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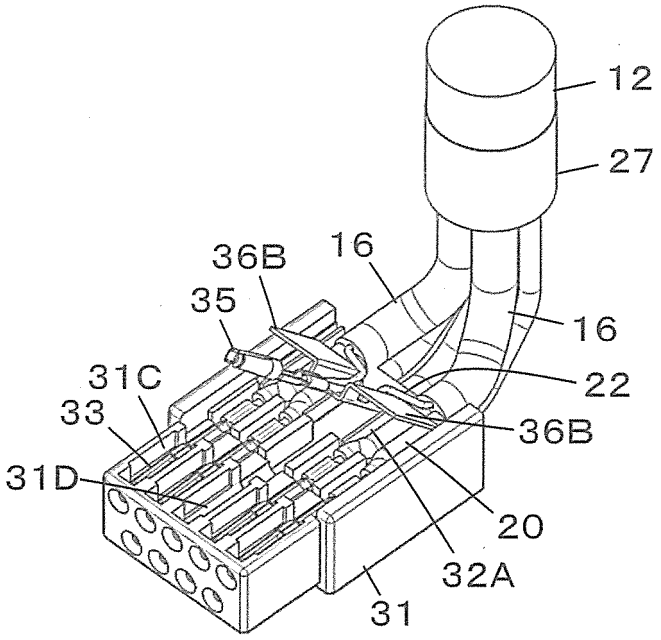
(54) **CONNECTOR**

(57) A connector includes an inner housing (13, 47) made of an insulating material, at least one signal contact (33) that is accommodated in the inner housing and respectively connected to the at least one high-speed signal transmission line exposed from the shield layer, a signal ground contact (35, 43) that is accommodated in the inner housing and connected to the drain line, a shield portion (32, 36, 44) that is connected to the signal ground contact and surrounds on at least three sides an exposed portion of the at least one high-speed signal transmission line exposed from the shield layer in the inner housing, and a frame ground shell (14) that covers the inner housing and is connected to the braided shield.

FIG. 11



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a connector, particularly, to a connector that is connected to a cable having at least one signal line covered by a shield layer and a drain line connected to the shield layer.

[0002] As a connector of this type, for example, JP 2001-351741 A discloses a connector that is connected to a cable 3 having two signal lines 1 and a drain line 2, as illustrated in FIG. 28. The connector includes two signal terminals 4 that are connected to the two signal lines 1, a shielding member 6 formed integrally with a drain terminal 5 that is connected to the drain line 2, and an insulating housing 7. The housing 7 holds the two signal terminals 4 and is covered by the shielding member 6.

[0003] Since the drain terminal 5 is formed integrally with the shielding member 6, when the drain line 2 is simply connected to the drain terminal 5, the shielding member 6 can exhibit shielding function.

[0004] In the connector disclosed in JP 2001-351741 A, the drain line 2 disposed along the two signal lines 1 inside the cable 3 is connected to the drain terminal 5, whereby the so-called signal ground is formed for the respective signal lines 1. However, since the drain terminal 5 is formed integrally with the shielding member 6 and thus does not have the so-called frame ground independently from the signal ground, there is a problem that when the connector is mounted and used on an electronic device, noises from a frame of the electronic device would be easily conducted to the drain line 2 via the shielding member 6.

[0005] In addition, while tip ends of the signal lines 1 that are exposed from the cable 3 are connected to the signal terminals 4, the impedance of the portions of the signal lines 1 exposed from the cable 3 needs to be matched in order for the signal lines 1 to efficiently transmit high-speed signals. If the impedance of the exposed portions of the signal lines 1 is not matched, the quality of signals to be transmitted is degraded. A signal line that requires impedance matching as described above is referred to as a high-speed signal transmission line, whereas a signal line that transmits relatively low-speed signals and thus does not require impedance matching is referred to as a low-speed signal transmission line.

SUMMARY OF THE INVENTION

[0006] The present invention has been made to solve the conventional problem and aims at providing a connector in which a drain line disposed along a high-speed signal transmission line is prevented from being affected by noises from the frame ground, and impedance matching of the high-speed signal transmission line exposed from a cable is possible.

[0007] A connector according to the present invention is connected to a cable in which at least one high-speed signal transmission line covered by a shield layer and a drain line disposed along each of the at least one high-speed signal transmission line and connected to the shield layer are enclosed with a braided shield, the connector comprising:

an inner housing made of an insulating material;
at least one signal contact that is accommodated in the inner housing and respectively connected to the at least one high-speed signal transmission line exposed from the shield layer;
a signal ground contact that is accommodated in the inner housing and connected to the drain line;
a shield portion that is connected to the signal ground contact and surrounds on at least three sides an exposed portion of the at least one high-speed signal transmission line exposed from the shield layer in the inner housing; and
a frame ground shell that covers the inner housing and is connected to the braided shield.

[0008] The cable may include two differential signal line pairs, each of the two differential signal line pairs being covered by the shield layer and including two high-speed signal transmission lines for transmitting differential signals and the drain line connected to the shield layer, the drain line of each of the two differential signal line pairs being connected to the signal ground contact.

[0009] Preferably, the shield portion includes two differential signal line accommodation portions respectively disposed on both sides of a base part of the signal ground contact, each of the two differential signal line accommodation portions accommodating exposed portions of the two high-speed signal transmission lines in a corresponding differential signal line pair of the two differential signal line pairs.

[0010] The signal ground contact may include a crimping portion, the drain line of each of the two differential signal line pairs being crimped to the crimping portion of the signal ground contact, and the shield portion may have a ground bar that is connected to the signal ground contact and includes two gutter-shaped portions having a U-shaped cross section and disposed on both sides of the base part of the signal ground contact, and two flat-plate portions that are integrally formed with the base part of the signal ground contact and cover over the two gutter-shaped portions, the two gutter-shaped portions and the two flat-plate portions together forming the two differential signal line accommodation portions.

[0011] Otherwise, the connector may further comprise two drain contacts, the drain line of each of the two differential signal line pairs being crimped to each of the two drain contacts, the two differential signal line accommodation portions of the shield portion being two gutter-shaped portions having a U-shaped cross section that are integrally formed with the signal ground contact, and the inner housing may include two side walls that respectively face the two gutter-shaped portions, the two drain

contacts being respectively inserted between the two gutter-shaped portions and the two side walls of the inner housing so as to be connected to the signal ground contact.

[0012] The inner housing may include: an inner housing main body that is provided with at least one signal contact accommodation portion for accommodating the at least one signal contact, a signal ground contact accommodation portion for accommodating the signal ground contact and a shield accommodation portion for accommodating the shield portion; and an inner cover member that is attached to the inner housing main body so as to cover the at least one signal contact accommodation portion, the signal ground contact accommodation portion and the shield accommodation portion.

[0013] The cable may include a power supply line and a power supply ground line, the inner housing including a divider that divides an interior space of the inner housing into a first accommodation space and a second accommodation space, and the at least one signal contact accommodation portion, the signal ground contact accommodation portion and the shield accommodation portion may be laid out in the first accommodation space, the power supply line and the power supply ground line being accommodated in the second accommodation space.

[0014] The cable may include a low-speed signal transmission line whose exposed portion does not require impedance matching, and the low-speed signal transmission line being accommodated in the second accommodation space.

[0015] The frame ground shell may include: a shell main body that covers the inner housing; a cover shell that is connected to the shell main body and covers the at least one high-speed signal transmission line and the drain line that are drawn out from the cable to the inner housing; and a crimp barrel portion that is integrally formed with the shell main body or the cover shell and is wound around to be connected to the braided shield that is folded back.

