

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
15 April 2010 (15.04.2010)

PCT

(10) International Publication Number
WO 2010/042579 A2

(51) International Patent Classification:
H01R 13/646 (2006.01)

(21) International Application Number:
PCT/US2009/059786

(22) International Filing Date:
7 October 2009 (07.10.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2008-260403 7 October 2008 (07.10.2008) JP

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,

DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: COAXIAL CONNECTOR AND COAXIAL MULTI-POLE CONNECTOR

(57) Abstract: A coaxial connector is disclosed. The coaxial connector comprises a terminal unit for transmitting a high-frequency signal, which is provided with signal terminals connected to a signal line of a coaxial cable, and ground terminals connected to a ground line of the coaxial cable. The terminal unit comprises a cylindrical part, a semi-cylindrical part and a tongue-shaped part. Each signal terminal is provided with a signal tail portion and a signal contact portion. Each ground terminal comprises a ground tail portion, a ground body portion and a ground contact portion.



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COAXIAL CONNECTOR AND COAXIAL MULTI-POLE CONNECTOR

FIELD OF THE INVENTION

5 The present invention relates to a coaxial connector and a coaxial multi-pole connector.

BACKGROUND OF THE INVENTION

Hitherto, with an electrical device, an electronic device, and the like, when a
10 coaxial cable transmitting a high-frequency signal is connected to a board such as a printed circuit board, the coaxial cable is connected to a coaxial multi-pole connector which is provided with a signal terminal connected to a signal line of the coaxial cable and a shield terminal arranged to surround the signal terminal and to be connected to a shield of the coaxial cable and is mounted on the board (reference should be made to,
15 for example, Japanese Patent Application Laid-Open (Kokai) No. 8-021446).

Fig. 6 is a view illustrating a shield terminal of a coaxial multi-pole connector according to the prior art. Referring to Fig. 6, the shield terminal of a coaxial multi-pole connector, generally designated by reference numeral 851 has a lower end connected to a ground pin configured to project from a surface of a non-illustrated board and an
20 upper end connected to an end portion of a shield of a non-illustrated coaxial cable, so that the shield of the coaxial cable is electrically connected to a ground line of the board. Moreover, a non-illustrated signal pin configured to project from the surface of the board is inserted in the center of the shield terminal 851 having a hollow shape so as to be connected to a non-illustrated signal line of the coaxial cable.

25 Here, the shield terminal 851 includes a cylindrical portion 852 connected to the

end portion of the shield of the coaxial cable and a coaxial half-cylindrical portion 853 connected to be integral with a lower end of the cylindrical portion 852. Moreover, the half-cylindrical portion 853 is provided with a pair of ground connection portions 854 configured to extend outwardly from both ends of the half-cylindrical portion per se and
5 pin contact portions 855 configured to extend downwardly from respective lower ends of the ground connection portions 854 and to be bent inwardly so as to form opposite V-shape ridges at the middle thereof. Furthermore, the cylindrical portion 852 is provided with a pair of shield-contact portions 856 which are cut and depressed inwardly.

The ground pin projecting from the surface of the board is clamped by the pair of
10 pin contact portions 855 in a sandwich manner, so that the shield terminal 851 is connected to the ground line of the board. On the other hand, the end portion of the shield of the coaxial cable is pinched between the pair of shield-contact portions 856, so that the shield terminal 851 is connected to the shield of the coaxial cable.

However, in the conventional coaxial multi-pole connector, a structure in which a
15 high-frequency signal transmission line is formed by the signal pin and the shield terminal 851 surrounding the signal pin abruptly changes between a position at which the shield of the coaxial cable makes contact with the shield-contact portion 856 and a different position at which the ground pin makes contact with the pin contact portion 855. Therefore, a transmission mode of the transmission line must abruptly change
20 depending on the structure of the transmission line. Consequently, generation of loss such as reflection, attenuation, resonance or radiation takes place in relation to frequency bands, and thus, the high-frequency signal transmission characteristics are necessarily deteriorated.

Moreover, when the number of coaxial multi-pole connectors and the number of
25 signal and ground pins projecting from the surface of the board are increased to comply

with an increase in the number of signal channels for transmission through the coaxial cable, an overall size of each of the connectors may increase accordingly. Therefore, when there is no dimensional margin in an electronic device or the like having the board mounted thereon and there is a limitation in the width dimension of respective one of the
5 connectors, it is difficult to sufficiently cope with a request for multiplying the channel for signal transmission, that is, for multiplying the signal polarities.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to obviate the above-described
10 problems encountered by the conventional coaxial multi-pole connector and to provide a coaxial connector and a coaxial multi-pole connector respectively having such a configuration that a semi-cylindrical ground portion arranged to surround a half-perimeter of a signal line exposed by coming out of an end of a coaxial cable and a strip-like relay base having an upper surface thereof on which a flat plate-like signal wire
15 connected to the signal line and a flat plate-like ground wire connected to the semi-cylindrical ground portion are disposed in parallel with each other, are arranged in series with one another in an axial direction, whereby it is possible not only to prevent generation of loss such as reflection, attenuation, resonance or radiation in a high-frequency signal transmission line provided by a signal terminal and a ground terminal
20 but also to connect a number of coaxial cables to a counterpart board without increasing the dimension in the width and thickness directions of each connector. Accordingly, the coaxial connector and the coaxial multi-pole connector are able to appropriately comply with multiplying of signal polarities, to realize high durability and high reliability thereof and to enable manufacture thereof with a small size at a low cost and in a simple
25 structure.

Therefore, a coaxial connector according to the present invention comprises a terminal unit for transmitting a high-frequency signal, which is provided with signal terminals connected to a signal line of a coaxial cable and ground terminals connected to a ground line of the coaxial cable, wherein: the terminal unit comprises a cylindrical part, a semi-cylindrical part arranged in front of the cylindrical part, and a tongue-shaped part arranged in front of the semi-cylindrical part; each of the signal terminals is provided with a signal tail portion connected to the signal line in the semi-cylindrical part and a signal contact portion configured to make contact with a counterpart signal terminal of a counterpart connector in the tongue-shaped part; and each of the ground terminals comprises a ground tail portion connected to the ground line in the cylindrical part, a ground body portion configured to cover an upper portion of the signal tail portion in the semi-cylindrical part, and a ground contact portion configured to make contact with the counterpart ground terminal of the counterpart connector in the tongue-shaped part.

The coaxial connector according to another embodiment of the present invention has such a configuration that the signal tail portion has a flat plate-like shape, and the signal contact portion is provided with a flat plate-like contact surface portion arranged to make contact with the counterpart signal terminal, that the ground body portion is provided with a half-cylinder portion arranged to cover an upper portion of the signal tail portion, and the ground contact portion is provided with a flat plate-like contact surface portion arranged to make contact with the counterpart ground terminal, and that the contact surface portion of the signal contact portion and the contact surface portion of the ground contact portion are even with each other and extend in an axial direction of the terminal unit at an equal interval and in parallel with each other.

The coaxial connector according to a further embodiment of the present invention

has such a configuration that each of the signal terminals is provided with a signal connection portion configured to connect the signal tail portion and the signal contact portion, that each of the ground terminals is provided with a ground connection portion configured to connect the ground tail portion and the ground contact portion, and that a distance between the signal tail portion and the ground tail portion is identical with a distance between the signal connection portion and the ground connection portion and with a distance between the signal contact portion and the ground contact portion.

The coaxial connector according to a still further embodiment of the present invention has such a configuration that an outer diameter of each of the cylindrical part and the semi-cylindrical part and a width of the tongue-shaped part are substantially identical with an outer diameter of the coaxial cable, respectively.

The coaxial connector according to another embodiment of the present invention has such a configuration that the tongue-shaped part has a thickness thereof equal to or smaller than a radius of the coaxial cable.

