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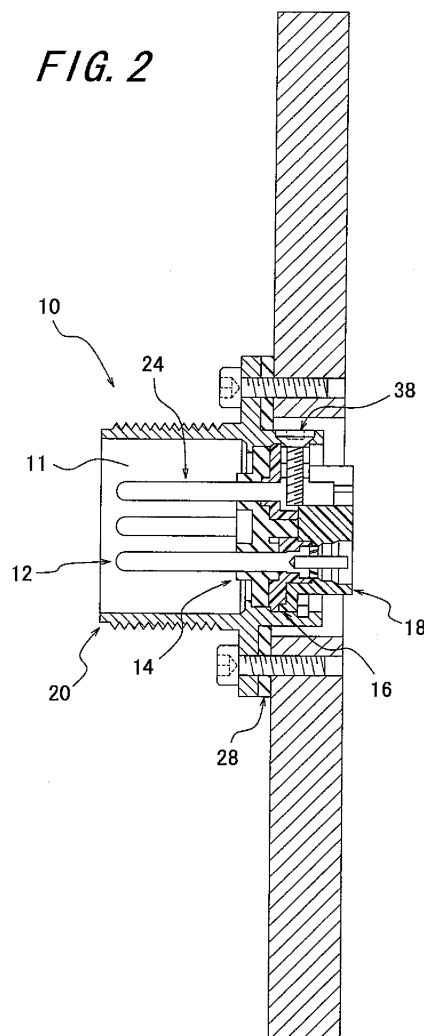
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(54) **Electrical connector**

(57) An electrical connector includes a plurality of pin contacts, at least two inserts each having inserting holes for inserting and arranging the pin contacts therein, holders for holding the pin contacts relatively to the inserts, a shell forming a fitting opening and having a fitting device to be fitted with a mating connector, a fixing device for fixing the inserts to said shell, and a sealing member for preventing moisture from a casing. One insert located on the fitting opening side is formed from a sealing member, and outer circumferences of the inserting holes on the sides of the inserts in contact with each other are in fitted relationship of projections and recesses. A space is formed between the shell and an outer circumference of the insert nearest to the connection side, and a pouring opening is provided for pouring a waterproof material so as to reach the surface of the insert in contact with the insert nearest to the connection side. A waterproof material is caused to flow through the pouring opening into the space and between the respective inserts so as not to reach the pin contacts to improve waterproof property on the connection side, thereby preventing defective connection due to dew condensation.

FIG. 2



Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to an electrical connector to be mounted on an airtight casing of an industrial apparatus or electric or electronic appliance, and more particularly to an electrical connector with a structure ensuring a superior waterproof property by pouring an amount of a waterproof material into the cable connection side of the connector, thereby preventing any defective connection due to dew condensation.

[0002] A hitherto used electrical connector will be explained, which is adapted to be mounted on an airtight casing. The electrical connector includes a plurality of pin contacts each having at least at one end a contact portion adapted to contact a mating connector, at the other end a connection portion to be connected to a cable, and a flange located between the contact portion and the connection portion; a pin front insert having inserting holes for inserting and arranging the pin contacts therein; an intermediate insert having inserting holes for inserting and arranging the pin contacts therein; and a pin rear insert having inserting holes for inserting and arranging the pin contacts therein. The electrical connector further includes a shell having an inserting bore for inserting the pin front insert, the intermediate insert, and the pin rear insert, in which inserting bore there are provided a shoulder adapted to engage the pin front insert, and a groove portion for receiving a retainer ring therein. The shell is formed with an fitting opening for receiving the pin front insert and the mating connector therein, and has fitting means to be fitted with the mating connector. Moreover, the electrical connector includes holding means for holding the pin contacts relatively to the pin rear insert, the retainer ring for fixing the pin front insert, the intermediate insert, and the pin rear insert to the shell, and a seal member for preventing moisture from the casing.

[0003] As examples of electrical connectors with cables, incorporated herein are Japanese Patent Application Opened No. 2005-285,333 (Patent Literature 1) and Japanese Patent Application Opened No. H10-223,297 (1998) (Patent Literature 2) proposed by the applicant of the present case.

[0004] Patent Literature 1

According to the abstract of the Japanese Patent Application Opened No. 2005-285,333, this invention has an object to provide a unitary construction waterproof connector of a rear release type which is simple to assemble and low priced even with narrower pitches. Disclosed is a unitary construction waterproof connector including a receptacle shell 60, a front insert 20, an intermediate insert 30, and a rear insert 40, a retainer ring 70 for fixing, in that order, the front 20, intermediate 30, and rear inserts 40 to the receptacle shell 60, and crimp pin contacts 50 installed in these inserts of the rear release type, wherein the connector comprises at least one engaging means on the front insert 20 on the side of the interme-

mediate insert 30 or on the intermediate insert 30 on the side of the front insert 20, and anchoring means on the intermediate insert 30 or the front insert 20 at a location corresponding to the engaging means.

[0005] Incidentally, claim 1 of the Japanese Patent Application Opened No. 2005-285,333 recites a unitary construction waterproof crimp connector including a receptacle shell, an intermediate insert having a plurality of inserting holes for crimp pin contacts and adapted to be installed in said receptacle shell and made from an insulating material, a front insert having inserting holes of the same number as that of said inserting holes of said intermediate insert for inserting the crimp pin contacts and held on the front side of said intermediate insert and made from an insulating elastic material, a rear insert having inserting holes of the same number as that of the inserting holes of said intermediate insert for the crimp pin contacts and contact retainers in the inserting holes and installed on the rear side of said intermediate insert and made from an insulating material, a retainer ring for fixing said intermediate, front and rear inserts to said receptacle shell, and the crimp pin contacts installed in the rear release structure inserts consisting of said intermediate, front and rear inserts, characterized in that at least one engaging means is provided on the front insert on the side of said intermediate insert or on the intermediate insert on the side of said front insert, and anchoring means is provided on said intermediate insert or on the front insert at a location corresponding to said engaging means. Claim 2 recites the unitary construction waterproof crimp connector claimed in claim 1, wherein as said engaging means at least one engaging projection is provided so as to extend from said front insert onto the side of said intermediate insert or from said intermediate insert onto the side of said front insert, and as said anchoring means an anchoring portion is provided on said intermediate insert or said front insert at a location corresponding to said engaging projection so that said anchoring portion engages said engaging projection. Claim 3 recites the unitary construction waterproof crimp connector claimed in claim 1, wherein as said engaging means at least one engaging projection is provided so as to extend from said front insert onto the side of said intermediate insert, and as said anchoring means an anchoring hole is provided in said intermediate insert at a location corresponding to said engaging projection so that said anchoring hole engages said engaging projection, and wherein said rear insert is provided with a relief portion for said engaging projection at a location corresponding to said engaging projection of said front insert. Claim 4 recites the unitary construction waterproof crimp connector claimed in claim 2 or 3, wherein said five engaging projections are provided on said front insert at its center and at four locations spaced 90 degrees apart. Claim 5 recites the unitary construction waterproof crimp connector claimed in claim 4, wherein in each of the inserting holes of said front insert for said crimp pin contacts, at least one annular protrusion is provided to make the portion of the crimp pin contact