[0016] The connector may further comprise an outer housing that is made of an insulating material and covers the frame ground shell.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 is a perspective view showing a connector according to Embodiment 1 of the present invention.
FIG. 2 is a perspective view showing the connector according to Embodiment 1 from which an outer housing and a frame ground shell are removed.
FIG. 3 is a cross-sectional view showing an internal structure of a cable connected to the connector of Embodiment 1.
FIG. 4 is a perspective view showing an end portion of the cable that is connected to the connector of Embodiment 1.
FIG. 5 is a perspective view showing an inner housing main body of an inner housing used in the connector of Embodiment 1.
FIG. 6 is a perspective view showing a signal contact used in the connector of Embodiment 1.
FIG. 7 is a perspective view showing a ground member used in the connector of Embodiment 1.
FIG. 8 is a perspective view showing a state where the ground member in Embodiment 1 is connected to the cable.
FIG. 9 is a perspective view showing a state where the ground member and a plurality of signal contacts in Embodiment 1 are connected to the cable.
FIG. 10 is a perspective view showing a state where the ground member in Embodiment 1 is slanted with respect to the plurality of signal contacts.
FIG. 11 is a perspective view showing a state where the plurality of signal contacts in Embodiment 1 that are connected to the cable are mounted on the inner housing main body.
FIG. 12 is a perspective view showing a state where the ground member and the plurality of signal contacts in Embodiment 1 that are connected to the cable are mounted on the inner housing main body.
FIG. 13 is a perspective view showing a state where the contacts that are connected to a power supply line, a power supply ground line and low-speed signal transmission signal lines of the cable are mounted on the inner housing main body in Embodiment 1.
FIG. 14 is a perspective view showing a state where a pair of inner cover members are attached to the inner housing main body in Embodiment 1.
FIG. 15 is a cross-sectional view showing an inside of the inner housing in Embodiment 1.
FIG. 16 is a perspective view showing a state where a frame ground shell is attached to the inner housing in Embodiment 1 that is connected to the cable.
FIG. 17 is a perspective view showing a state where an outer housing main body is attached to an outside of the frame ground shell in Embodiment 1.
FIG. 18 is a perspective view showing a state where an outer cover member is attached to the outer housing main body in Embodiment 1.
FIG. 19 is a perspective view showing an inner housing main body of an inner housing used in a connector of Embodiment 2.
FIG. 20 is a perspective view showing a ground member used in the connector of Embodiment 2.
FIG. 21 is a perspective view showing a drain contact used in the connector of Embodiment 2.
FIG. 22 is a perspective view showing a state where the drain contact and a plurality of signal contacts in Embodiment 2 are connected to a cable.
FIG. 23 is a perspective view showing a state where the drain contact and the plurality of signal contacts in Embodiment 2 that are connected to the cable are mounted on the inner housing main body.

FIG. 24 is a cross-sectional view showing a state where the drain contact and the plurality of signal contacts in Embodiment 2 that are connected to the cable are mounted on the inner housing main body.
FIG. 25 is a perspective view showing a state where a pair of inner cover members are attached to the inner housing main body in Embodiment 2.
FIG. 26 is a cross-sectional view showing an inside of the inner housing in Embodiment 2.
FIG. 27 is a cross-sectional view showing an internal structure of a cable used in Embodiment 3.
FIG. 28 is an exploded perspective view showing a conventional connector.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Embodiments of the present invention will be described below based on the appended drawings.

Embodiment 1

[0019] FIG. 1 illustrates the structure of a connector 11 according to Embodiment 1. The connector 11 is connected to an end of a cable 12, and includes an inner housing 13 made of an insulating material, a frame ground shell 14 made of a conductive material that covers the inner housing 13, and an outer housing 15 made of an insulating material that covers the frame ground shell 14.

[0020] The inner housing 13 accommodates a plurality of contacts that are connected to a plurality of signal lines and the like extending from the cable 12 as illustrated in FIG. 2.

[0021] FIG. 3 illustrates the internal structure of the cable 12 connected to the connector 11. The cable 12 is a composite cable containing two differential signal line pairs 16 for high-speed signal transmission, a differential signal line pair 17 for low-speed signal transmission, a power supply line 18 and a power supply ground line 19.

[0022] Each of the two differential signal line pairs 16 for high-speed signal transmission has a structure in which two high-speed signal transmission lines 20 that transmit differential signals are covered by a shield layer 21, a drain line 22 is disposed along the high-speed signal transmission lines 20 and is in contact with an outer circumferential surface of the shield layer 21, and the shield layer 21 and the drain line 22 are covered by an insulating layer 23.

[0023] The shield layer 21 is made from a tape that has an inner face made of polyethylene terephthalate (PET) and an outer face made of aluminum and that is wound around the two high-speed signal transmission lines 20, whereas the drain line 22 is not covered by an insulating layer and has its conductive wire exposed. Accordingly, as being disposed in contact with the outer circumferential surface of the shield layer 21, the drain line 22 is electrically connected to an aluminum layer that constitutes the outer face of the shield layer 21.

[0024] On the other hand, the differential signal line pair 17 for low-speed signal transmission has a structure in which two low-speed signal transmission lines 24 that transmit differential signals are covered by a shield layer 25.

[0025] The shield layer 25 is made from a tape that has an inner face made of PET and an outer face made of aluminum or has both faces made of aluminum and that is wound around the two low-speed signal transmission lines 24.

[0026] The two differential signal line pairs 16 for high-speed signal transmission, the differential signal line pair 17 for low-speed signal transmission, the power supply line 18 and the power supply ground line 19 are covered by a press-winding shield 26, the press-winding shield 26 is covered by a braided shield 27, and the braided shield 27 is covered by an insulating sheath 28.

[0027] The press-winding shield 26 is made from a tape that has both an inner face and an outer face made of aluminum, and the inner face of the press-winding shield 26 is in contact with the aluminum outer face of the shield layer 25 of the differential signal line pair 17, whereby the shield layer 25 of the differential signal line pair 17 is electrically connected to the braided shield 27 via the press-winding shield 26.

[0028] While the press-winding shield 26 is wound around the two differential signal line pairs 16 for high-speed signal transmission, the insulating layer 23 constitutes the outermost layer of each of the differential signal line pairs 16, whereby the shield layer 21 of the differential signal line pair 16 and the drain line 22 are insulated from the press-winding shield 26 and the braided shield 27.

[0029] Within the interior space enclosed with the press-winding shield 26, provided are the two differential signal line pairs 16 for high-speed signal transmission, the differential signal line pair 17 for low-speed signal transmission, the power supply line 18, the power supply ground line 19, and in addition, a filler 29 to fill up the interior space.

[0030] The cable 12 having such structure is connected to the connector 11 while having the two differential signal line pairs 16 for high-speed signal transmission, the differential signal line pair 17 for low-speed signal transmission, the power supply line 18 and the power supply ground line 19 drawn out from the insulating sheath 28, the braided shield 27 and the press-winding shield 26, and, in addition, having the two high-speed signal transmission lines 20 and the drain line 22 exposed from the insulating layer 23 and the shield layer 21 of each of the differential signal line pairs 16 and the two low-speed signal transmission lines 24 exposed from the shield layer 25 of the differential signal line pair 17, as illustrated in FIG. 4.

[0031] The braided shield 27 is folded back on the outer circumference of the cable 12.

[0032] In a shielded area S where the differential signal line pairs 16 are drawn out from the insulating sheath 28,

the braided shield 27 and the press-winding shield 26 but are respectively covered by the shield layer 21, the two high-speed signal transmission lines 20 are electromagnetically coupled to the shield layer 21, whereby the impedance matching is achieved. On the contrary, in an exposed area E where the two high-speed signal transmission lines 20 are uncovered by the shield layer 21, since the high-speed signal transmission lines 20 are not electromagnetically coupled to the shield layer 21, the impedance is not matched.

[0033] FIG. 5 illustrates an inner housing main body 31 used in the inner housing 13 of the connector 11. The inner housing main body 31 includes a pair of side walls 31A facing each other with a distance therebetween, and a divider 31B that bridges between the side walls 31A in the middle of their height so as to divide the internal space of the inner housing main body 31 into a first accommodation space C1 and a second accommodation space C2.

[0034] In the first accommodation space C1, two signal contact accommodation portions 31C, one signal ground contact accommodation portion 31D, and additional two signal contact accommodation portions 31C are formed and arranged in this order from one of the side walls 31A toward the other side wall 31A. Adjacent to the signal contact accommodation portions 31C and the signal ground contact accommodation portion 31D, a shield accommodation portion 31E is also formed between the pair of side walls 31A.

[0035] A ground bar 32 made of a conductive material such as a metal is fitted in the shield accommodation portion 31E. The ground bar 32 is made from a flat plate that is cut out in a predetermined shape and then bent, and has two gutter-shaped portions 32A each having a U-shaped cross section that are arranged in parallel with a distance therebetween. These gutter-shaped portions 32A are disposed so as to respectively communicate with the two signal contact accommodation portions 31C formed near one of the side walls 31A and the other two signal contact accommodation portions 31C formed near the other side wall 31A. In other words, each of the gutter-shaped portions 32A corresponds to the two signal contact accommodation portions 31C.