A coaxial multi-pole connector according to the present invention comprises: a terminal unit for transmitting a high-frequency signal, which is provided with signal terminals, each being connected to a signal line of a coaxial cable and ground terminals, each being connected to a ground line of the coaxial cable; and a housing which is provided with a terminal support member configured to support the terminal unit and is capable of being engaged, by fitting, with a counterpart housing of a counterpart connector, wherein: the terminal unit is provided with cylindrical parts, semi-cylindrical parts arranged in front of the cylindrical parts, and tongue-shaped parts arranged in front of the semi-cylindrical parts; each of the signal terminals being provided with a signal tail portion connected to the signal line in the semi-cylindrical part and a signal contact portion configured to make contact with a counterpart signal terminal of the

counterpart connector in the tongue-shaped part and; and each of the ground terminals being provided with a ground tail portion connected to the ground line in the cylindrical part, a ground body portion configured to cover an upper portion of the signal tail portion in the semi-cylindrical part and a ground contact portion configured to make contact with the counterpart ground terminal of the counterpart connector in the tongue-shaped part.

The coaxial multi-pole connector according to another embodiment of the present invention has such a configuration that the semi-cylindrical parts are arranged so that the semi-cylindrical parts have respective open ends thereof which are disposed to face each other.

In accordance with the present invention, the coaxial connector has a configuration in which a semi-cylindrical ground portion configured to surround a half-perimeter of a signal line exposed by coming out of an end of a coaxial cable and a strip-like relay base having an upper surface, on which a flat plate-like signal line connected to the signal line and a flat plate-like ground line connected to the semi-cylindrical ground portion are arranged in parallel with one another, are arranged in series with each other in an axial direction. Owing to this configuration, it is possible to prevent generation of loss such as reflection, attenuation, resonance or radiation in a high-frequency signal transmission line provided by a signal terminal and a ground terminal. Moreover, it is possible to connect a number of coaxial cables to a counterpart board without increasing the dimension in the width and thickness directions. Accordingly, it is possible to provide a coaxial connector and a coaxial multi-pole connector which are capable of appropriately coping with demands for multiplying signal polarities, which have high durability and high reliability and can be manufactured with a small size at a low cost and in a simple structure.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a cable connector according to an embodiment of the present invention, illustrating a state where any counterpart connector is not yet tightly fitted to the cable connector;

5 Fig. 2 is a cross-sectional view of the cable connector according to the embodiment of the present invention, illustrating a state where the coaxial cables are tightly fitted to a board connector;

Fig. 3 is a perspective view illustrating the positional relationship between the terminal units according to the embodiment of the present invention and the counterpart
10 terminals;

Figs. 4A to 4G are four planar views and cross-sectional views illustrating the structure of the terminal unit according to the embodiment of the present invention, in which Fig. 4A is a top plan view, Fig. 4B is a front view, Fig. 4C is a rear view, Fig. 4D is a side view, Fig. 4E is a cross-sectional view taken along the arrows Z-Z in Fig. 4A, Fig.
15 4F is a cross-sectional view taken along the arrows Y-Y in Fig. 4A, and Fig. 4G is a cross-sectional view taken along the arrows X-X in Fig. 4A;

Figs. 5A to 5D are perspective views and exploded views illustrating the structure of the terminal unit according to the embodiment of the present invention, in which Fig. 5A is a perspective view, Fig. 5B is an exploded view with a ground terminal removed
20 therefrom, Fig. 5C is an exploded view of a relay base, and Fig. 5D is a perspective view of the relay base; and

Fig. 6 is a view illustrating a shield terminal of a coaxial multi-pole connector according to the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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Description of preferred embodiments of the present invention will be provided herein below in detail with reference to the accompanying drawings.

Fig. 1 is a perspective view illustrating a state where a cable connector according to an embodiment of the present invention is not yet fitted to any counterpart connector; and Fig. 2 is a cross-sectional view illustrating a state where the cable connector according to the embodiment of the present invention is tightly fitted to a board connector.

In the drawing figures, a cable connector as a coaxial multi-pole connector being an example of a coaxial connector according to the present embodiment, generally designated by reference numeral 1, is a connector connected to front ends of a plurality of cables 91 constructing wires. As illustrated in Fig. 2, the cable connector 1 is engaged, by tight fitting, with a board connector 101 as a counterpart connector connected to one side surface (the right side surface in Fig. 2) of a board 191.

The board 191 is a flat plate-like cable, such as a printed circuit board, a Flexible Printed Circuit (FPC), or a Flexible Flat Cable (FFC), used in an electronic device or apparatus such as a computer, or electric devices or apparatuses such as consumer electronic appliances, and may be any type of board as long as it is a flat plate-like cable.

Moreover, a plurality of non-illustrated connection electrodes arranged to be in parallel with one another at a predetermined pitch in the width direction (a direction perpendicular to the drawing sheet of Fig. 2) of the board 191 is exposed to a surface of the board 191. The respective connection electrodes are connected to a plurality of lines of non-illustrated conductive traces formed on the surface of the board 191 and arranged to be in parallel with one another at a predetermined pitch in the width direction of the board 191. It is to be noted that the pitch and the number of the

connection electrodes and the conductive traces can be appropriately configured, if necessary.

Although the cable 91 may be any type of cable, it will be described as being a thin coaxial cable, for example, which is suitable for transmitting a high-frequency signal.

5 As will be described later, the cable 91 is a linear object having an approximately circular sectional shape, which is provided with a conductive core line 92 as a signal line arranged at the center and a conductive shielding member 94, as a ground line, formed, for example, of a metallic mesh and arranged to surround a perimeter of the core line 92. Moreover, the cable 91 is arranged to extend in the width direction of the cable
10 connector 1 and to form a plurality of rows. Furthermore, although the pitch and the number of the cables 91 may be appropriately configured, in the example illustrated in the drawing figures, the cable 91 is arranged to extend in the width direction of the cable connector 1 and to form two rows.

In addition, in the present embodiment, representations of directions such as up,
15 down, left, right, front, rear, and the like, used for explaining the structure and movement of the cable connector 1, the board connector 101, and each part of other components are not absolute, but relative. These representations are appropriate when the cable connector 1, the board connector 101, and each part of other components are in the position shown in the drawing figures. If the position of the cable connector 1, the
20 board connector 101, or each part of other components changes, however, it is assumed that these representations are to be changed according to a change in the position of the cable connector 1, the board connector 101, or each part of other components.

Here, the cable connector 1 is provided with a first housing 11 as a housing that
25 is integrally formed of an insulating material such as synthetic resin and a terminal

support member 17 which is arranged in the first housing 11. The terminal support member 17 is a rectangular plate-like member that is integrally formed of an insulating material such as synthetic resin, and terminal units 50 connected to the front end of the cable 91 are attached to top and back surfaces thereof. As illustrated in Fig. 1, on the top and back surfaces of the terminal support member 17, a plurality of terminal units 50 is arranged to extend in the width direction of the terminal support member 17, that is, in the width direction of the cable connector 1.

Moreover, the first housing 11 is provided with a terminal accommodating opening portion 13 that accommodates therein the terminal support member 17. The terminal accommodating opening portion 13 is an opening portion which has a perimeter thereof defined by upper and lower top plate parts 12 and left and right lateral plate parts 14 and is opened to a fitting surface side. Moreover, an interior of the terminal accommodating opening portion 13 is divided into two parts of upper and lower parts by the terminal support member 17 so that the terminal unit 50 is accommodated in each of the two parts. Furthermore, latching openings 11a are formed on outer surfaces of the top plate parts 12 so as to latch latching portions 73d of the terminal units 50.

The terminal unit 50 connected to the front end of each cable 91 is fixed by being inserted into both upper and lower parts of the terminal support member 17 from a rear surface (a surface opposite to the fitting surface) side of the first housing 11. The terminal unit 50 includes a later-described relay base 31 that is integrally formed of an insulating material such as synthetic resin and a metallic ground terminal 71 that is fixed to the relay base 31 and is connected to the shielding member 94 of the cable 91 by means of soldering or the like. Moreover, on an upper surface of a strip plate-like tongue part 32 of the relay base 31, a plate-like signal contact portion 52 connected to

the core line 92 of the cable 91 and a plate-like ground contact portion 72 being a front end portion of the ground terminal 71 are arranged in parallel with each other. In this manner, on both upper and lower surfaces of the terminal support member 17, a plurality of elongated plate-like signal contact portions 52 extending in the fitting direction of the cable connector 1 and a plurality of ground contact portions 72 are alternately arranged to be in parallel with each other. Moreover, it should be appreciated that the pitch and the number of the terminal units 50 on the upper and lower surfaces of the terminal support member 17 may be appropriately set as required.