to be a waterproof construction. Claim 6 recites the unitary construction waterproof crimp connector claimed in claim 5, wherein said front insert is made from an elastic body. Claim 7 recites a method for assembling the unitary construction waterproof crimp connector wherein said engaging projection is provided at its tip with an extension portion, and said extension portion is pulled to cause the engaging projection of said front insert to be engaged with said intermediate insert, and thereafter said extension portion is cut off. Claim 8 recites the method for assembling the unitary construction waterproof crimp connector claimed in claim 7, wherein said engaging projection is formed with a notch between said tip of the engaging projection and said extension portion, and after the engaging projection of said front insert has been engaged with said intermediate insert, said extension portion is merely pulled to cut off the extension portion.

[0006] Patent Literature 2

According to the abstract of the Japanese Patent Application Opened No. H10-223,297 (1998), this invention has an object to provide a unitary construction waterproof crimp connector enabling crimp pin contacts to be securely and easily installed in the connector. Disclosed is a unitary construction waterproof crimp connector comprising a receptacle shell 1, an intermediate insert 12 made of an insulating material having a plurality of inserting holes for crimp pin contacts 15, a front insert 13 having inserting holes of the same number as that in the intermediate insert 12 for the crimp pin contacts 15 and formed integrally with and fixed to the intermediate insert 12, a rear insert 14 made of an insulating material and having inserting holes of the same number as that in the intermediate insert 12 for the crimp pin contacts 15 and having contact retainers 14b in the inserting holes, a retainer ring 6 for fixing the intermediate insert 12, the front insert 13 and the rear insert 14 to the receptacle shell 1, and the crimp pin contacts to be installed in the inserting holes of the respective inserts, respectively.

[0007] Incidentally, claim 1 of the Japanese Patent Application Opened No. H10-223,297 recites a unitary construction waterproof crimp connector comprising a receptacle shell, an intermediate insert made of an insulating material having a plurality of inserting holes for crimp pin contacts and installed in said receptacle shell, a front insert made of an insulating elastic body having inserting holes of the same number as that in said intermediate insert for the crimp pin contacts and formed integrally with and fixed to said intermediate insert, a rear insert made of an insulating material having inserting holes of the same number as that in said intermediate insert for the crimp pin contacts and having contact retainers in said inserting holes and installed on the rear surface of said intermediate insert, a retainer ring for fixing said intermediate, front, and rear inserts to said receptacle shell, and the crimp pin contacts to be installed in the rear release structure inserts consisting of said intermediate, front, and rear inserts. Claim 2 recites the unitary construction waterproof crimp connector claimed in claim 1,

wherein said intermediate insert and said front insert are fixed to each other by means of an adhesive.

[0008] When an electrical connector mounted on an airtight casing of an industrial apparatus or electric or electronic appliance is being used, the temperatures of environmental air and in the sealed casing are raised by heating caused by contacts of the electrical connector through which signals pass. Upon stopping the use of the electrical connector, the temperature of the environmental air may lower faster than the temperature in the sealed casing so that the temperature in the sealed casing becomes higher than that of the environmental air, with the result that dew condensation would occur at a cable and the like in the sealed casing. The moisture (aqueous droplets) owing to the dew condensation would enter the insert assembly in the electrical connector through the cable so that the contacts could be short-circuited, resulting in defective or failed connection. This problem remains to be solved.

[0009] There has been a requirement for coating of silicone between the front insert and the rear insert in order to prevent the defective connection even if the dew condensation occurs. However, the coating of silicone is tedious and time-consuming, making the whole production process lengthy in terms of the number of steps involved, and potentially costly.

[0010] Moreover, it has been proposed to pour silicone or the like between said front insert and said rear insert. However, the pouring does not cause the silicone to enter (flow into) between the inserts so that it is impossible to waterproof the contacts by preventing the moisture (aqueous droplets) caused by the dew condensation from flowing into between the contacts.

[0011] The objects of the inventions of the Patent Literatures 1 and 2 are different from those discussed herein so that the structures disclosed in these Literatures could not solve the problems as just described.

SUMMARY OF THE INVENTION

[0012] In view of the problems of the prior art described above the invention has been completed, and it is an object of the invention to provide an electrical connector including an amount of waterproof material poured onto the cable connection side in a simple manner to ensure the waterproof for contacts, thereby preventing any defective or failed connection due to dew condensation.

[0013] The object of the invention can be achieved by the electrical connector 10 to be connected to and disconnected from a mating connector and adapted to be connected to a cable and to be mounted onto an airtight casing, and said electrical connector 10 including a plurality of pin contacts 12 each having at one end a contact portion 121 adapted to contact said mating connector and at the other end a connection portion 123 to be connected to said cable, at least two inserts each having inserting holes for inserting and arranging said pin contacts 12 therein, holding means for holding said pin con-

tacts 12 on said inserts, a shell 20 accommodating said at least two inserts therein, forming a fitting opening 11 for receiving said mating connector with said inserts, and having fitting means to be fitted with said mating connector, fixing means for fixing said at least two inserts to said shell 20, and a sealing member for preventing moisture from said casing, constructed according to the invention in that one of said at least two inserts located on the side of said fitting opening 11 is formed from a sealing member, and outer circumferences of said inserting holes on the sides of the two inserts in contact with each other are in fitted relationship of projections and recesses, that a space 32 is formed between said shell 20 and an outer circumference of one of said at least two inserts nearest to the side of the connection portion, and a pouring opening 34 is provided in said insert nearest to the side of the connection portion for pouring a waterproof material, said pouring opening reaching the surface of the insert in contact with the insert nearest to the side of the connection portion, and that a waterproof material is poured through said pouring opening into said space 32 and between respective inserts in a manner not reaching to said pin contacts 12 so as to obtain high waterproof characteristic on the side of the connection portion.