[0036] FIG. 6 illustrates a signal contact 33 that is connected to each of the power supply line 18, the power supply ground line 19, the high-speed signal transmission lines 20 and the low-speed signal transmission lines 24. The signal contact 33 has at its one end a contact portion 33A that comes into contact with a corresponding contact of a counter connector (not shown) to be electrically connected thereto and at the other end a crimping portion 33B to which a core wire of, for example, the signal line is crimped for connection.

[0037] FIG. 7 illustrates a ground member 34 that is connected to the drain line 22. The ground member 34 includes a signal ground contact 35 that has a similar structure to that of the signal contact 33 and a plate-like portion 36 integrally formed with the base part of the signal ground contact 35.

[0038] The signal ground contact 35 includes a contact portion 35A that comes into contact with a corresponding contact of the counter connector (not shown) to be electrically connected thereto and a crimping portion 35B to which the drain line 22 is crimped.

[0039] In the meantime, the plate-like portion 36 has a gutter-shaped portion 36A having a U-shaped cross section and joined to the signal ground contact 35 near the crimping portion 35B thereof, and a pair of flat-plate portions 36B disposed on both sides of the gutter-shaped portion 36A and extending along the same plane. The gutter-shaped portion 36A is inserted between the pair of gutter-shaped portions 32A of the ground bar 32 and is provided on its both lateral parts with a pair of protrusions 36C protruding in the opposite directions from each other. The pair of flat-plate portions 36B constitute lids of the respectively corresponding gutter-shaped portions 32A of the ground bar 32 and close the internal spaces of the gutter-shaped portions 32A, thereby forming, together with the gutter-shaped portions 32A of the ground bar 32, differential signal line accommodation portions to accommodate the high-speed signal transmission lines 20.

[0040] Here, the procedure to connect the connector 11 to an end of the cable 12 will be described.

[0041] First, as illustrated in FIG. 4, the two high-speed signal transmission lines 20 and the drain line 22 are exposed from each of the differential signal line pairs 16, and the two low-speed signal transmission lines 24 are exposed from the differential signal line pair 17. As illustrated in FIG. 8, the two drain lines 22 drawn out from the two differential signal line pairs 16 for high-speed signal transmission are twined together and are crimped to the crimping portion 35B of the signal ground contact 35.

[0042] Next, as illustrated in FIG. 9, the power supply line 18, the power supply ground line 19, the high-speed signal transmission lines 20 and the low-speed signal transmission lines 24 are crimped to the crimping portions 33B of the corresponding signal contacts 33, respectively.

[0043] Subsequently, while the signal ground contact 35 is held slanted with respect to the other signal contacts 33 as illustrated in FIG. 10, the signal contacts 33 are accommodated in the inner housing main body 31 as illustrated in FIG. 11. In this process, the high-speed signal transmission lines 20 that are exposed from the differential signal line pairs 16 for high-speed signal transmission are accommodated in the gutter-shaped portions 32A of the ground bar 32 that is fitted in the inner housing main body 31, and the signal contacts 33 respectively connected to the high-speed signal transmission lines 20 are accommodated in the corresponding signal contact accommodation portions 31C of the inner housing main body 31.

[0044] Furthermore, as illustrated in FIG. 12, while the signal ground contact 35 connected to the two drain lines

22 is accommodated in the signal ground contact accommodation portion 31D of the inner housing main body 31, the gutter-shaped portion 36A of the plate-like portion 36 that is integrally formed with the signal ground contact 35 is inserted between the pair of gutter-shaped portions 32A of the ground bar 32. Accordingly, the pair of protrusions 36C formed on the gutter-shaped portion 36A of the plate-like portion 36 come into contact with the pair of gutter-shaped portions 32A of the ground bar 32 so that the plate-like portion 36 and the ground bar 32 are electrically connected to each other. In the meantime, the flat-plate portions 36B of the plate-like portion 36 become lids of the gutter-shaped portions 32A of the ground bar 32 so that the exposed portions of the high-speed signal transmission lines 20 accommodated in each of the gutter-shaped portions 32A of the ground bar 32 are surrounded on four sides by the ground bar 32 and the plate-like portion 36, forming a shield portion with four faces.

[0045] As illustrated in FIG. 13, four signal contact accommodation portions 31C are formed and arranged in the direction from one of the side walls 31A toward the other side wall 31A in the second accommodation space C2 of the inner housing main body 31. The four signal contacts 33 connected to the power supply line 18, the power supply ground line 19 and the two low-speed signal transmission lines 24 that are drawn out from the differential signal line pair 17 are accommodated in the corresponding signal contact accommodation portions 31C. Any of the power supply line 18, the power supply ground line 19 and the two low-speed signal transmission lines 24 that are disposed in the second accommodation space C2 of the inner housing main body 31 does not require impedance matching, and the second accommodation space C2 does not include any member, such as the ground bar 32 and the plate-like portion 36, that is associated with the shielding function.

[0046] Thereafter, as illustrated in FIG. 14, an inner cover member 37A made of an insulating material is attached to the inner housing main body 31 so as to cover the plurality of signal contact accommodation portions 31C and the signal ground contact accommodation portion 31D in the first accommodation space C1 of the inner housing main body 31, and an inner cover member 37B made of an insulating material is attached to the inner housing main body 31 so as to cover the plurality of signal contact accommodation portions 31C in the second accommodation space C2 of the inner housing main body 31. The inner housing main body 31 and the inner cover members 37A and 37B together form the inner housing 13.

[0047] FIG. 15 illustrates how the two high-speed signal transmission lines 20 exposed from each of the differential signal line pairs 16 are surrounded by the gutter-shaped portion 32A and the flat-plate portion 36B.

[0048] The inner housing 13 thus connected to the cable 12 is covered by a shell main body 14A while the two differential signal line pairs 16 for high-speed signal transmission, the differential signal line pair 17 for low-speed signal transmission, the power supply line 18 and the power supply ground line 19 that are drawn out from the cable 12 to the inner housing 13 are covered by a cover shell 14B as illustrated in FIG. 16. The shell main body 14A and the cover shell 14B are swaged or the like to be joined to each other. The shell main body 14A and the cover shell 14B together constitute a frame ground shell 14 and are both made of a conductive material. A crimp barrel portion 14C is integrally formed on the shell main body 14A and is wound around the braided shield 27 that is folded back in the cable 12, whereby the frame ground shell 14 is electrically connected to the braided shield 27.

[0049] As illustrated in FIG. 17, the inner housing 13 to which the frame ground shell 14 is attached is inserted into an outer housing main body 15A made of an insulating material, and as illustrated in FIG. 18, an outer cover member 15B made of an insulating material closes the rear part of the outer housing main body 15A. Accordingly, the outer housing 15 that covers the frame ground shell 14 is formed, whereby the connector 11 as illustrated in FIG. 1 is obtained.

[0050] As described above, the shield layers 21 of the two differential signal line pairs 16 for high-speed signal transmission are insulated from the braided shield 27 in the cable 12 and electrically connected to the signal ground contact 35 in the inner housing 13 via the drain lines 22, whereas the braided shield 27 is electrically connected to the frame ground shell 14.

[0051] In this manner, the signal ground of the high-speed signal transmission lines 20 of the differential signal line pairs 16 can be separated from the frame ground routed through the frame ground shell 14, whereby the signal ground can be prevented from being affected by noises from the frame ground when the connector 11 is mounted and used on an electronic device or the like.

[0052] In addition, since the exposed portions of the two high-speed signal transmission lines 20 that are exposed from each of the differential signal line pairs 16 are surrounded by the ground bar 32 and the plate-like portion 36 inside the inner housing 13, the impedance matching of the high-speed signal transmission lines 20 becomes possible.

Embodiment 2

[0053] While the two drain lines 22 are together crimped to the single crimping portion 35B of the signal ground contact 35 in Embodiment 1, this is not the sole case. The two drain lines 22 can be independently connected to the signal ground contacts.

[0054] FIG. 19 illustrates an inner housing main body 41 used in a connector according to Embodiment 2. The inner housing main body 41 has a similar structure to that of the inner housing main body 31 used in the connector 11 of Embodiment 1 and includes a pair of side walls 41A and a divider 41B that divides the internal space of the

inner housing main body 41 into a first accommodation space C1 and a second accommodation space C2.

[0055] In the first accommodation space C1, two signal contact accommodation portions 41C, one signal ground contact accommodation portion 41D, and additional two signal contact accommodation portions 41C are formed and arranged in this order from one of the side walls 41A toward the other side wall 41A. Adjacent to the signal contact accommodation portions 41C and the signal ground contact accommodation portion 41D, a shield accommodation portion 41E is also formed between the pair of side walls 41A.