Meanwhile, the board connector 101 includes a second housing 111 as a counterpart housing formed of an insulating material such as synthetic resin and a plurality of counterpart terminals 161 formed of conductive metal and fitted in the second housing 111.

As illustrated in Fig. 2, the second housing 111 is provided with a counterpart-side opening portion 113 that is opened on the fitting face side, so that a predetermined range of portion from an extreme portion of the terminal support member 17 is permitted to come into the counterpart opening portion 113 under a state where the board connector 101 and the cable connector 1 are engaged to be fitted to each other.

The counterpart terminals 161 are accommodated in a plurality of terminal receiving grooves 114 formed in upper and lower inner faces of the second housing 11.

The terminal receiving grooves 114 also extend inside the counterpart-side opening portion 113. Moreover, it should be appreciated that the counterpart terminals 161 include counterpart signal terminals configured to make contact with later-described signal terminals 51 and counterpart ground terminals configured to make contact with the ground terminals 71. However, since the counterpart signal terminals and the counterpart ground terminals have the same structure, these elements will be described

as the counterpart terminals 161 without distinctive identification among them.

The counterpart terminal 161 is provided with a body portion 162 that is mounted in the terminal receiving groove 114, a cantilever-like contacting arm portion 163 configured to extend frontwardly from the body portion 162, that is, toward the fitting
5 face of the mated connectors, a contacting bulging portion 164 disposed in the vicinity of the front end of the contacting arm portion 163 so as to protrude toward the center in the thickness direction (the up-down direction in Fig. 2) of the second housing 111, and a contacting leg portion 165 that is formed by bending a midway of a portion extending from the body portion 162 rearwardly, namely, in a direction away from the above-
10 mentioned fitting face of the mated connectors, and is configured to extend outwardly in the thickness direction of the second housing 111. Moreover, at least a part of the contacting leg portion 165 extends beyond the rear end of the second housing 111 to be exposed to the outside of the second housing 111.

In a state where the board connector 101 and the cable connector 1 are engaged
15 by fitting together with each other, the contacting bulging portions 164 make contact with the signal contact portions 52 and the ground contact portions 72 arranged respectively on the opposite surfaces of the terminal support member 17. In this case, the contacting arm portions 163 having elastic properties function as a plate spring, respectively, so that the contacting bulging portions 164 are urged against the surfaces
20 of the signal contact portions 52 and the ground contact portions 72 in response to an urging force exerted by the respective contacting arm portions 163, whereby mechanical and electrical contact with the signal contact portions 52 and the ground contact portions 72 can be certainly maintained.

Moreover, the board 191 and the board connector 101 are fixedly secured to
25 each other by means of conductive fixing means such as soldering with the contacting

leg portions 165 being in contact with non-illustrated connection electrodes which are arranged to be exposed to both surfaces of the board 191.

In this manner, when the cable connector 1 is engaged, by fitting, with the board connector 101 attached to the board 191, the signal contact portions 52 and the ground contact portions 72 of the terminal unit 50 connected to each cable 91 are electrically connected to corresponding connection electrodes of the board 191 via the counterpart terminal 161. Therefore, the signal line and the ground line of each cable 91 are electrically connected to corresponding conductive traces of the board 191.

Moreover, the pitch and the number of the counterpart terminals 161 may be appropriately configured to be suitable for the pitch and the number of the signal contact portions 52 and the ground contact portions 72 and the pitch and the number of the connection electrodes.

Next, a detailed description of the structure of the terminal unit 50 will now be provided herein below.

Fig. 3 is a perspective view illustrating the positional relationship between a terminal unit and a counterpart terminal according to the embodiment of the present invention; Figs. 4A to 4G are four planar views and cross-sectional views illustrating the structure of the terminal unit according to the embodiment of the present invention; and Figs. 5A to 5D are perspective views and exploded views illustrating the structure of the terminal unit according to the embodiment of the present invention. In Figs. 4A to 4G, Fig. 4A is a top plan view, Fig. 4B is a front view, Fig. 4C is a rear view, Fig. 4D is a side view, Fig. 4E is a cross-sectional view taken along the arrows Z-Z in Fig. 4A, Fig. 4F is a cross-sectional view taken along the arrows Y-Y in Fig. 4A, and Fig. 4G is a cross-sectional view taken along the arrows X-X in Fig. 4A. In Figs. 5A to 5D, Fig. 5A is a perspective view, Fig. 5B is an exploded view with a ground terminal removed therefrom,

Fig. 5C is an exploded view of a relay base, and Fig. 5D is a perspective view of the relay base.

In the present embodiment, as described above, the terminal unit 50 is connected to the front end of each cable 91. As illustrated in Fig. 5B, the cable 91 is a linear object having an approximately circular sectional shape, which is provided with the conductive core line 92 as a signal line arranged at the center, an insulating inside cladding 93 configured to cover the perimeter of the core line 92, the conductive shielding member 94, as a ground line, formed, for example, of a metallic mesh and arranged to cover the perimeter of the inside cladding 93, and an insulating outside cladding 95 configured to cover the perimeter of the shielding member 94. Moreover, at the front end of the cable 91, the outside cladding 95, the shielding member 94, and the inside cladding 93 are removed in order so that the shielding member 94, the inside cladding 93, and the core line 92 are exposed in order.

Moreover, the terminal unit 50 includes the elongated relay base 31 that is integrally formed of an insulating material such as synthetic resin, the metallic ground terminal 71 that is fixed to the relay base 31 and is connected to the shielding member 94 of the cable 91 by means of soldering or the like, and a metallic strip plate-like signal terminal 51 that is coupled by integral molding to the relay base 31. Furthermore, the terminal unit 50 is divided into a cylindrical part 50a, a semi-cylindrical part 50b, and a tongue-shaped part 50c from rear to front in the axial direction.

As illustrated in Fig. 5C, the relay base 31 is provided with a central part 33 disposed in the semi-cylindrical part 50b, a strip plate-like tongue part 32 disposed in the tongue-shaped part 50c and extending frontward (leftward in the figure) from the central part 33, a front end portion 37 formed at a front end of the tongue part 32 and disposed in the tongue-shaped part 50c, a cable receiving portion 34 disposed in the

semi-cylindrical part 50b and extending rearward (rightward in the figure) from the central part 33, and a positioning projection 35 disposed in the semi-cylindrical part 50b and projecting upwardly from a connection portion of the central part 33 and the cable receiving portion 34.

5 Moreover, a cladding-accommodating concave portion 34a is formed in an upper surface of the cable receiving portion 34 so as to accommodate a portion of the cable 91 exposing the inside cladding 93. Furthermore, a groove portion 35a configured to pass the exposed core line 92 therethrough is formed in the positioning projection 35. Furthermore, a tail-accommodating concave portion 33a is formed in an upper surface
10 of the central part 33 so as to accommodate a signal tail portion 53 of the signal terminal 51. In addition, a bridge 33b configured to connect both sidewalls of the tail-accommodating concave portion 33a is formed above a front end of the tail-accommodating concave portion 33a to thereby regulate an upward displacement of the signal tail portion 53 accommodated in the tail-accommodating concave portion 33a as
15 illustrated in Fig. 4F, thus preventing the signal tail portion 53 from being removed from the tail-accommodating concave portion 33a. Although Fig. 5C illustrates a state where the signal terminal 51 and the relay base 31 are separated from each other for better understanding of the structure of the relay base 31, the signal terminal 51 is formed to be integral with the relay base 31 as illustrated in Fig. 5D by a molding method such as
20 overmolding using resin, for example, and thus, it is a member that cannot be removed from the relay base 31. Furthermore, latching projections 36 are formed on both side surfaces of the cable receiving portion 34 and the central part 33 so as to latch the ground terminal 71.