[0014] The object of the invention can also be achieved by the electrical connector 10 to be connected to and disconnected from a mating connector and adapted to be connected to a cable and to be mounted onto an airtight casing, and said electrical connector 10 including a plurality of pin contacts 12 each having at one end a contact portion 121 adapted to contact said mating connector, at the other end a connection portion 123 to be connected to said cable, and a flange 122 located between said contact portion 121 and said connection portion 123, a pin front insert 14 having inserting holes 141 for inserting and arranging said pin contacts 12 therein, an intermediate insert 16 having inserting holes 161 for inserting and arranging said pin contacts 12 therein, a pin rear insert 18 having inserting holes 181 for inserting and arranging said pin contacts 12 therein, a shell 20 having an inserting bore 201 for inserting said pin front insert 14, said intermediate insert 16 and said pin rear insert 18, in which inserting bore 201 there are provided a shoulder 202 adapted to engage said pin front insert 14 and a groove portion 203 for receiving a retainer ring 22, and said shell further having a fitting opening 11 formed for receiving said pin front insert 14 and said mating connector, and fitting means to be fitted with said mating connector, holding means for holding said pin contacts 12 relatively to said pin rear insert 18, the retainer ring 22 for fixing said pin front insert 14, said intermediate insert 16, and said pin rear insert 18 to said shell 20, and a sealing member for preventing moisture from said casing, constructed according to the invention in that said pin front insert 14 is formed from a sealing member, and outer circumferences of said inserting holes 141, 161 and 181 on the side of the respective inserts 14, 16 and 18 in contact with each other are in fitted relationship of

projections and recesses, that a space 32 is formed between said shell 20 and an outer circumference of said pin rear insert 18, and said pin rear insert 18 is provided with a pouring opening 34 reaching a surface of said intermediate insert 16 for pouring a waterproof material, and that a waterproof material is provided to improve waterproof property on the side of the connection portion by pouring the waterproof material into said space 32 and between the respective inserts so as not to reach said pin contacts 12.

[0015] The electrical connector 10 claimed in claim 3 is so constructed that said waterproof material has a viscosity of a predetermined value or less, and the waterproof material is poured so as to reach the end surface of said shell 20 on the side of the connection portion. Moreover, the electrical connector 10 claimed in claim 4 is so constructed that said waterproof material has a viscosity of 25 Pa·s or less. Ideally, it is preferable to use a waterproof material having a viscosity of 0.6 to 20 Pa·s. Further, the electrical connector 10 claimed in claim 5 is so constructed that recesses are formed between said inserting holes at least in either of the surfaces in contact with each other of the insert nearest to the side of the connection portion and of the insert in contact with said insert nearest to the side of the connection portion, or at least in either of surfaces in contact with each other of said intermediate insert 16 and said pin rear insert 18.

[0016] The electrical connector 10 claimed in claim 6 is so constructed that said holding means is formed integrally with said insert nearest to the side of the connection portion or said pin rear insert 18.

Moreover, the electrical connector 10 claimed in claim 7 is so constructed that said holding means comprises a plurality of comb teeth 183 which are bent.

Further, the electrical connector 10 claimed in claim 8 is so constructed that at least one of said pin contacts 12 is used as an earth pin contact 24, and mounted on said earth pin contact 24 is an earth lug 26 by means of which said earth pin contact 24 is brought into electrical continuity with said shell 20.

[0017] As can be seen from the above description, the electrical connector to be connected to a cable according to the invention can bring about the following significant functions and effects.

(1) In the electrical connector 10 to be connected to and disconnected from a mating connector and adapted to be connected to a cable and to be mounted onto an airtight casing, and said electrical connector 10 including a plurality of pin contacts 12 each having at one end a contact portion 121 adapted to contact said mating connector and at the other end a connection portion 123 to be connected to said cable, at least two inserts each having inserting holes for inserting and arranging said pin contacts 12 therein, holding means for holding said pin contacts 12 on said inserts, a shell 20 accommodating said at least two inserts therein, forming a fitting opening 11 for receiving said mating connector with said inserts, fixing means for fixing said at least two inserts to said

shell 20, and a sealing member for preventing moisture from said casing, according to the invention as claimed in claim 1 the electrical connector is so constructed that one of said at least two inserts located on the side of said fitting opening 11 is formed from a sealing member, and outer circumferences of said inserting holes on the sides of the two inserts in contact with each other are in fitted relationship of projections and recesses, that a space 32 is formed between said shell 20 and an outer circumference of one of said at least two inserts nearest to the side of the connection portion, and a pouring opening 34 is provided in said insert nearest to the side of the connection portion for pouring a waterproof material, said pouring opening reaching the surface of the insert in contact with the insert nearest to the side of the connection portion, and that a waterproof material is poured through said pouring opening into said space 32 and between respective inserts in a manner not reaching to said pin contacts 12 so as to obtain high waterproof characteristic on the side of the connection portion. According to the invention, an amount of a waterproof material can be easily poured into the aimed portions so that the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0018] (2) In the electrical connector 10 to be connected to and disconnected from a mating connector and adapted to be connected to a cable and to be mounted onto an airtight casing, and said electrical connector 10 including, a plurality of pin contacts 12 each having at one end a contact portion 121 adapted to contact said mating connector, at the other end a connection portion 123 to be connected to said cable, and a flange 122 located between said contact portion 121 and said connection portion 123, a pin front insert 14 having inserting holes 141 for inserting and arranging said pin contacts 12 therein, an intermediate insert 16 having inserting holes 161 for inserting and arranging said pin contacts 12 therein, a pin rear insert 18 having inserting holes 181 for inserting and arranging said pin contacts 12 therein, a shell 20 having an inserting bore 201 for inserting said pin front insert 14, said intermediate insert 16 and said pin rear insert 18, in which inserting bore 201 there are provided a shoulder 202 adapted to engage said pin front insert 14 and a groove portion 203 for receiving a retainer ring 22, and said shell further having a fitting opening 11 formed for receiving said pin front insert 14 and said mating connector, and fitting means to be fitted with said mating connector, holding means for holding said pin contacts 12 relatively to said pin rear insert 18, the retainer ring 22 for fixing said pin front insert 14, said intermediate insert 16, and said pin rear insert 18 to said shell 20, and a sealing member for preventing moisture from said casing, according to the invention as claimed in claim 2 the electrical connector is so constructed that said pin front insert 14 is formed from a sealing member, and outer circumferences of said inserting holes 141, 161 and 181 on the side of the respective inserts 14, 16 and 18