[0056] A ground member 42 made of a conductive material such as a metal is fitted in the signal ground contact accommodation portion 41D and the shield accommodation portion 41E. The ground member 42 includes a signal ground contact 43 and a ground bar 44 formed integrally with the base part of the signal ground contact 43 as illustrated in FIG. 20.

[0057] The signal ground contact 43 has a contact portion 43A that comes into contact with a corresponding contact of a counter connector (not shown) to be electrically connected thereto.

[0058] In the meantime, the ground bar 44 includes two gutter-shaped portions 44A each having a U-shaped cross section and disposed on both sides of the base part of the signal ground contact 43 in parallel with a distance therebetween. The gutter-shaped portions 44A constitute differential signal line accommodation portions that accommodate the high-speed signal transmission lines 20.

[0059] Each of the gutter-shaped portions 44A is provided on its outer lateral part with a protrusion.

[0060] As illustrated in FIG. 19, the two gutter-shaped portions 44A of the ground bar 44 are disposed so as to respectively communicate with the two signal contact accommodation portions 41C formed near one of the side walls 41A and the other two signal contact accommodation portions 41C formed near the other side wall 41A. In other words, each of the gutter-shaped portions 44A corresponds to the two signal contact accommodation portions 41C.

[0061] In addition, when the ground member 42 is fitted in the inner housing main body 41, a recess portion 41F in a predetermined size is formed between the outer lateral surface of each of the gutter-shaped portions 44A in the ground bar 44 and the inner surface of the corresponding side wall 41A of the inner housing main body 41.

[0062] In Embodiment 2, a drain contact 45 as illustrated in FIG. 21 is connected to each of the drain lines 22. The drain contact 45 includes a contact portion 45A that comes into contact with the outer lateral surface of each of the gutter-shaped portions 44A of the ground bar 44 to be electrically connected thereto, and a crimping portion 45B that is jointed to the contact portion 45A and to which the drain line 22 is crimped.

[0063] The power supply line 18, the power supply ground line 19, the high-speed signal transmission lines 20 and the low-speed signal transmission lines 24 are respectively connected to the signal contacts 33 as illustrated in FIG. 6.

[0064] Next, the procedure to connect the connector according to Embodiment 2 to an end of the cable 12 will be described.

[0065] Similarly to Embodiment 1, first, as illustrated in FIG. 4, the two high-speed signal transmission lines 20 and the drain line 22 are exposed from each of the differential signal line pairs 16, and the two low-speed signal transmission lines 24 are exposed from the differential signal line pair 17. As illustrated in FIG. 22, each of the power supply line 18, the power supply ground line 19, the high-speed signal transmission lines 20 and the low-speed signal transmission lines 24 is crimped to the crimping portion 33B of the corresponding signal contact 33.

[0066] Moreover, the two drain lines 22 drawn out from the two differential signal line pairs 16 for high-speed signal transmission are respectively crimped to the crimping portions 45B of the corresponding drain contacts 45.

[0067] Next, as illustrated in FIG. 23, the signal contacts 33 are accommodated in the inner housing main body 41. In this process, the high-speed signal transmission lines 20 that are exposed from each of the differential signal line pairs 16 for high-speed signal transmission are accommodated in each of the gutter-shaped portions 44A of the ground bar 44 that is fitted in the inner housing main body 41 so as to be surrounded by the gutter-shaped portion 44A on three sides. The signal contacts 33 respectively connected to the high-speed signal transmission lines 20 are accommodated in the corresponding signal contact accommodation portions 41C of the inner housing main body 41.

[0068] Furthermore, the drain contacts 45 respectively connected to the drain lines 22 are inserted in the recess portions 41F each formed between the outer lateral surface of the gutter-shaped portion 44A of the ground bar 44 and the inner surface of the side wall 41A of the inner housing main body 41. The protrusions 44B formed on the outer lateral parts of the respective gutter-shaped portions 44A of the ground bar 44 come into contact with the contact portions 45A of the drain contacts 45 in this manner, whereby the ground bar 44 and the drain contacts 45 are electrically connected. That is, the two drain lines 22 are connected to the signal ground contact 43.

[0069] FIG. 24 illustrates that the two high-speed signal transmission lines 20 exposed from each of the differential signal line pairs 16 are surrounded by each of the gutter-shaped portions 44A, and that the drain contacts 45 are inserted in the recess portions 41F each formed between the gutter-shaped portion 44A and the side wall 41A.

[0070] Similarly to the connector of Embodiment 1, in the second accommodation space C2 of the inner housing main body 41, accommodated are four signal con-

tacts 33 that are respectively connected to the power supply line 18, the power supply ground line 19 and the two low-speed signal transmission lines 24 that are drawn out from the differential signal line pair 17. Any of the power supply line 18, the power supply ground line 19 and the two low-speed signal transmission lines 24 does not require impedance matching, and the second accommodation space C2 does not include any member, such as the ground bar 44, that is associated with the shielding function.

[0071] Thereafter, as illustrated in FIG. 25, an inner cover member 46A made of an insulating material is attached to the inner housing main body 41 so as to cover the first accommodation space C1 of the inner housing main body 41, and an inner cover member 46B made of an insulating material is attached to the inner housing main body 41 so as to cover the second accommodation space C2 of the inner housing main body 41. The inner housing main body 41 and the inner cover members 46A and 46B together form an inner housing 47.

[0072] As illustrated in FIG. 26, the inner cover member 46A is preliminarily provided with convexed portions 46C in certain parts that respectively face the two gutter-shaped portions 44A of the ground bar 44, and when the first accommodation space C1 of the inner housing main body 41 is covered by the inner cover member 46A, the convexed portions 46C of the inner cover member 46A are inserted in the gutter-shaped portions 44A and come in the vicinity of or in contact with the two high-speed signal transmission lines 20 that are accommodated in the respective gutter-shaped portions 44A. Accordingly, since the air layer to which the high-speed signal transmission lines 20 are exposed inside each of the gutter-shaped portions 44A can be reduced, an increase in the impedance of the high-speed signal transmission lines 20 can be suppressed.

[0073] Here, if a resin having a high dielectric constant is selected as the material for forming the inner cover member 46A, the increase in the impedance can be further suppressed.

[0074] Similarly to Embodiment 1, the inner housing 47 thus connected to the cable 12 is covered by the frame ground shell 14 and the outer housing 15, and the connector according to Embodiment 2 is obtained.

[0075] In the connector of Embodiment 2 having such structure, the signal ground of the high-speed signal transmission lines 20 of the differential signal line pairs 16 can be also separated from the frame ground routed through the frame ground shell 14, whereby the signal ground can be prevented from being affected by noises from the frame ground.

[0076] In addition, since the exposed portions of the two high-speed signal transmission lines 20 exposed from each of the differential signal line pairs 16 are surrounded on three sides by one of the gutter-shaped portions 44A of the ground bar 44, forming a shield portion with three faces, inside the inner housing 47. Accordingly, the impedance matching of the high-speed signal transmission lines 20 becomes possible.

[0077] While the inner cover member 46A made of an insulating material covers over the gutter-shaped portions 44A of the ground bar 44, this is not the sole case. Similarly to Embodiment 1, a conductive member may cover over the gutter-shaped portions 44A. In this manner, the increase in the impedance can be further suppressed. The conductive member that covers over the gutter-shaped portions 44A may be disposed in the inner housing main body 41 independently from the inner cover member 46A or may be disposed on the surface of the inner cover member 46A that faces the gutter-shaped portions 44A.

Embodiment 3

[0078] In the cables 12 used in Embodiments 1 and 2 described above, each of the drain lines 22 is disposed outside the shield layer 21 that encloses the two high-speed signal transmission lines 20, while the shield layer 21 and the drain line 22 are covered by the insulating layer 23 as illustrated in FIG. 3. However, as illustrated in FIG. 27, a cable 52 in which the drain line 22 is disposed inside a shield layer 21A that encloses the two high-speed signal transmission lines 20, and the shield layer 21A is not covered by an insulating layer may also be used.