 Moreover, in an upper surface of the tongue part 32, a signal contact-
25 accommodating concave portion 32c in which a contact surface portion 52a of the

signal contact portion 52 of the signal terminal 51 is accommodated and a ground contact-accommodating concave portion 32b in which a contact surface portion 72a of the ground contact portion 72 of the ground terminal 71 are formed in parallel with each other. Moreover, a portion disposed between the signal contact-accommodating concave portion 32c and the ground contact-accommodating concave portion 32b becomes an elongated linear convex boundary part 32a that extends in the axial direction of the cable 91, that is, in the axial direction of the terminal unit 50. The convex boundary part 32a has an almost constant width, so that a constant gap between the signal contact portion 52 and the ground contact portion 72 can be maintained. Moreover, a height of the convex boundary part 32a, that is, a dimension measured from an upper surface of the signal contact-accommodating concave portion 32c and an upper surface of the ground contact-accommodating concave portion 32b to an upper surface of the convex boundary part 32a is almost identical with the thickness of the contact surface portion 52a of the signal contact portion 52 and the thickness of the contact surface portion 72a of the ground contact portion 72. Owing to such a configuration, in a state where the signal terminal 51 and the ground terminal 71 are attached to the relay base 31, the upper surface of the convex boundary part 32a is even with the contact surface portion 52a of the signal contact portion 52 and with the contact surface portion 72a of the ground contact portion 72, as illustrated in Fig. 4E.

Moreover, a sloped surface 37a downwardly inclined toward the front side is formed on an upper surface of the front end of the front end portion 37. The sloped surface 37a functions as a guide surface that guides the contacting bulging portion 164 of the counterpart terminal 161 so that, when the cable connector 1 and the board connector 101 are engaged by tight fitting with each other, the contacting bulging portion 164 is relatively moved along the sloped surface 37a to thereby make smooth

contact with the contact surface portion 52a of the signal contact portion 52 and with the contact surface portion 72a of the ground contact portion 72. Furthermore, concave portions 37b and 37c are formed at boundary portions between the front end portion 37 and the ground contact-accommodating concave portion 32b and the signal contact-accommodating concave portion 32c, respectively. The front end portion 72c of the ground contact portion 72 and the front end portion 52c of the signal contact portion 52 are accommodated in the concave portions 37b and 37c, respectively. Therefore, no step is formed between the upper surface of the front end portion 37 and the contact surface portion 72a of the ground contact portion 72 and the contact surface portion 52a of the signal contact portion 52. As a result, it is possible to smoothly guide the contacting bulging portion 164 of the counterpart terminal 161 when the cable connector 1 and the board connector 101 are engaged by tight fitting with each other.

The ground terminal 71 is a member that is integrally formed by applying processing, e.g., punching and bending, to a metal plate. The ground terminal 71 is provided with the ground body portion 73 disposed in the semi-cylindrical part 50b so as to cover the central part 33 of the relay base 31 and the upper surface and the side surfaces of the cable receiving portion 34, the strip plate-like ground contact portion 72 disposed in the tongue-shaped part 50c so as to extend frontward from the ground body portion 73, the strip plate-like ground tail portion 74 disposed in the cylindrical part 50a so as to extend rearward from the ground body portion 73, and a ground connection portion 75 configured to connect the ground body portion 73 and the ground contact portion 72.

As illustrated in Fig. 4G, the ground body portion 73 is provided with a half-cylinder portion 73a having a semi-cylindrical shape and configured to cover the central part 33 of the relay base 31 and the upper surface of the cable receiving portion 34,

side surface portions 73b configured to extend downward from lower ends on both sides of the half-cylinder portion 73a and to cover the central part 33 and the side surfaces of the cable receiving portion 34, a latching hole 73c configured as a hole formed in the side surface portion 73b to be latched to the latching projection 36 of the relay base 31, and a latching piece 73d configured as a cut and raised piece formed by cutting and raising the upper surface of the half-cylinder portion 73a so that, when the terminal unit 50 is inserted into both upper and lower parts of the terminal support member 17 of the first housing 11, it is latched to the latching opening 11a of the first housing 11, thereby functioning as a removal preventing member of the terminal unit 50.

The ground tail portion 74 includes a winding portion 74a wound around the perimeter of the exposed shielding member 94 of the cable 91 and a connection opening 74b configured as an opening formed in an upper surface of the winding portion 74a so that the ground tail portion 74 and the shielding member 94 are physically fixed and electrically connected to each other by applying a conductive fixing agent such as solder thereto. Moreover, as illustrated in Fig. 4C, the winding portion 74a preferably covers, and makes abutting contact with, the perimeter of the shielding member 94 within a range of angles equal to and greater than 180 degrees and smaller than 360 degrees.

The ground contact portion 72 is provided with the contact surface portion 72a that is parallel with the upper surface of the tongue part 32 and the side surface portions 72b that are parallel with the side surfaces of the tongue part 32, thus exhibiting an L shape in sectional view, as illustrated in Fig. 4E. Moreover, the side surface portions 72b cover the side surfaces of the tongue part 32 to be even with the ground connection portion 75 and one side surface portion 73b of the ground body portion 73. Furthermore, the ground contact portion 72 is provided with the front end portion 72c formed at the

front end to be accommodated in the concave portion 37b of the front end portion 37.

The signal terminal 51 is a member that is integrally formed by applying processing, e.g., punching and bending, to a metal plate. The signal terminal 51 is provided with the signal tail portion 53 disposed in the semi-cylindrical part 50b so as to make contact with the exposed core line 92 of the cable 91, the strip plate-like signal contact portion 52 disposed in the tongue-shaped part 50c so as to extend frontward from the signal tail portion 53, and a signal connection portion 55 configured to connect the signal tail portion 53 and the signal contact portion 52.

The signal tail portion 53 is a rectangular flat plate-like member and is accommodated in the tail-accommodating concave portion 33a of the relay base 31. Moreover, as illustrated in Fig. 4G, the core line 92 is in contact with the upper surface of the signal tail portion 53. Preferably, the signal tail portion 53 and the core line 92 are physically fixed and electrically connected to each other by applying a conductive fixing agent such as solder.

The signal contact portion 52 is provided with the contact surface portion 52a that is parallel with the upper surface of the tongue part 32 and the side surface portions 52b that are parallel with the side surfaces of the tongue part 32, thus exhibiting an L shape in sectional view, as illustrated in Fig. 4E. Although the contact surface portion 52a extends in the axial direction of the terminal unit 50 similar to the signal tail portion 53, it is offset from the signal tail portion 53 in the width direction of the terminal unit 50 as viewed from the upper surface thereof. Owing to such a configuration, the signal connection portion 55 extends oblique to the axial direction of the terminal unit 50. Moreover, the side surface portions 52b cover the side surfaces of the tongue part 32. Furthermore, the signal contact portion 52 is provided with the front end portion 52c formed at the front end to be accommodated in the concave portion 37c of the front end

portion 37.

As described above, the signal terminal 51 is formed to be integral with the relay base 31 as illustrated in Fig. 5D by a molding method such as overmolding using resin. Moreover, as illustrated in Fig. 5B, the front end of the cable 91 in which the shielding member 94, the inside cladding 93, and the core line 92 are exposed in order is connected to the relay base 31. In this case, the inside cladding 93 is accommodated in the cladding-accommodating concave portion 34a, and the core line 92 has one part thereof being fitted in the groove portion 35a of the positioning projection 35 and the other part thereof being placed on the signal tail portion 53 accommodated in the tail-accommodating concave portion 33a. Moreover, the positioning in the axial direction of the cable 91 with respect to the relay base 31 is carried out by bringing the front end of the inside cladding 93 into abutting contact with the positioning projection 35. Furthermore, preferably, the signal tail portion 53 and the core line 92 are physically fixed and electrically connected to each other by applying a conductive fixing agent such as solder.