in contact with each other are in fitted relationship of projections and recesses, that a space 32 is formed between said shell 20 and an outer circumference of said pin rear insert 18, and said pin rear insert 18 is provided with a pouring opening 34 reaching a surface of said intermediate insert 16 for pouring a waterproof material, and that a waterproof material is provided to improve waterproof property on the side of the connection portion by pouring the waterproof material into said space 32 and between the respective inserts so as not to reach said pin contacts 12. Therefore, an amount of a waterproof material can be easily poured into the aimed portions so that the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0019] (3) The electrical connector 10 claimed in claim 3 is so constructed that said waterproof material has a viscosity of a predetermined value or less, and the waterproof material is poured so as to reach the end surface of said shell 20 on the side of the connection portion. Consequently, an amount of a waterproof material can be easily poured into the aimed portions so that the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0020] (4) The electrical connector 10 claimed in claim 4 is so constructed that said waterproof material has a viscosity of 25 Pa·s or less. Accordingly, an amount of a waterproof material can be easily poured into the aimed portions so that the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation. Ideally, it is preferable to use a waterproof material having a viscosity of 0.6 to 20 Pa·s. If a waterproof material of a viscosity of 0.6 Pa·s or less, the waterproof material flows into superfluous portions, while a waterproof material of a viscosity of 20 Pa·s or more does not flow to a required extent, resulting in an unsatisfactory result.

[0021] (5) The electrical connector 10 claimed in claim 5 is so constructed that recesses are formed between said inserting holes at least in either of the surfaces in contact with each other of the insert nearest to the side of the connection portion and of the insert in contact with said insert nearest to the side of the connection portion, or at least in either of surfaces in contact with each other of said intermediate insert 16 and said pin rear insert 18. Therefore, when the waterproof material flows into between the inserts, the waterproof material is reliably prevented from reaching the contacts so that the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0022] (6) The electrical connector 10 claimed in claim 6 is so constructed that said holding means is formed integrally with said insert nearest to the side of the connection portion or said pin rear insert 18. Consequently, the pin contacts can be held in a simple manner, and the

required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0023] (7) The electrical connector 10 claimed in claim 7 is so constructed that said holding means comprises a plurality of comb teeth 183 which are bent. Therefore, the pin contacts can be held in a simple manner, and the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0024] (8) The electrical connector 10 claimed in claim 8 is so constructed that at least one of said pin contacts 12 is used as an earth pin contact 24, and mounted on said earth pin contact 24 is an earth lug 26 by means of which said earth pin contact 24 is brought into electrical continuity with said shell 20. Accordingly, an earth connection can be achieved in a simple manner, and the required waterproof can be surely achieved to prevent any defective or failed connection even if moisture (aqueous droplets) would occur due to dew condensation.

[0025] The invention will be more fully understood by referring to the following detailed specification and claims taken in connection with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Figure 1A is a perspective view of the electrical connector according to the invention viewed from its fitting side;

Figure 1B is a perspective view of the electrical connector according to the invention viewed from the side of its cable;

Figure 2 is a longitudinal sectional view of the electrical connector according to the invention mounted on a casing;

Figure 3 is a perspective view of a pin contact;

Figure 4A is a perspective view of a pin front insert viewed from the fitting side;

Figure 4B is a perspective view of the pin front insert viewed from the connection side;

Figure 4C is a sectional view of the pin front insert taken along a W-W plane shown in Figure 4A;

Figure 5A is a perspective view of an intermediate insert viewed from the fitting side;

Figure 5B is a perspective view of the intermediate insert viewed from the connection side;

Figure 5C is a sectional view of the intermediate insert taken along an X-X plane shown in Figure 5A;

Figure 6A is a perspective view of a pin rear insert viewed from the fitting side;

Figure 6B is a perspective view of the pin rear insert viewed from the connection side;

Figure 6C is a sectional view of the pin rear insert taken along a Y-Y plane;

Figure 7A is a perspective view of a receptacle shell viewed from the fitting side;

Figure 7B is a perspective view of the receptacle shell viewed from the connection side;

Figure 7C is a sectional view of the receptacle shell taken along a Z-Z plane;

Figure 8 is a perspective view of a retainer ring;

Figure 9A is a perspective view of the receptacle shell, pin front insert, intermediate insert, pin rear insert, retainer ring, and pin contacts viewed from the fitting side;

Figure 9B is a perspective view of the pin contacts, retainer ring, pin rear insert, intermediate insert, pin front insert, and receptacle shell viewed from the cable side;

Figure 10A is an explanatory view of the electrical connector according to the invention in the state that the sealing material has been poured;

Figure 10B is an explanatory view of the electrical connector in the state that the sealing material is not poured yet;

Figure 11A is a perspective view of an earth pin contact; and

Figure 11B is a perspective view of an earth lug to be used for the earth pin contact.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] One embodiment of the electrical connector according to the invention will be explained with reference to Figures 1A to 11B.