[0079] The shield layer 21A is made from a tape that has an inner face made of aluminum and an outer face made of PET and that is wound around the two high-speed signal transmission lines 20, and the drain line 22 in contact with the inner face of the shield layer 21A is electrically connected to an aluminum layer that constitutes the inner face of the shield layer 21A. At the same time, since the outer face of the shield layer 21A is made of a PET layer, even when the shield layer 21A is in contact with the inner face of the press-winding shield 26 or the shield layer 25 of the differential signal line pair 17 for low-speed signal transmission, the aluminum layer constituting the inner face of the shield layer 21A and the drain line 22 are insulated from the press-winding shield 26 and the shield layer 25 of the differential signal line pair 17.

[0080] Even when the cable 52 having such structure is used, similarly to Embodiments 1 and 2, the drain line 22 disposed along the high-speed signal transmission lines 20 can be prevented from being affected by noises from the frame ground, and the impedance matching of the exposed portions of the high-speed signal transmission lines 20 where the cable 52 does not cover becomes possible.

[0081] Embodiments 1 and 2 described above exemplify the connector that is connected to the cable 12 having two differential signal line pairs 16 for high-speed signal transmission and one differential signal line pair 17 for low-speed signal transmission. However, the number of the differential signal line pairs 16 for high-speed signal transmission and the number of the differential signal line

pair 17 for low-speed signal transmission are not limited thereto, and the connector may be connected to a cable, for example, having no low-speed signal transmission line. Moreover, high-speed signal transmission lines are not limited to those constituting a differential signal line pair, and the present invention can be applied to a wide variety of connectors that are connected to cables in each of which at least one high-speed signal transmission line covered by a shield layer and a drain line disposed along the high-speed signal transmission line and connected to the shield layer are enclosed with a braided shield.

Claims

1. A connector that is connected to a cable (12) in which at least one high-speed signal transmission line (20) covered by a shield layer (21, 21A) and a drain line (22) disposed along each of the at least one high-speed signal transmission line and connected to the shield layer are enclosed with a braided shield (27), the connector comprising:

an inner housing (13, 47) made of an insulating material;
at least one signal contact (33) that is accommodated in the inner housing and respectively connected to the at least one high-speed signal transmission line exposed from the shield layer;
a signal ground contact (35, 43) that is accommodated in the inner housing and connected to the drain line;
a shield portion (32, 36, 44) that is connected to the signal ground contact and surrounds on at least three sides an exposed portion of the at least one high-speed signal transmission line exposed from the shield layer in the inner housing; and
a frame ground shell (14) that covers the inner housing and is connected to the braided shield.

2. The connector according to claim 1,
wherein the cable includes two differential signal line pairs (16),
wherein each of the two differential signal line pairs is covered by the shield layer (21, 21A) and includes two high-speed signal transmission lines (20) for transmitting differential signals and the drain line (22) connected to the shield layer, and
wherein the drain line of each of the two differential signal line pairs is connected to the signal ground contact (35, 43).

3. The connector according to claim 2,
wherein the shield portion includes two differential signal line accommodation portions (32A, 36B, 44A) respectively disposed on both sides of a base part of the signal ground contact (35, 43), each of the two differential signal line accommodation portions accommodating exposed portions (E) of the two high-speed signal transmission lines in a corresponding differential signal line pair of the two differential signal line pairs.

4. The connector according to claim 3,
wherein the signal ground contact (35) includes a crimping portion (35B),
wherein the drain line (22) of each of the two differential signal line pairs is crimped to the crimping portion of the signal ground contact,
wherein the shield portion has a ground bar (32) that is connected to the signal ground contact and includes two gutter-shaped portions (32A) having a U-shaped cross section and disposed on both sides of the base part of the signal ground contact, and two flat-plate portions (36B) that are integrally formed with the base part of the signal ground contact and cover over the two gutter-shaped portions, and
wherein the two gutter-shaped portions and the two flat-plate portions together form the two differential signal line accommodation portions.

5. The connector according to claim 3, further comprising two drain contacts (45), the drain line of each of the two differential signal line pairs being crimped to each of the two drain contacts,
wherein the two differential signal line accommodation portions of the shield portion are two gutter-shaped portions (44A) having a U-shaped cross section that are integrally formed with the signal ground contact,
wherein the inner housing includes two side walls (41A) that respectively face the two gutter-shaped portions, and
wherein the two drain contacts are respectively inserted between the two gutter-shaped portions and the two side walls of the inner housing so as to be connected to the signal ground contact (43).

6. The connector according to any one of claims 1 to 5, wherein the inner housing (13, 47) includes:

an inner housing main body (31, 41) that is provided with at least one signal contact accommodation portion (31C, 41C) for accommodating the at least one signal contact, a signal ground contact accommodation portion (31D, 41D) for accommodating the signal ground contact and a shield accommodation portion (31E, 41E) for accommodating the shield portion; and
an inner cover member (37A, 37B, 46A, 46B) that is attached to the inner housing main body so as to cover the at least one signal contact accommodation portion, the signal ground contact accommodation portion and the shield accommodation portion.

7. The connector according to claim 6,
wherein the cable (12) includes a power supply line (18) and a power supply ground line (19),
wherein the inner housing (13, 47) includes a divider (31B, 41B) that divides an interior space of the inner housing into a first accommodation space (C1) and a second accommodation space (C2),
wherein the at least one signal contact accommodation portion, the signal ground contact accommodation portion and the shield accommodation portion are laid out in the first accommodation space (C1), and
wherein the power supply line and the power supply ground line are accommodated in the second accommodation space (C2).

8. The connector according to claim 7,
wherein the cable (12) includes a low-speed signal transmission line (24) whose exposed portion does not require impedance matching, and
wherein the low-speed signal transmission line is accommodated in the second accommodation space (C2).

9. The connector according to any one of claims 1 to 8, wherein the frame ground shell (14) includes:

a shell main body (14A) that covers the inner housing;
a cover shell (14B) that is connected to the shell main body and covers the at least one high-speed signal transmission line and the drain line that are drawn out from the cable to the inner housing; and
a crimp barrel portion (14C) that is integrally formed with the shell main body or the cover shell and is wound around to be connected to the braided shield that is folded back.

10. The connector according to any one of claims 1 to 9, further comprising an outer housing (15) that is made of an insulating material and covers the frame ground shell (14).

