

5. The cable end connector as claimed in claim 1, wherein a receiving hole is defined in the plate of the cover and the retention portion extends into the receiving hole, the latching portion of the locking member mechanically engages with the retention portion.

6. The cable end connector as claimed in claim 5, wherein the latching portion has an engaging portion extends downwardly and is bent forwardly therefrom, a retention hole is defined in the retention portion, the engaging portion of the latching portion is correspondingly received in the retention hole of the retention portion.

7. The cable end connector as claimed in claim 1, wherein a first rib protrudes upwardly from the plate of cover and adjacent to a front end of the cover, the first rib supports the locking member and function as a fulcrum when the tab works.

8. The cable end connector as claimed in claim 1, wherein a second rib protrudes upwardly from a middle of the plate of the cover, the second rib supports the locking member and functions as a fulcrum when the push portion is pushed downwardly.

9. The cable end connector as claimed in claim 1, wherein the connector further comprises a contact insert, the plurality of contacts is insert-molded in the contact insert.

10. The cable end connector as claimed in claim 9, wherein the housing comprises an L-shaped receiving space and a block protrudes into the receiving space, a plurality of passageways is defined in the block, the contact insert is assembled to the cover and the contacts are received into the passageways and partly exposed to the receiving space.

11. The cable end connector as claimed in claim 1, wherein a guide projection protrudes sidewardly from a side surface of the housing for complementing with a corresponding guiding portion of the complementary connector.

12. The cable end connector as claimed in claim 1, wherein the locking portion comprises a plate portion extending forwardly from the main portion and a pair of locking sections extending forwardly from the plate portion for locking with the complementary connector.

13. The cable end connector as claimed in claim 5, wherein the latching portion is a pair of claws locating at a pair of opposite ends of the main portion.

14. The cable end connector as claimed in claim 13, wherein the receiving hole of the cover is a pair of through holes separately defined in opposite sides of the first and second ribs of the upper plate.

15. The cable end connector as claimed in claim 14, wherein the retention portion is a pair of projecting blocks which protrudes upwardly from the upper surface of the housing and are respectively received into the through holes of cover.

16. An electrical connector assembly adapted for being mounted on a printed circuit board, comprising:

a cable end connector comprising a housing defining a receiving space, a plurality of contacts mounted in the receiving space, a cable having a plurality of conductors electrically connecting the contacts, a cover enclosing a rear end of the housing, a locking member having a main portion abutting against a top plate of the cover, a latch portion extending from the main portion

6

and latching with the housing, and a locking portion extending forwardly from the main portion;

a complementary connector having a base portion and a tongue portion extending forwardly from the base portion and respectively received into the receiving space of the cable end connector, a plurality of terminals received into the tongue portion and respectively electrically contacting the contacts of the cable end connector;

wherein the locking portion of the locking member respectively lock with the base portion of the complementary connector for providing a mechanical connection between the cable end connector and the complementary connector.

17. The electrical connector assembly as claimed in claim 16, wherein the locking portion locks and abuts against a rear surface of the base portion of the complementary connector.

18. The electrical connector assembly as claimed in claim 16, wherein the cable end connector comprises a guiding projection protruding from a side surface of the housing, the base portion of the complementary connector has a guiding post locating at a side thereof, the guiding projection is respectively received into the guiding post.

19. An electrical connector assembly comprising:

a receptacle connector mounted on a printed circuit board, said receptacle connector including a base portion and a tongue portion extending from and perpendicular to said base portion;

a plurality of terminals received in the tongue portion;

a cable end connector connected to a cable at a rear end thereof, and including an insulative housing defining a longitudinal direction thereof and a receiving space therein, a plurality of contacts disposed in the housing and respectively electrically connected to corresponding conductors of the cable;

a cover enclosing a rear portion of the cable end connector; and

at least one locking member pivotally fastened to at least one of said cover and said housing, said locking member defining a moveable locking end thereof; wherein when mated, the tongue portion is received in the receiving space with the contacts and the terminals mechanically and electrically engaged with each other, and locking end of the locking member is latchably engaged with the base portion close to the printed circuit board.

20. The assembly as claimed in claim 19, wherein said locking end is located behind the base portion along a mating direction of said cable end connector and said receptacle connector.

21. The assembly as claimed in claim 19, wherein said locking member generally extends on a plane parallel to the longitudinal direction.

22. The assembly as claimed in claim 21, wherein said cable end connector is provided with another locking member opposite to said locking member with the housing therebetween.

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