Figure 1A is a perspective view of the electrical connector according to the invention viewed from its fitting side, while Figure 1B is a perspective view of the electrical connector according to the invention viewed from the side of its cable. Figure 2 is a longitudinal sectional view of the electrical connector according to the invention, and Figure 3 is a perspective view of a pin contact. Figure 4A is a perspective view of a pin front insert viewed from the fitting side, while Figure 4B is a perspective view of the pin front insert viewed from the connection side, and Figure 4C is a sectional view of the pin front insert taken along a W-W plane shown in Figure 4A. Figure 5A is a perspective view of an intermediate insert viewed from the fitting side, and Figure 5B is a perspective view of the intermediate insert viewed from the connection side, while Figure 5C is a sectional view of the intermediate insert taken along an X-X plane shown in Figure 5A. Figure 6A is a perspective view of a pin rear insert viewed from the fitting side, while Figure 6B is a perspective view of the pin rear insert viewed from the connection side, and Figure 6C is a sectional view of the pin rear insert taken along a Y-Y plane shown in Figure 6A. Figure 7A is a perspective view of a receptacle shell viewed from the fitting side, while Figure 7B is a perspective view of the receptacle shell viewed from the connection side, and Figure 7C is a sectional view of the receptacle shell taken along a Z-Z plane shown in Figure 7B. Figure 8 is a perspective view of a retainer ring. Figure 9A is a perspective view of the receptacle shell, the pin front-insert, the in-

intermediate insert, the pin rear insert, the retainer ring and the pin contacts viewed from the side of the fitting opening, and Figure 9B is a perspective view of the pin contacts, the retainer ring, the pin rear insert, the intermediate insert, the pin front insert, and the receptacle shell viewed from the side of the cable. Figure 10A is an explanatory view of the state that the sealing material has been poured, and Figure 10B is an explanatory view of the state that the sealing material has not been poured. Figure 11A is a perspective view of an earth pin contact, while Figure 11B is a perspective view of an earth lug.

[0028] The electrical connector 10 according to the invention comprises at least a plurality of pin contacts 12, at least two inserts, holding means for holding said pin contacts 12 relatively to said inserts, a shell 20, fixing means for fixing said inserts to said shell, a sealing member for protecting the electrical connector against moisture coming from a casing, and a waterproof material. In the embodiment, a front insert 14, an intermediate insert 16, a pin rear insert 18 are used as the inserts, and a retainer ring 22 (Fig. 8) is used as the fixing means for fixing these inserts to said shell. Further, a gasket 28 is used as the sealing member for protecting the electrical connector against the moisture from the casing, while said holding means for holding the pin contacts relatively to said insert are formed integrally with said pin rear insert 18 as described below.

[0029] Referring to Figure 10A, first a method for pouring a waterproof material onto the connection side of the electrical connector will be explained. The waterproof material is poured onto the connection side of the electrical connector in a simple manner to prevent moisture (aqueous droplets) from going up to the fitting opening side and to the contacts through clearances of the shell and the inserts and cable even if dew condensation occurs, thereby preventing any defective connection. For this purpose, when the waterproof material is poured into a pouring opening, the waterproof material flows into spaces 32 shown in Fig. 10B between the shell 20 and the inserts and clearances between the respective inserts. In this case, outer circumferences of inserting holes provided in the respective inserts are in fitted relationship of projections and recesses as described below so that the waterproof material does not reach the pin contacts 12. The waterproof material having a viscosity of 25 Pa·s (pascal second) or less is used so that the waterproof material reaches the end face of the shell 20 on the connection side. However, ideally, it is preferable to use a waterproof material having a viscosity of 0.6 to 20 Pa·s. If a waterproof material has a viscosity of 0.6 Pa·s or less, the waterproof material flows into superfluous portions, while a waterproof material of a viscosity of 20 Pa·s or more does not flow to a required extent, resulting in an unsatisfactory result. Waterproof materials fulfilling viscosities within the range of 0.6 to 20 Pa·s include silicone rubber, nitrile rubber, and chloroprene rubber and synthetic materials thereof and adhesive agents. The adhesive agents include sealing materials, epoxy resin, poly-

urethane families and the like.

[0030] Then, the pin contacts 12 will be explained. As shown in Figure 3, the pin contact 12 is substantially in the form of a bar. Said pin contact 12 is made of a metal and formed by cutting of the known technique. Preferred metals from which to form said pin contacts 12 include brass, beryllium copper, phosphor bronze and the like which comply with the requirements as to dimensional stability, electric conductivity, and the like. The pin contact 12 mainly comprises a contact portion 121 at one end adapted to contact a mating connector, a connection portion 123 at the other end to be connected to a cable, and a flange 122 between said contact portion 121 and said connection portion 123. The pin contacts 12 are fixed to the pin rear insert 18 by means of holding means.

[0031] Said contact portion 121 is adapted to contact the mating connector and may be suitably designed in consideration of contact state with the mating connector, shape, contact force and the like. In the illustrated embodiment, the contact portion is pin-shaped. Said flange 122 serves to position the pin contact 12 relatively to said pin rear insert when the pin contact 12 is inserted into said pin rear insert. The shape and size of the flange 122 may be suitably designed taking into account such a function. Said connection portion 123 is connected to the cable. The shape and size of the connection portion 123 may be suitably designed depending upon a connection method. In the illustrated embodiment, the connection to the cable is effected by firmly forcing against each other to be bonded.

[0032] The pin front insert 14 will then be explained. As shown in Figures 4A and 4B, the pin front insert 14 is substantially in the form of a circular disc. Said pin front insert 14 is made of an electrically insulating rubber and formed by the compression molding of the known technique. The materials for the pin front insert 14 may be suitably selected in consideration of elasticity, dimensional stability, workability, manufacturing cost, and the like and generally include silicone rubber, nitrile rubber, and chloroprene rubber, and synthetic materials thereof.

[0033] The pin front insert 14 is formed with a required number of inserting holes 141 for inserting the pin contacts 12 at locations corresponding to mating objects (contacts). The pin front insert 14 is further formed with an inserting hole at a location for inserting an earth pin contact. The inserting holes 141 only needs to enable the pin contacts 12 to be inserted. Since the pin front insert 14 is made of the rubber, the pin contacts 12 are closely fitted in the inserting holes 141 so that the waterproof property is improved. In order to improve the close contact therebetween, the inserting holes 141 are slightly smaller than the pin contacts 12 within a limitation enabling the pin contacts to be inserted. The same holds true in the case of the inserting hole for the earth pin contact 24. Moreover, inner surfaces of said inserting holes 141 are formed with a plurality of protrusions 145 to improve the close contact with the pin contacts 12. The sizes of the protrusions 145 may be suitably designed in consid-

eration of improvement in close contact with and insertion of the pin contacts 12.