Subsequently, as illustrated in Fig. 5B, the ground terminal 71 is attached from the upper side of the relay base 31 to which the front end of the cable 91 is connected. In this case, positioning is carried out such that the ground body portion 73 covers the central part 33 of the relay base 31, the upper surface of the cable receiving portion 34, and the upper surface of the core line 92 and the inside cladding 93 of the cable 91, that the ground tail portion 74 covers the upper surface of the shielding member 94 of the cable 91, and that the contact surface portion 72a of the ground contact portion 72 is accommodated in the ground contact-accommodating concave portion 32b of the relay base 31. Moreover, the latching projection 36 of the relay base 31 is latched to the latching hole 73c of the ground body portion 73. Furthermore, the ground tail portion 74

is deformed so as to cover the perimeter of the shielding member 94 within a range of angles equal to or greater than 180 degrees and smaller than 360 degrees. In addition, the ground tail portion 74 and the shielding member 94 are physically fixed and electrically connected to each other by applying a conductive fixing agent such as solder to the connection opening 74b. In this way, it is possible to obtain the terminal unit 50 to which the front end of the cable 91 is connected.

In the terminal unit 50, the signal terminal 51 is connected to the core line 92 of the cable 91 being a coaxial cable to thereby function as a signal line of a high-frequency signal transmission line. Moreover, the ground terminal 71 is connected to the shielding member 94 of the cable 91 to thereby function as a shield capable of blocking noise components and as a ground line of the high-frequency signal transmission line. Here, a transmission mode of the transmission line transmitting a high-frequency signal changes depending on the structure of the transmission line, specifically, on the shape, dimension, arrangement and the like of the signal line and the ground line. Therefore, when the shape, dimension, arrangement, and the like of the signal line and the ground line change abruptly, as described above in "Summary Of The Invention," the transmission mode of the transmission line changes abruptly, and thus, loss such as reflection, attenuation, resonance or radiation occurs depending on frequency bands, thus deteriorating the high-frequency signal transmission characteristics.

Therefore, in the present embodiment, by gradually changing the shape, dimension, arrangement, and the like of the signal terminal 51 functioning as the signal line and the ground terminal 71 functioning as the ground line in the terminal unit 50, the transmission mode of the signal terminal 51 and the ground terminal 71 being the transmission line of the high-frequency signal is made to change gradually. More

specifically, an arrangement of the signal line and the ground line formed by the elongated strip-like signal tail portion 53 connected to the lower end of the narrow circular column-shaped core line 92 and the half-cylinder portion 73a and the side surface portions 73b covering the upper portion of the signal tail portion 53 within a range of angles equal to or greater than 180 degrees is changed to an arrangement of the signal line and the ground line formed by the elongated strip-like signal connection portion 55 and the elongated strip-like ground connection portion 75 having a sectional shape that extends perpendicular to the signal connection portion 55, while being changed to an arrangement of the signal line and the ground line formed by the signal contact portion 52 and the ground contact portion 72 having an L shape in sectional view and extending in parallel with each other, whereby the transmission mode of the transmitted high-frequency signal is gradually changed.

As will be clearly understood from comparison between Figs. 4F and 4G, the closest distance between the signal connection portion 55 and the ground connection portion 75 is almost identical with the closest distance between the signal tail portion 53 and the ground body portion 73. That is, within a range of areas from the signal tail portion 53 and the ground body portion 73 to the signal connection portion 55 and the ground connection portion 75, the gap between the signal line and the ground line is almost constant.

Moreover, as is obvious from Fig. 4A, a gap between the contact surface portion 72a of the ground connection portion 75 and the ground contact portion 72 and the contact surface portion 52a of the signal connection portion 55 and the signal contact portion 52 is almost constant in the portion disposed closer to the front end than the ground body portion 73, that is, over the approximately entire range of the tongue part 32. That is, over the approximately entire range of the tongue part 32, the gap between

the signal line and the ground line formed in parallel on the same surface is almost constant.

As described above, in the terminal unit 50, since the gap between the signal line and the ground line is maintained constant, the transmission mode of the transmission
5 line does not change abruptly, and loss such as reflection, attenuation, resonance or radiation does not occur, and thus, good transmission characteristics of the high-frequency signal can be provided. Therefore, by connecting the terminal unit 50 to the cable 91 being the coaxial cable, it is possible to change the arrangement between the signal line disposed at the center and the ground line surrounding the signal line on a
10 concentric circle to the arrangement between the signal line and the ground line arranged in parallel on the same surface without abruptly changing the transmission mode and causing loss such as reflection, attenuation, resonance or radiation while maintaining good transmission characteristics of the high-frequency signal.

Moreover, an outside diameter of the cable 91 is almost identical with an outside
15 diameter of the cylindrical part 50a and the semi-cylindrical part 50b of the terminal unit 50, and a width of the tongue-shaped part 50c is almost identical with the outside diameter. That is, as illustrated in Fig. 4A, the width of the terminal unit 50 is formed to be almost identical with the outside diameter of the cable 91. Furthermore, the signal contact portion 52 and the ground contact portion 72 of the tongue-shaped part 50c are
20 arranged to be received in the above-mentioned width. Owing to such a configuration, as illustrated in Fig. 3, a pair of counterpart terminals 161 making contact with the signal contact portion 52 and the ground contact portion 72 can be arranged to be received in the above-mentioned width.

Furthermore, as illustrated in Fig. 4D, a height of the cylindrical part 50a and the
25 semi-cylindrical part 50b of the terminal unit 50, excluding the latching piece 73d of the

ground body portion 73 is formed to be almost identical with the outside diameter of the cable 91. In addition, a thickness of the tongue-shaped part 50c, that is, a height of the contact surface portion 52a of the signal contact portion 52 and of the contact surface portion 72a of the ground contact portion 72 on the upper surface of the tongue part 32, corresponds to a height equal to or lower than the center of the cable 91, that is, a dimension equal to or smaller than a radius of the cable 91. Owing to such a configuration, as illustrated in Fig. 2, an amount of projection of the counterpart terminal 161 from the body portion 162 of the contacting arm portion 163 in a state where it is in contact with the contact surface portion 52a of the signal contact portion 52 and with the contact surface portion 72a of the ground contact portion 72 can be designed to fall within the height of the terminal unit 50.

As described above, the outside dimension of the terminal unit 50 connected to each cable 91, except the latching piece 73d, might not exceed the outside dimension of the cable 91 with respect to the cross-sectional direction of the cable 91. Moreover, the outside dimension of a pair of counterpart terminals 161 corresponding to the terminal unit 50, except the portion close to the board 191, might not exceed the outside dimension of the cable 91 with respect to the cross-sectional direction of the cable 91. Owing to such a configuration, it is possible to connect a number of cables 91 to the counterpart board 191 without increasing the dimension in the width and thickness directions of the cable connector 1 and the board connector 101.

As described above, the cable connector 1 according to the present embodiment includes the terminal unit 50 which is provided with the signal terminal 51 connected to the core line 92 of the cable 91 and the ground terminal 71 connected to the shielding member 94 of the cable 91, for transmitting a high-frequency signal, and the first housing 11 which is provided with the terminal support member 17 configured to be

capable of supporting the terminal unit 50 and is engaged, by tight fitting, with the second housing 111 of the board connector 101. The terminal unit 50 is provided with the cylindrical part 50a, the semi-cylindrical part 50b arranged in front of the cylindrical part 50a, and the tongue-shaped part 50c arranged in front of the semi-cylindrical part 50b. The signal terminal 51 is provided with the signal tail portion 53 disposed in the semi-cylindrical part 50b and connected to the core line 92, and the signal contact portion 52 disposed in the tongue-shaped part 50c and configured to make contact with the counterpart terminal 161 of the board connector 101. The ground terminal 71 is provided with the ground tail portion 74 disposed in the cylindrical part 50a and connected to the shielding member 94, the ground body portion 73 disposed in the semi-cylindrical part 50b and configured to cover the upper portion of the signal tail portion 53, and the ground contact portion 72 disposed in the tongue-shaped part 50c and configured to make contact with the counterpart terminal 161 of the board connector 101.

Owing to such a configuration, it is possible to prevent occurrence of loss such as reflection, attenuation, resonance or radiation in the high-frequency signal transmission line of the terminal unit 50.