FIG. 1

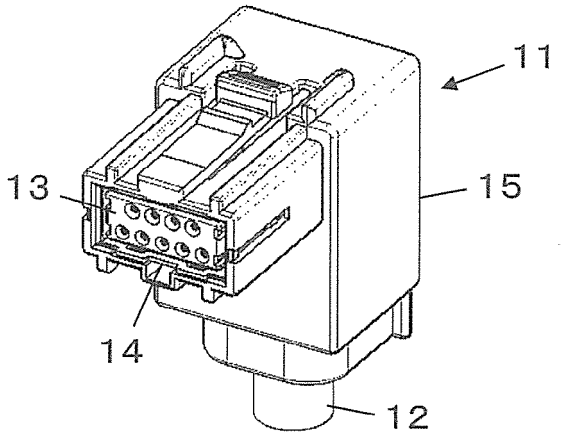


FIG. 2

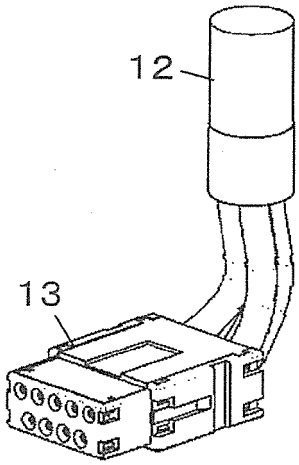


FIG. 3

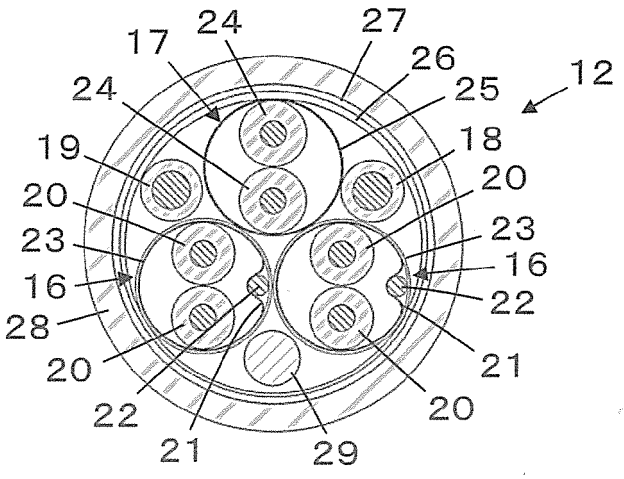


FIG. 4

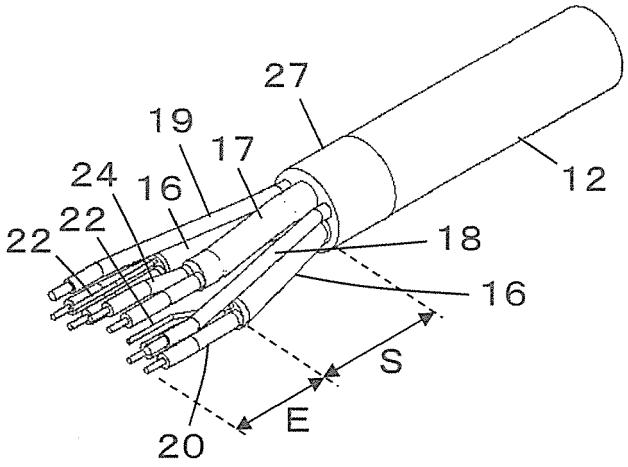


FIG. 5

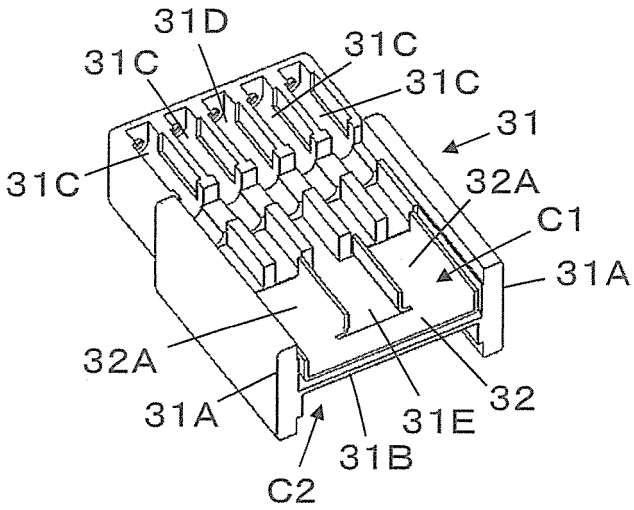


FIG. 6

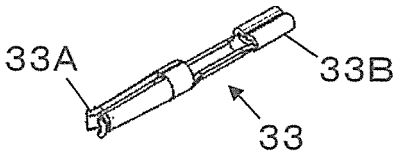


FIG. 7

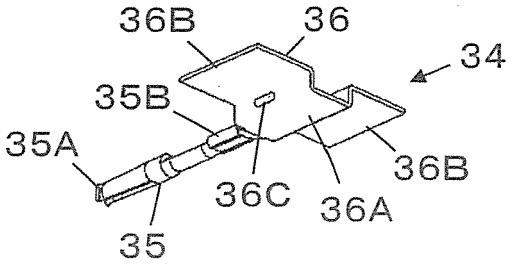


FIG. 8

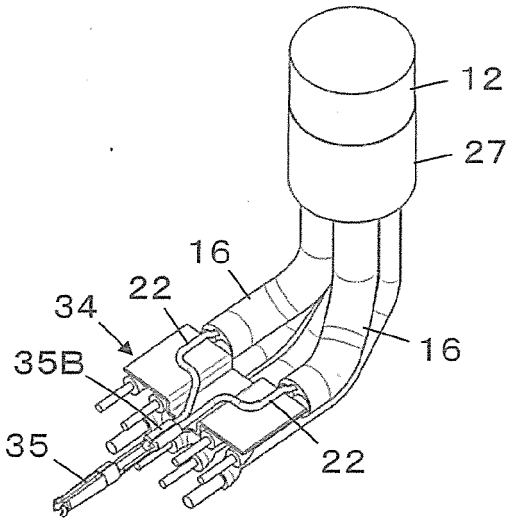


FIG. 9

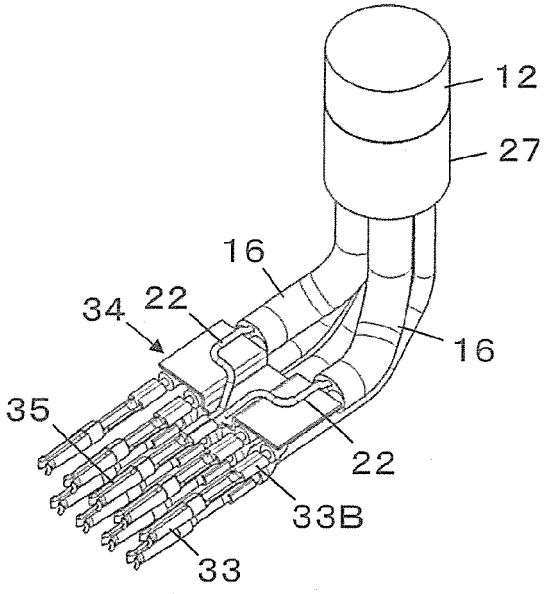


FIG. 10

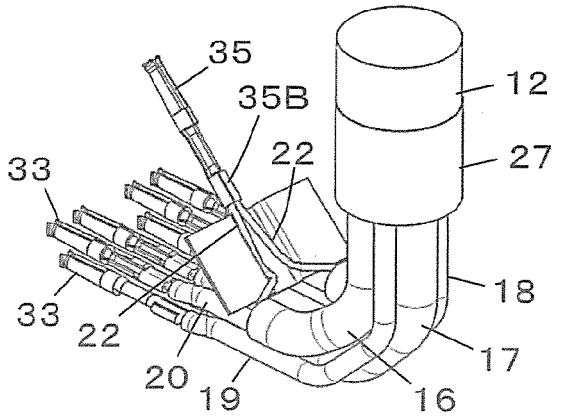


FIG. 11

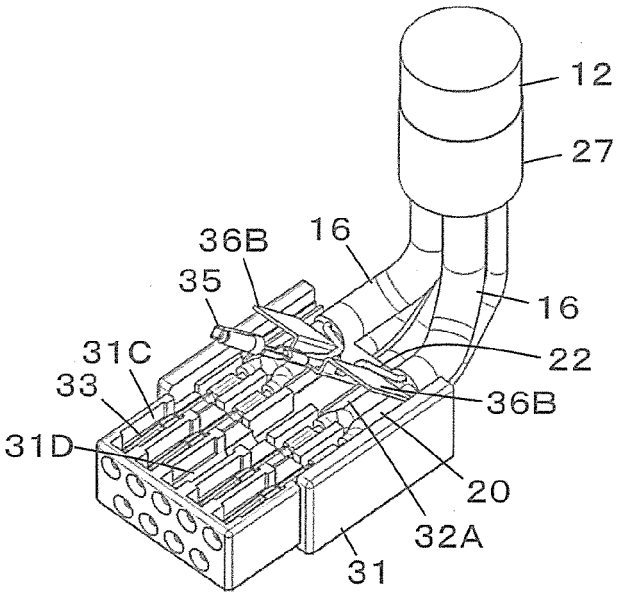


FIG. 12

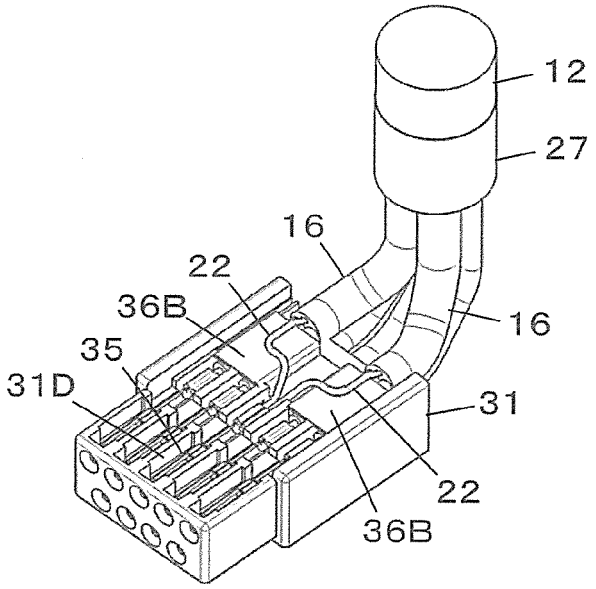


FIG. 13