[0034] The pin front insert 14 is provided on the fitting side and connection side with projections 142 so as to surround the inserting holes 141 as outer circumferences thereof, respectively. The projections 142 on the fitting side serve to enlarge the contact surfaces between the inserting holes 141 and the pin contacts, while the projections 142 on the connection side serve to enlarge the contact surfaces between the inserting holes 141 and the pin contacts and simultaneously to prevent the waterproof material from flowing so that the waterproof material does not reach the pin contacts 12 by the engagement of the projections 142 with recesses 163 of said intermediate insert 16. The sizes of the projections 142 may be suitably designed taking into account such functions.

[0035] Moreover, the pin front insert 14 is provided on the fitting side with a projection 142 surrounding said inserting hole for inserting said earth pin contact 24, and is provided on the connection side with a recess 143 which is formed in the outer circumference of the inserting hole for inserting said earth pin contact and communicates with the inserting hole. The projection 142 on the fitting side serves to function similarly to those of the projections described above. The recess 143 on the connection side serves to enlarge the contact surface between the earth pin contact 24 and the intermediate insert 16, and simultaneously to prevent the waterproof material from flowing so that the waterproof material does not reach the earth pin contact 24 by the engagement of the recess 143 with projection 162 of said intermediate insert 16. The size of the projection 142 and the recess 143 may be suitably designed in consideration of such functions.

[0036] The pin front insert 14 is further formed with a plurality of engaging projections 144 so as not to intersect the inserting holes 141 for the pin contacts 12 and the earth pin contact 24. Said engaging projections 144 engage anchoring recesses 164 of the intermediate insert 16 to prevent said pin front insert 14 from moving away from said intermediate insert 16, that is, to improved the close contact between said pin front insert 14 and said intermediate insert 16. The size and shape of said engaging projections 144 may be suitably designed taking into account such functions. Distal ends of the engaging projections 144 are enlarged so as to enhance the holding force in consideration of the functions in the illustrated embodiment. In the illustrated embodiment, the five engaging projections 144 are provided so as not to interfere with said pin contacts 12 and said earth pin contact 24 in consideration of balancing.

[0037] The intermediate insert 16 will then be explained. The intermediate insert 16 is substantially in the form of a circular disc as shown in Figures 5A and 5B. The intermediate insert 16 is formed from an electrically insulating plastic material by means of the injection molding of the known technique. The materials for the inter-

mediate insert 16 may be suitably selected in consideration of dimensional stability, workability, manufacturing cost, and the like and generally include polybutylene terephthalate (PBT), polyamide (66PA or 46PA), liquid crystal polymer (LCP), polycarbonate (PC) and the like and combination thereof.

[0038] The intermediate insert 16 is formed with a plurality of inserting holes 161 for inserting said pin contacts 12 and said earth pin contact 24, respectively. The inserting holes 161 need only enable said pin contacts 12 and said earth pin contact 24 to be inserted therethrough, and are somewhat larger than said pin contacts 12 and said earth pin contact 24.

[0039] The intermediate insert 16 is formed with the recesses 163 at locations where said pin contacts 12 are inserted on the side of the intermediate insert 16 adapted to contact said pin front insert 14. The recesses 163 receive therein the projections 142 of said pin front insert 14 and communicate with said inserting holes 161, respectively. Moreover, the intermediate insert 16 is formed with the projection 162 at a location where said earth pin contact 24 is inserted. The projection 162 is adapted to be fitted in the recess 143 of said pin front insert 14.

[0040] Further, said intermediate insert 16 is formed with projections 162 at locations where said pin contacts 12 are inserted on the side of the intermediate insert 16 adapted to contact said pin rear insert 18. The projections 162 are adapted to be fitted in recesses 182 (Fig. 6C) of said pin rear insert 18. Moreover, the intermediate insert 16 is formed with inserting grooves 165 (Fig. 5C) at locations where said pin contacts 12 are inserted. The inserting grooves 165 are adapted to be fitted with shoulders 124 of said pin contacts 12 and communicate with said inserting holes 161, respectively.

[0041] The respective projections 162 and the recesses 163 are adapted to fit with the recesses 143 and the projections 142 of said pin front insert 14 and further the projections 162 are adapted to be fitted with recesses 182 of said pin rear insert 18 so that these serve to prevent the waterproof material from reaching the pin contacts 12 upon the waterproof material being poured. The shapes and sizes of these projections 162 and recesses 163 may be suitably designed taking into account such functions, strength and degree of fitting. Moreover, said inserting grooves 165 receive the shoulders 124 of said pin contacts 12 for positioning the pin contacts 12, respectively.

[0042] The intermediate insert 16 is formed with a groove portion 166 having a shape substantially the same as that of a pouring opening 34 of the pin rear insert 18 at a location corresponding to the pouring opening 34 for pouring the waterproof material. The groove portion 166 cooperates with the pouring opening 34 of the pin rear insert 18 to form a complete pouring opening 34, thereby causing the waterproof material to flow between the intermediate insert 16 and the pin rear insert 18 to an extent such that the waterproof material does not reach the pin contacts 12. The shape of said groove por-

tion 166 is substantially the same as that of the pouring opening 34 of the pin rear insert 18 in consideration of such functions, and the size of said groove portion 166 may be suitably designed taking into account such functions and strength.

[0043] Moreover, the intermediate insert 16 is formed at locations corresponding to the engaging projections 144 of said pin front insert 14 with anchoring recesses 164 adapted to be engaged with said engaging projections 144, respectively. In the illustrated embodiment, said anchoring recesses 164 are formed as through-holes and the portions of the through-holes on the side of the pin front insert 14 are formed in a conical shape in order to make it easy to insert the engaging projections 144. The size of said anchoring recesses 164 is determined so that said engaging projections 144 abut against the surface of said intermediate insert 16 in contact with said pin rear insert 18.