Moreover, the signal tail portion 53 has a flat plate-like shape, and the signal contact portion 52 is provided with the flat plate-like contact surface portion 52a configured to make contact with the counterpart terminal 161. The ground body portion 73 is provided with the half-cylinder portion 73a configured to cover the upper portion of the signal tail portion 53, and the ground contact portion 72 is provided with the flat plate-like contact surface portion 72a configured to make contact with the counterpart terminal 161. The contact surface portion 52a of the signal contact portion 52 and the contact surface portion 72a of the ground contact portion 72 are even with each other

and extend in the axial direction of the terminal unit 50 at regular intervals and parallel with each other. Owing to such a configuration, it is possible to change the arrangement between the signal line disposed at the center and the ground line surrounding the signal line on a concentric circle to the arrangement between the signal
5 line and the ground line arranged in parallel on the same surface without abruptly changing the transmission mode and causing loss such as reflection, attenuation, resonance or radiation while maintaining good transmission characteristics of the high-frequency signal.

Furthermore, the signal terminal 51 is provided with the signal connection portion
10 55 configured to connect the signal tail portion 53 and the signal contact portion 52, and the ground terminal 71 is provided with the ground connection portion 75 configured to connect the ground tail portion 74 and the ground contact portion 72. The distance between the signal tail portion 53 and the ground tail portion 74 is designed to be identical with the distance between the signal connection portion 55 and the ground
15 connection portion 75 and with the distance between the signal contact portion 52 and the ground contact portion 72. Owing to such a configuration, since the gap between the signal line and the ground line is maintained constant, the transmission mode of the transmission line does not change abruptly, and loss such as reflection, attenuation, resonance or radiation does not occur, and thus, good transmission characteristics of
20 the high-frequency signal can be provided.

Furthermore, the outside diameter of the cylindrical part 50a and the semi-cylindrical part 50b and the width of the tongue-shaped part 50c are designed to be almost identical with the outside diameter of the cable 91. Owing to such a configuration, a pair of counterpart terminals 161 making contact with the signal contact
25 portion 52 and the ground contact portion 72 can be arranged to be received in a

predetermined width. Therefore, it is possible to connect a number of cables 91 to the counterpart board 191 without increasing the dimension in the width direction of the cable connector 1 and the board connector 101.

Furthermore, the thickness of the tongue-shaped part 50c is designed to be
5 equal to or smaller than the radius of the cable 91. Owing to such a configuration, the amount of projection of the counterpart terminal 161 from the body portion 162 of the contacting arm portion 163 can be designed to fall within the height of the terminal unit 50. Therefore, it is possible to connect a number of cables 91 to the counterpart board 191 without increasing the dimension in the thickness direction of the cable connector 1
10 and the board connector 101.

The present invention is not limited to the above-described embodiments, and may be changed or modified in various ways based on the gist of the present invention, and these changes and modification are not eliminated from the scope of the present invention as claimed in the attached claims.

Claim

What Is Claimed Is:

- 5 1. A coaxial connector (1) comprising:
 a terminal unit (50) for transmitting a high-frequency signal, which is
provided with signal terminals (51) connected to a signal line (92) of a coaxial cable (91)
and ground terminals (71) connected to a ground line (94) of the coaxial cable (91);
 wherein:
- 10 the terminal unit (50) comprises a cylindrical part (50a), a semi-
 cylindrical part (50b) arranged in front of the cylindrical part (50a),
 and a tongue-shaped part (50c) arranged in front of the semi-
 cylindrical part (50b);
- 15 each of the signal terminals (51) is provided with a signal tail portion
 (53) connected to the signal line (92) in the semi-cylindrical part
 (50b) and a signal contact portion (52) configured to make contact
 with a counterpart signal terminal (161) of a counterpart connector
 (101) in the tongue-shaped part (50c); and
- 20 each of the ground terminals (71) comprises a ground tail portion (74)
 connected to the ground line (94) in the cylindrical part (50a), a
 ground body portion (73) configured to cover an upper portion of
 the signal tail portion (53) in the semi-cylindrical part (50b), and a
 ground contact portion (72) configured to make contact with the
 counterpart ground terminal (161) of the counterpart connector
- 25 (101) in the tongue-shaped part (50c).

2. The coaxial connector (1) according to Claim 1, wherein:

the signal tail portion (53) has a flat plate-like shape, and the signal contact portion (52) is provided with a flat plate-like contact surface portion (52a) arranged to make contact with the counterpart signal terminal (161);

wherein the ground body portion (73) is provided with a half-cylinder portion (73a) arranged to cover an upper portion of the signal tail portion (53), and the ground contact portion (72) is provided with a flat plate-like contact surface portion (72a) arranged to make contact with the counterpart ground terminal (161); and

wherein the contact surface portion (52a) of the signal contact portion (52) and the contact surface portion (72a) of the ground contact portion (72) are even with each other and extend in an axial direction of the terminal unit (50) at an equal interval and in parallel with each other.

3. The coaxial connector (1) according to Claim 2, wherein:

wherein each of the signal terminals (51) is provided with a signal connection portion (55) configured to connect the signal tail portion (53) and the signal contact portion (52);

wherein each of the ground terminals (71) is provided with a ground connection portion (75) configured to connect the ground tail portion (74) and the ground contact portion (72); and

wherein a distance between the signal tail portion (53) and the ground tail portion (74) is identical with a distance between the signal connection portion (55) and the ground connection portion (75) and with a distance between the signal contact portion (52) and the ground contact portion (72).

4. The coaxial connector (1) according to Claim 3, wherein an outer diameter of each of the cylindrical part (50a) and the semi-cylindrical part (50b) and a width of the tongue-shaped part (50c) are substantially identical with an outer diameter of the coaxial cable (91), respectively.

5. The coaxial connector (1) according to Claim 4, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the coaxial cable (91).

6. The coaxial connector (1) according to Claim 2, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the coaxial cable (91).

7. The coaxial connector (1) according to Claim 2, wherein an outer diameter of each of the cylindrical part (50a) and the semi-cylindrical part (50b) and a width of the tongue-shaped part (50c) are substantially identical with an outer diameter of the coaxial cable (91), respectively.

8. The coaxial connector (1) according to Claim 7, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the coaxial cable (91).

9. The coaxial connector (1) according to Claim 3, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the

coaxial cable (91).

10. The coaxial connector (1) according to Claim 1, wherein:

wherein each of the signal terminals (51) is provided with a signal
5 connection portion (55) configured to connect the signal tail portion (53) and the signal
contact portion (52);

wherein each of the ground terminals (71) is provided with a ground
connection portion (75) configured to connect the ground tail portion (74) and the
ground contact portion (72); and

10 wherein a distance between the signal tail portion (53) and the ground tail
portion (74) is identical with a distance between the signal connection portion (55) and
the ground connection portion (75) and with a distance between the signal contact
portion (52) and the ground contact portion (72).

15 11. The coaxial connector (1) according to Claim 10, wherein an outer
diameter of each of the cylindrical part (50a) and the semi-cylindrical part (50b) and a
width of the tongue-shaped part (50c) are substantially identical with an outer diameter
of the coaxial cable (91), respectively.

20 12. The coaxial connector (1) according to Claim 11, wherein the tongue-
shaped part (50c) has a thickness thereof equal to or smaller than a radius of the
coaxial cable (91).

25 13. The coaxial connector (1) according to Claim 10, wherein the tongue-
shaped part (50c) has a thickness thereof equal to or smaller than a radius of the

coaxial cable (91).

14. The coaxial connector (1) according to Claim 1, wherein an outer diameter of each of the cylindrical part (50a) and the semi-cylindrical part (50b) and a width of the tongue-shaped part (50c) are substantially identical with an outer diameter of the coaxial cable (91), respectively.

15. The coaxial connector (1) according to Claim 14, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the coaxial cable (91).

16. The coaxial connector (1) according to Claim 1, wherein the tongue-shaped part (50c) has a thickness thereof equal to or smaller than a radius of the coaxial cable (91).