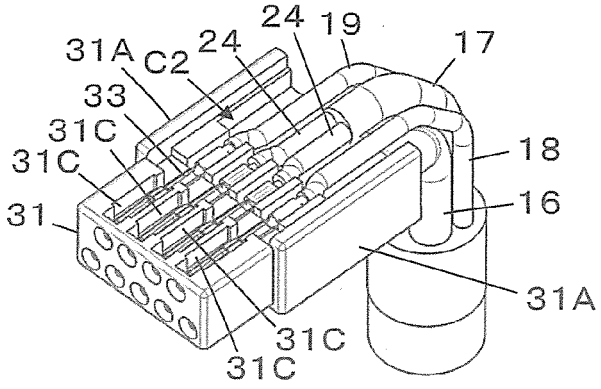


FIG. 14

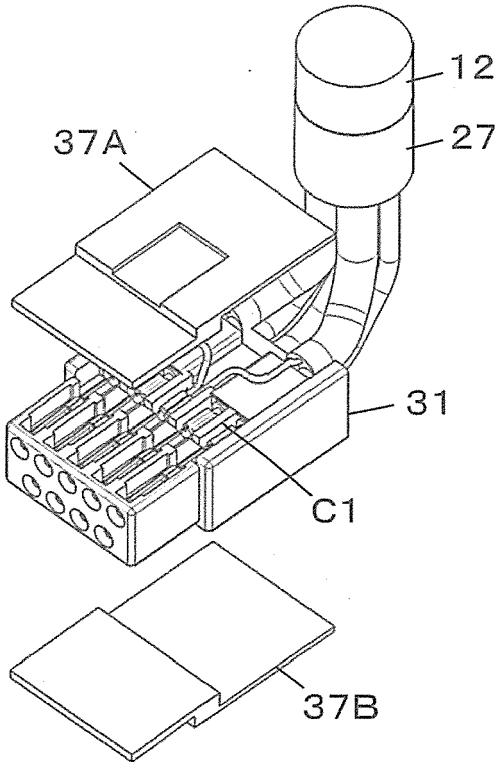

12
27
37A
31
C1
37B

FIG. 15

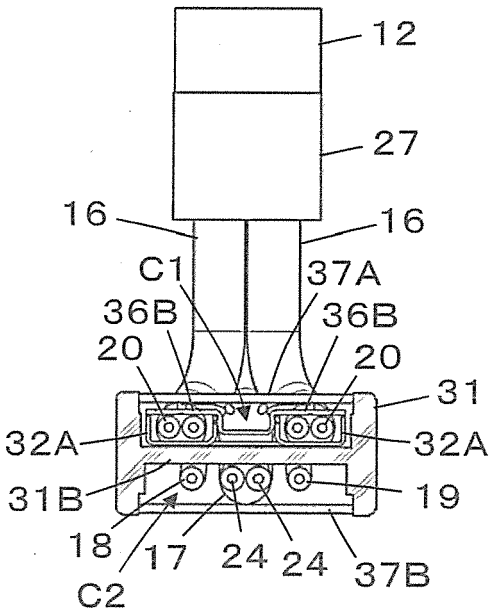

12
27
16
16
C1
37A
36B
36B
20
20
31
32A
32A
31B
19
18
17
24
24
37B
C2

FIG. 16

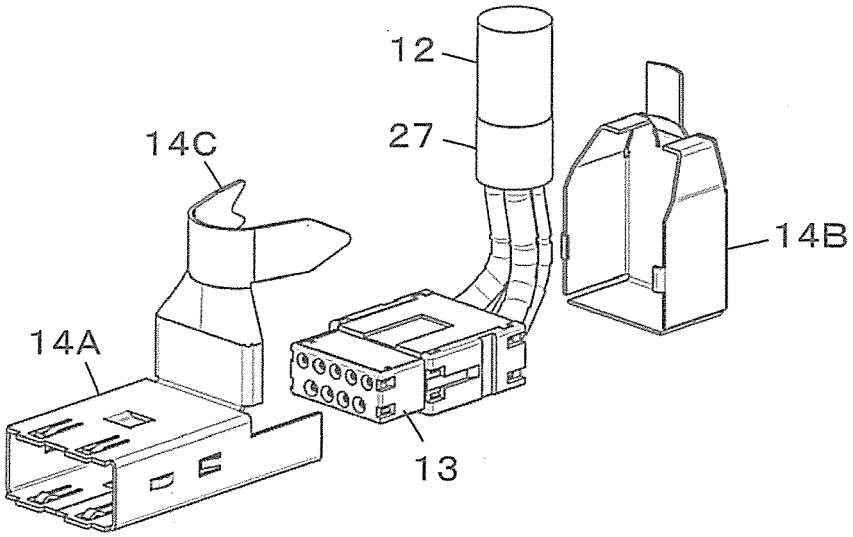


FIG. 17

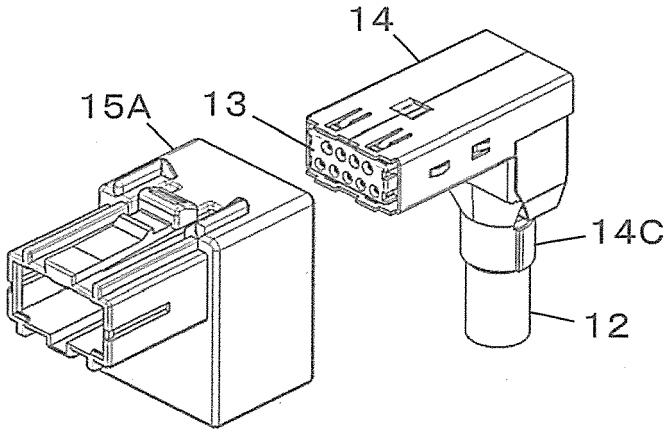


FIG. 18

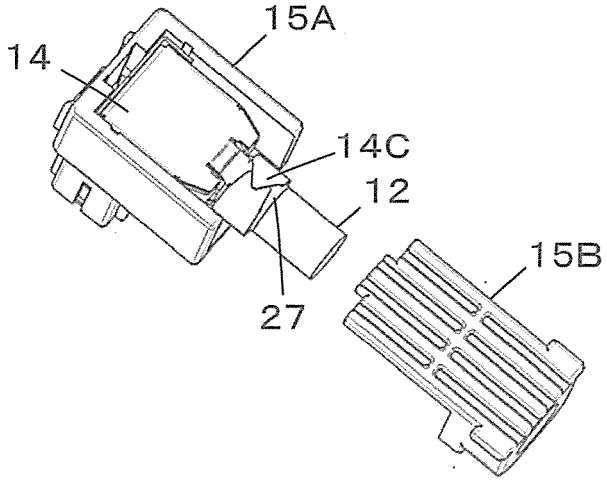


FIG. 19

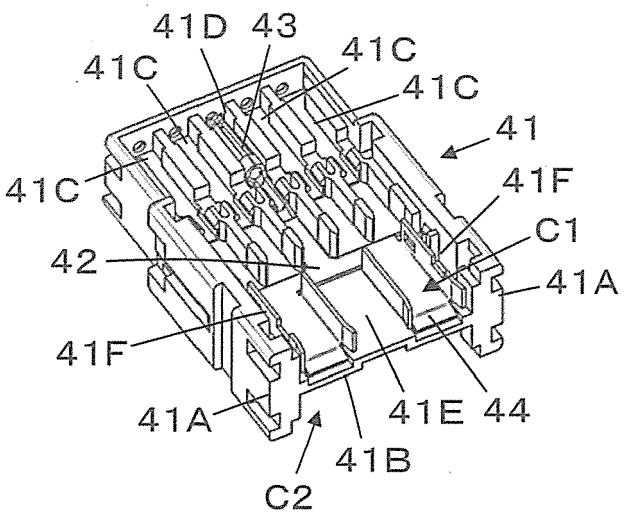


FIG. 20

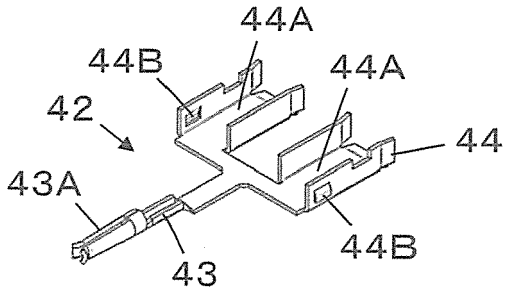


FIG. 21

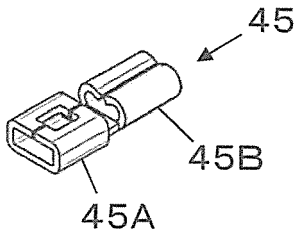


FIG. 22

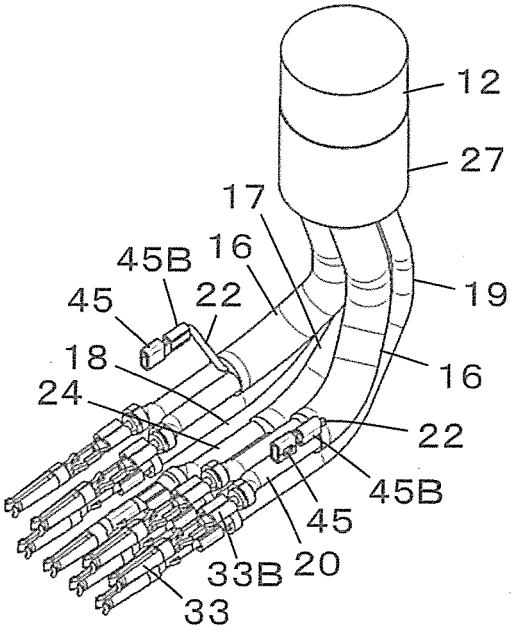

12
27
17
16
45B
22
45
19