[0044] Moreover, said intermediate insert 16 is formed on the side contacting said pin rear insert 18 with recesses 167 located between inserting holes 161 for inserting said pin contacts 12, respectively, and adapted to receive projecting pieces 186 of said pin rear insert 18. Said recesses 167 serve to surely prevent the waterproof material from reaching said pin contacts 12.

[0045] The pin rear insert 18 will then be explained. As shown in Figures 6A and 6B, the pin rear insert 18 is substantially cylindrical. The pin rear insert 18 is formed from an electrically insulating plastic material by means of the injection molding of the known technique. The materials for the pin rear insert 18 may be suitably selected in consideration of dimensional stability, workability, manufacturing cost, and the like and generally include polybutylene terephthalate (PBT), polyamide (66PA or 46PA), liquid crystal polymer (LCP), polycarbonate (PC) and the like and combination thereof.

[0046] The pin rear insert 18 is formed with a required number of inserting holes 181 for inserting the pin contacts 12 and the earth pin contact 24. The inserting holes 181 need only enable said pin contacts 12 and said earth pin contact 24 to be inserted therein and are somewhat larger than said pin contact 12 and said earth pin contact 24.

[0047] The pin rear insert 18 on the side adapted to contact said intermediate insert 16 is formed with the recesses 182 at locations where said pin contacts 12 are inserted. The recesses 182 receive therein the projections 162 of said intermediate insert 16 and communicate with said inserting holes 161, respectively. Said recesses 182 are fitted with the projections 162 of said intermediate insert 16 to prevent the waterproof material from reaching said pin contacts 12 upon pouring the waterproof material. The size of said recesses 182 may be suitably designed in consideration of such functions, strength, and degree of fitting.

[0048] In the illustrated embodiment, the pin rear insert 18 is provided at a location corresponding to said earth pin contact 24 with the pouring opening 34 which is sub-

stantially U-shaped and cooperates with the groove portion 166 of said intermediate insert 16 to complete the pouring opening 34 for pouring the waterproof material. The shape and size of the pouring opening 34 may be suitably designed in consideration of ease in pouring the waterproof material, strength, workability, and the like. The pouring opening 34 is provided so as to reach said earth pin contact 24 in the illustrated embodiment. If the pin contacts 12 only are arranged without the earth pin contact, the pouring opening 34 is provided so as not to reach the pin contacts as might be expected.

[0049] Moreover, the pin rear insert 18 is formed with relief grooves 185 at locations corresponding to said engaging projections 144 of the pin front insert 14 for receiving the engaging projections 144 without interfering with them. The shape and size of said relief grooves 185 may be any ones insofar as the relief grooves 185 are able to receive the engaging projections 144 without any interference and may be suitably designed taking into account such functions, strength and workability.

[0050] It is preferable to provide recessed portions 187 in the pin rear insert 18 at portions on which the waterproof material is intended to flow on the side of the pin rear insert 18 in contact with the intermediate insert 16.

In the recessed portions 187, moreover, there are provided projecting pieces 186 between said pin contacts 12 in order to prevent the waterproof material from reaching said pin contacts 12. Said recessed portions 187 are not required, if the waterproofing material flows between said intermediate insert 16 and said pin rear insert 18 without reaching said pin contacts. The shape and size of said recessed portions 187 may be suitably designed in consideration of the functions described above, strength, workability, and the like. The projecting pieces 186 are adapted to engage the recesses 167 of said intermediate insert 16 so that the waterproof material is surely prevented from reaching said pin contacts 12.

[0051] Said pin rear insert 18 is provided with holding means integral therewith in said inserting holes 181. As holding means, there are six comb teeth 183 whose tip ends extend inwardly toward each other and are adapted to engage the flange 122 of said pin contact 12 so as to hold it. The holding means is divided into the six comb teeth 183 to provide elasticity. The tips of the comb teeth 183 are somewhat narrowed or bent inwardly to make easy the engagement with the pin contact 12.

[0052] The holding means (the comb teeth) of the pin rear insert 18 forms inwardly an inserting hole for said pin contact 12. The shape and size of the inserting hole only needs to enable the insertion of said pin contact 12 and may be suitably designed according to the shape and size of the pin contact in consideration of miniaturization of the electrical connector.

[0053] The shell 20 will then be explained. The shell 20 is made of a metal and formed by means of cutting or die-casting of the known technique. Preferred metals from which to form said shell 20 include generally zinc alloys, aluminum alloys, and the like which comply with

the requirement as to dimensional stability, workability, manufacturing cost, and the like.

[0054] The shell 20 includes a substantially cylindrical body section and a flange section 205 substantially in the form of a square plate as shown in Figures 7A to 7C. The flange section 205 is formed with holes 206 at pre-determined positions and fixed to a casing by means of set screws passing through the holes 206. In the illustrated embodiment, the four holes 206 are provided in the four corners of the square-shaped flange section 205.

[0055] The body section is substantially cylindrical to form an inserting bore 201 passing through the body section as shown in Figures 7A to 7C. The inserting bore 201 forms with said pin front insert 14 a fitting opening 11 for receiving a mating connector. The body section is formed on its outer circumference on the fitting side with a male screw or external thread 204 adapted to engage the mating connector.

[0056] In the inserting bore 201, there is provided a groove portion 203 for receiving the retainer ring 22 at a predetermined position, which serves to fix said pin front insert 14, said intermediate insert 16, and said pin rear insert 18 in the shell 20. The shape and size of said groove portion 203 only need to receive said retainer ring 22 and may be suitably designed so as to fix said pin front insert 14, said intermediate insert 16, and said pin rear insert 18.

[0057] In the inserting bore 201 of said shell 20, there is provided a shoulder 202 at a predetermined position adapted to engage an end surface of said pin front insert 14 on its fitting side. The shoulder 202 not only serves to position said pin front insert 14 so as to prevent it from extending onto the fitting opening side but also cooperates with said retainer ring 22 to embrace said pin front insert 14, said intermediate insert 16 and said pin rear insert 18.

[0058] The positions of said groove portion 203 and said shoulder 202 may be suitably designed so as to enable said pin front insert 14, said intermediate insert 16, and said pin rear insert 18 to be fixed and enable the electrical connector 10 to be fitted with the mating connector.