17. A coaxial multi-pole connector (1), comprising:
a terminal unit (50) for transmitting a high-frequency signal, which is provided with signal terminals (51), each being connected to a signal line (92) of a coaxial cable (91) and ground terminals (71), each being connected to a ground line (94) of the coaxial cable (91); and

a housing (11) which is provided with a terminal support member (17) configured to support the terminal unit (50) and is capable of being engaged, by fitting, with a counterpart housing (111) of a counterpart connector (101);

wherein:

the terminal unit (50) is provided with cylindrical parts (50a), semi-

cylindrical parts (50b) arranged in front of the cylindrical parts (50a), and tongue-shaped parts (50c) arranged in front of the semi-cylindrical part (50b);

each of the signal terminals (51) is provided with a signal tail portion

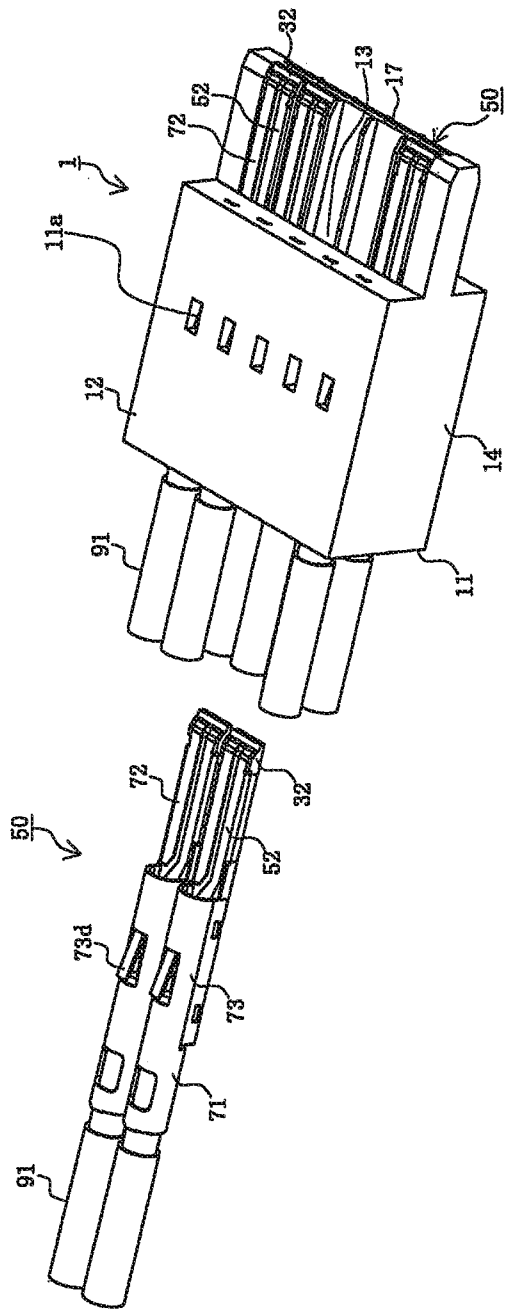
5 (53) connected to the signal line (92) in the semi-cylindrical part (50b) and a signal contact portion (52) configured to make contact with a counterpart signal terminal (161) of the counterpart connector (101) in the tongue-shaped part (50c); and

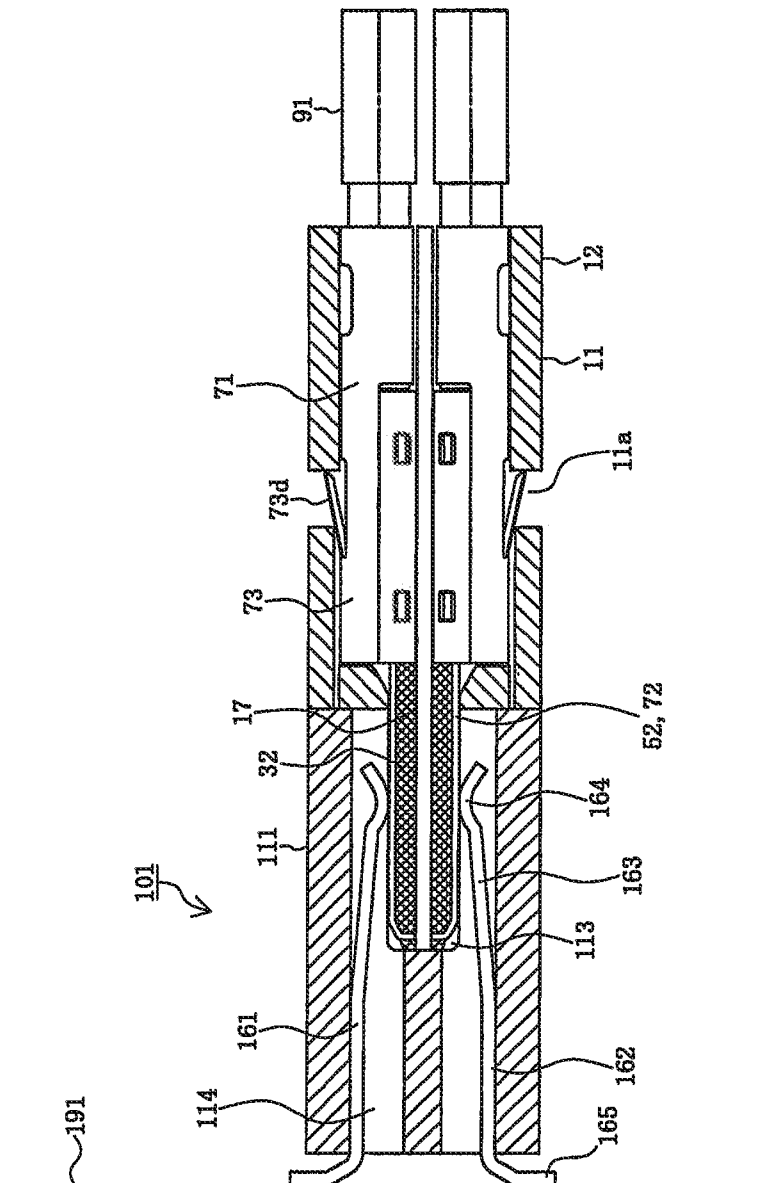
each of the ground terminals (71) is provided with a ground tail portion

10 (74) connected to the ground line (94) in the cylindrical part (50a), a ground body portion (73) configured to cover an upper portion of the signal tail portion (53) in the semi-cylindrical part (50b), and a ground contact portion (72) configured to make contact with the counterpart ground terminal (161) of the counterpart connector

15 (101) in the tongue-shaped part (50c).

18. The coaxial multi-pole connector (1) according to Claim 17, wherein the semi-cylindrical parts (50b) are arranged so that the semi-cylindrical parts have respective open ends thereof which are disposed to face each other.



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G
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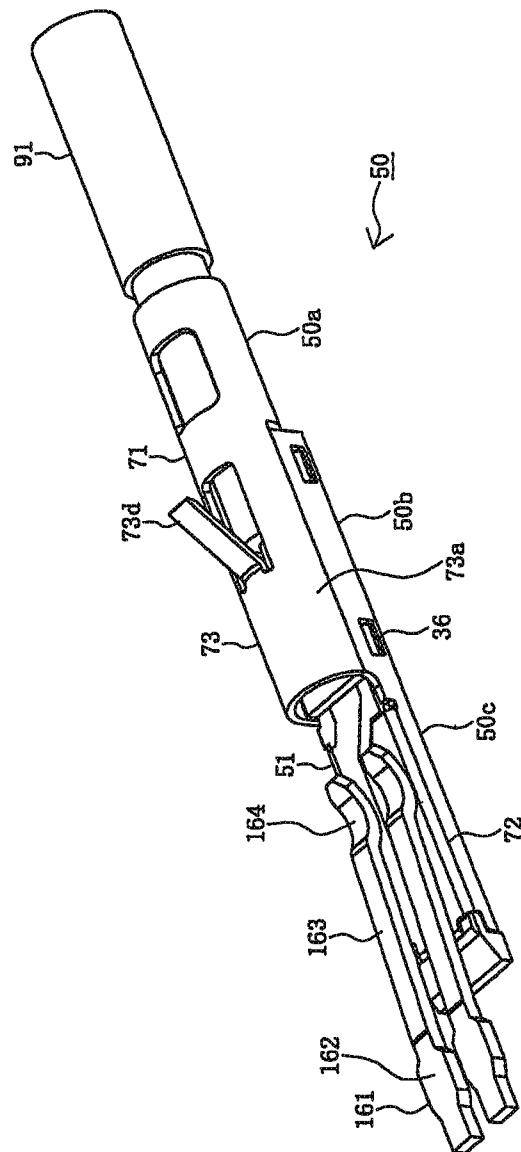