18
16
24
22
45B
45
33B
20
33

FIG. 23

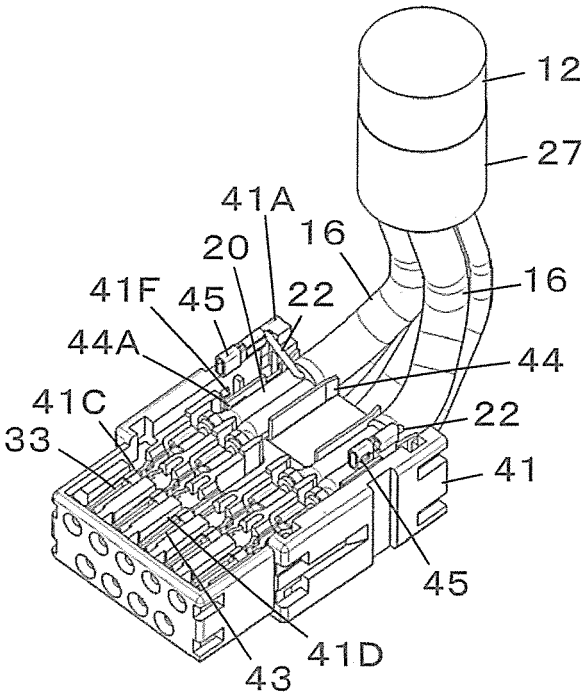

12
27
41A
16
20
16
41F
45
22
44A
44
41C
22
33
41
45
41D
43

FIG. 24

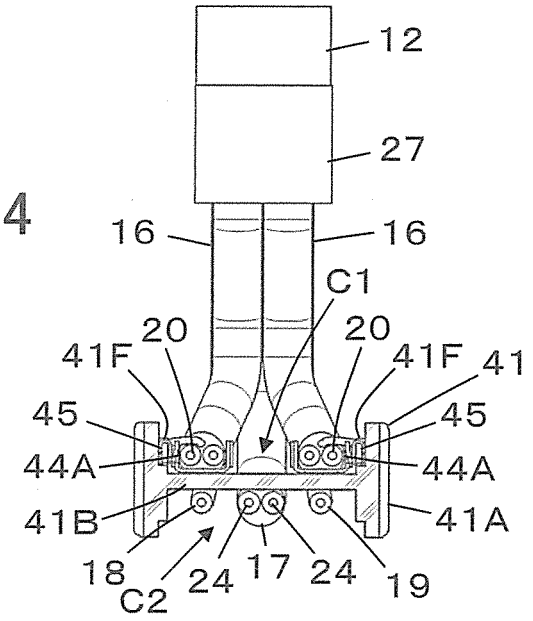

12
27
16
16
C1
20
20
41F
41F
41
45
45
44A
44A
41B
41A
18
C2
24
17
24
19

FIG. 25

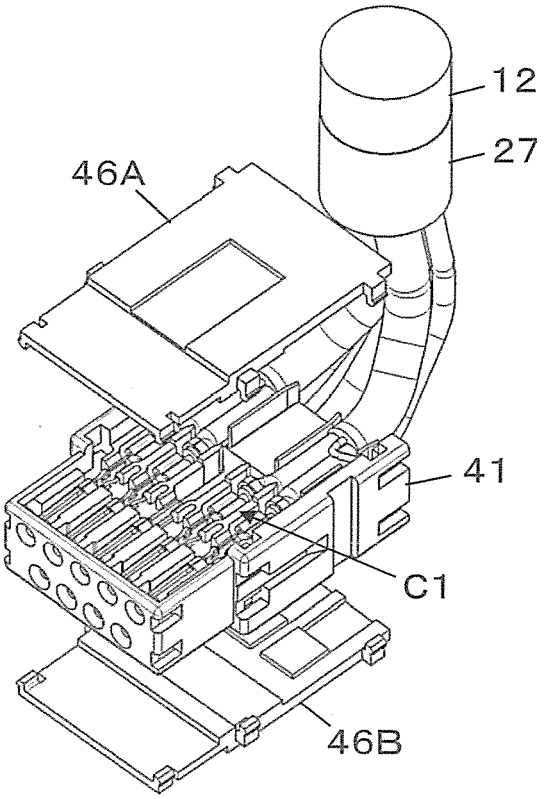

12
27
46A
41
C1
46B

FIG. 26

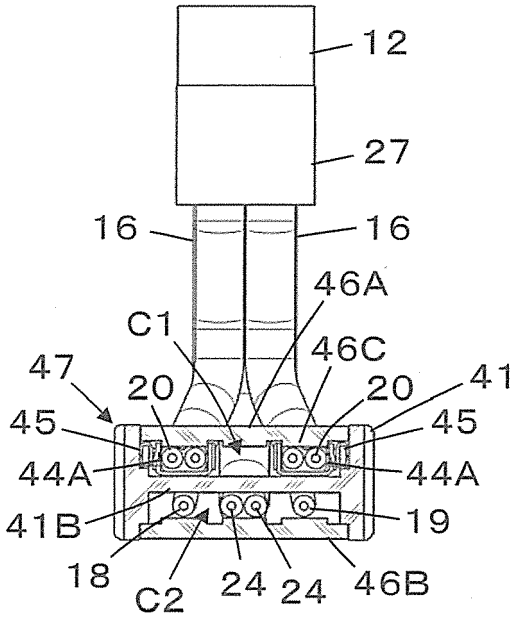


FIG. 27

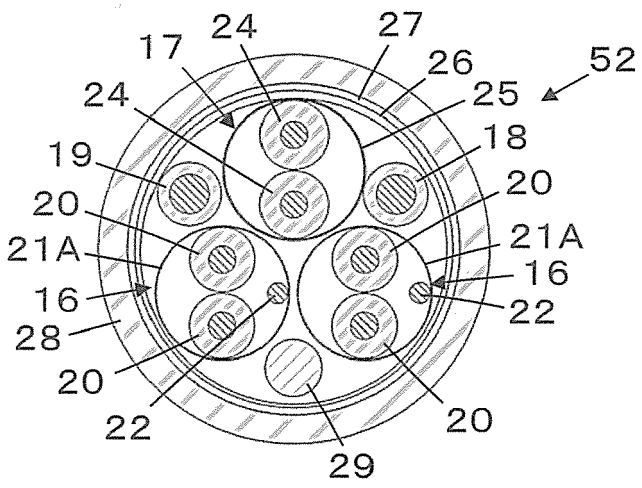
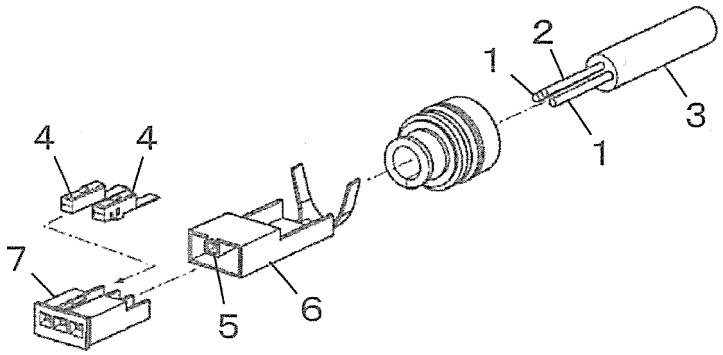


FIG. 28



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Patent documents cited in the description

- JP 2001351741 A **[0002] [0004]**