FIG. 3

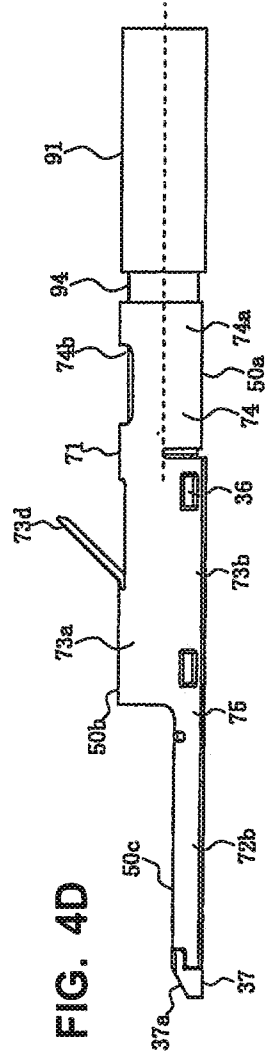
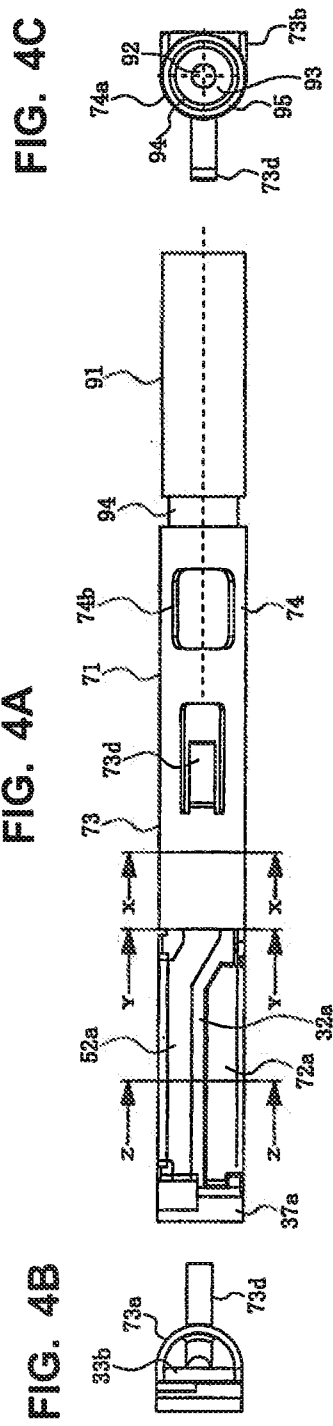


FIG. 5A

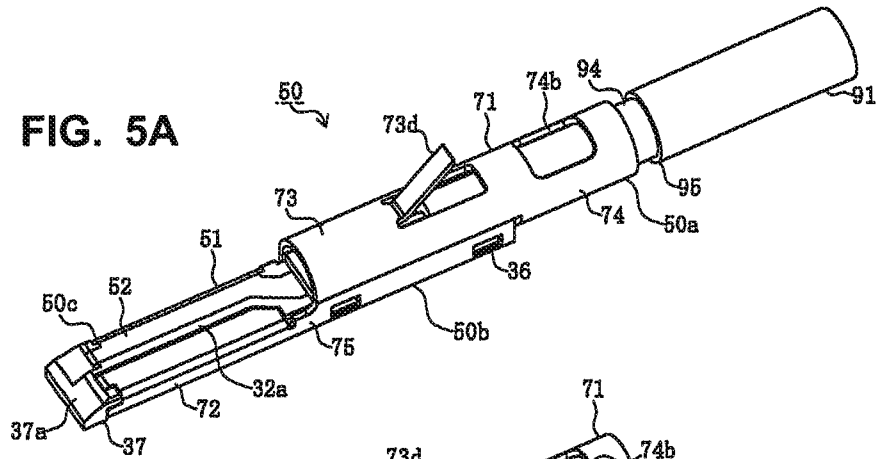


FIG. 5B

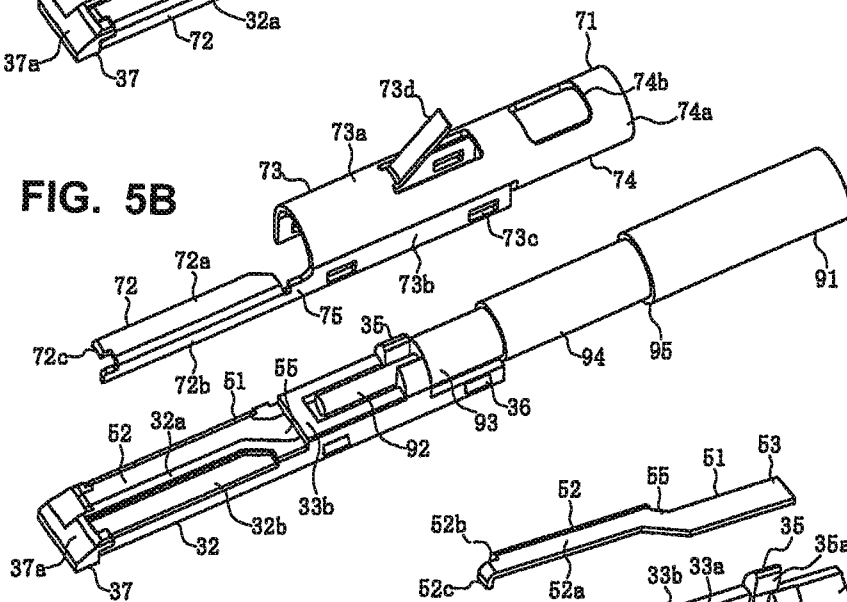


FIG. 5C

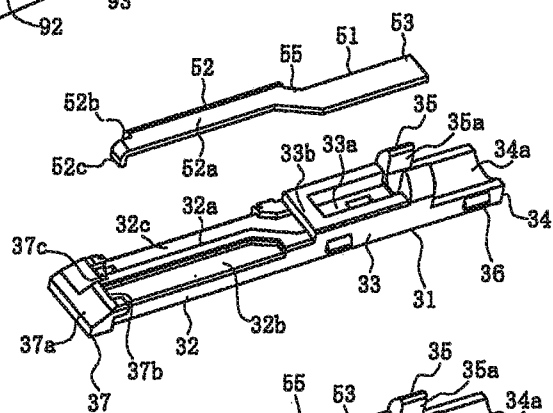
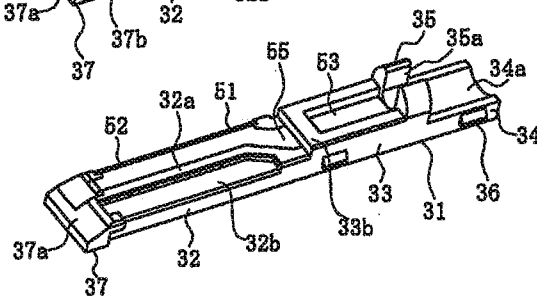
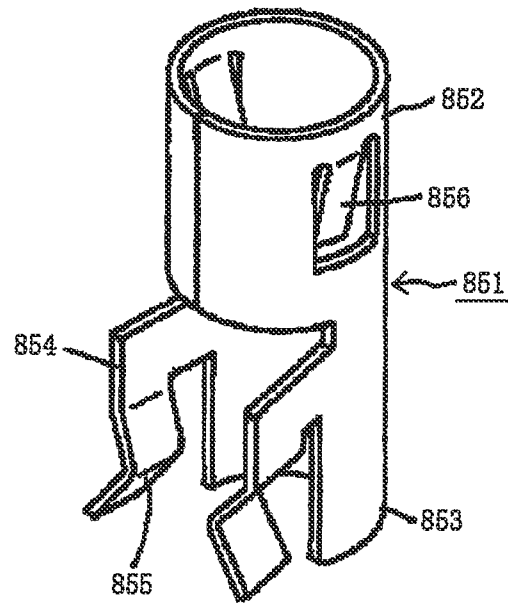


FIG. 5D





Prior Art

FIG. 6