[0059] A gasket 28 as a sealing material is arranged between the flange section 205 of said shell 20 and the casing to improve the air tightness.

[0060] The earth pin contact 24 will then be explained. The earth pin contact 24 is substantially bar-shaped as shown in Figure 11A. Said earth pin contact 24 is made of a metal and formed by cutting of the known technique. Preferred metals from which to form said earth pin contact 24 include brass, beryllium copper, phosphor bronze and the like which comply with the requirements as to dimensional stability, electric conductivity, and the like. The earth pin contact 24 mainly comprises at one end a contact portion 241 adapted to contact the mating connector and at the other end a larger diameter portion 242 formed with a female screw 243 diametrically passing through the larger diameter portion 242. The earth pin contact 24

is brought into electrical continuity with the shell 20 through the earth lug 26 so that the shell 20 is grounded.

[0061] The earth lug 26 will then be explained. As shown in Figure 11B, the earth lug 26 is substantially in the form of a hollow column and has a through-hole 261 for receiving a machine screw 38. The earth lug 26 has one surface formed so as to mate with said earth pin contact 24.

[0062] Finally, the retainer ring 22 will be explained. The retainer ring 22 is substantially C-shaped as shown in Figure 8 and made of a metal and formed by means of forming or coiling of the known technique. Preferred metals from which to form said retainer ring 22 include copper alloys such as beryllium copper, phosphor bronze and the like which comply with the requirements as to dimensional stability, workability, manufacturing cost, and the like. When the retainer ring 22 is fitted in the groove portion 203 of said shell 20, said pin front insert 14, said intermediate insert 16 and said pin rear insert 18 are embraced by the retainer ring 22 and the shoulder 202 of said shell 20, thereby fixing these inserts 14, 16 and 18 to said shell 20. The size of said retainer ring 22 may be suitably designed so as to be received in the groove portion 203 of said shell 20 in consideration of such functions, strength, workability, and the like.

[0063] Examples of applications of the invention are electrical connectors mounted onto an airtight casing of an industrial apparatus or electric or electronic appliance, and more particularly electrical connectors superior in waterproof property by pouring a waterproof material onto a cable connection side, thereby completely preventing any defective connection due to dew condensation.

[0064] While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details can be made therein without departing from the spirit and scope of the invention.

Claims

1. An electrical connector to be connected to and disconnected from a mating connector and adapted to be connected to a cable and to be mounted onto an airtight casing, and said electrical connector including a plurality of pin contacts each having at one end a contact portion adapted to contact said mating connector and at the other end a connection portion to be connected to said cable, at least two inserts each having inserting holes for inserting and arranging said pin contacts therein, holding means for holding said pin contacts on said inserts, a shell accommodating said at least two inserts therein, forming a fitting opening for receiving said mating connector with said inserts, and having fitting

means to be fitted with said mating connector,
 fixing means for fixing said at least two inserts to said
 shell, and
 a sealing member for preventing moisture from said
 casing,
 wherein one of said at least two inserts located on
 the side of said fitting opening is formed from a seal-
 ing member, and outer circumferences of said in-
 serting holes on the sides of the two inserts in contact
 with each other are in fitted relationship of projections
 and recesses,
 wherein a space is formed between said shell and
 an outer circumference of one of said at least two
 inserts nearest to the side of the connection portion,
 and a pouring opening is provided in said insert near-
 est to the side of the connection portion for pouring
 a waterproof material, said pouring opening reaching
 the surface of the insert in contact with the insert
 nearest to the side of the connection portion, and
 wherein a waterproof material is poured through said
 pouring opening into said space and between respec-
 tive inserts in a manner not reaching to said pin
 contacts so as to obtain high waterproof character-
 istic on the side of the connection portion.

2. An electrical connector to be connected to and dis-
 connected from a mating connector and adapted to
 be connected to a cable and to be mounted onto an
 airtight casing, and said electrical connector includ-
 ing
 a plurality of pin contacts each having at one end a
 contact portion adapted to contact said mating con-
 nector, at the other end a connection portion to be
 connected to said cable, and a flange located be-
 tween said contact portion and said connection por-
 tion,
 a pin front insert having inserting holes for inserting
 and arranging said pin contacts therein,
 an intermediate insert having inserting holes for in-
 serting and arranging said pin contacts therein,
 a pin rear insert having inserting holes for inserting
 and arranging said pin contacts therein,
 a shell having an inserting bore for inserting said pin
 front insert, said intermediate insert and said pin rear
 insert, in which inserting bore there are provided a
 shoulder adapted to engage said pin front insert and
 a groove portion for receiving a retainer ring, and
 said shell further having a fitting opening formed for
 receiving said pin front insert and said mating con-
 nector, and fitting means to be fitted with said mating
 connector,
 holding means for holding said pin contacts relatively
 to said pin rear insert,
 the retainer ring for fixing said pin front insert, said
 intermediate insert, and said pin rear insert to said
 shell, and
 a sealing member for preventing moisture from said
 casing,

wherein said pin front insert is formed from a sealing
 member, and outer circumferences of said inserting
 holes on the side of the respective inserts in contact
 with each other are in fitted relationship of projections
 and recesses,
 wherein a space is formed between said shell and
 an outer circumference of said pin rear insert, and
 said pin rear insert is provided with a pouring opening
 reaching a surface of said intermediate insert for
 pouring a waterproof material, and
 wherein a waterproof material is provided to improve
 waterproof property on the side of the connection
 portion by pouring the waterproof material into said
 space and between the respective inserts so as not
 to reach said pin contacts.

3. The electrical connector as claimed in claim 1 or 2,
 wherein said waterproof material has a viscosity of
 a predetermined value or less, and the waterproof
 material is poured so as to reach the end surface of
 said shell on the side of the connection portion.
4. The electrical connector as claimed in claim 3,
 wherein said waterproof material has a viscosity of
 25 Pa·s or less, and more preferably between 20.0
 and 0.6Pa·s
5. The electrical connector as claimed in claim 3 or 4,
 wherein recesses are formed between said inserting
 holes at least in either of the surfaces in contact with
 each other of the insert nearest to the side of the
 connection portion and of the insert in contact with
 said insert nearest to the side of the connection por-
 tion, or at least in either of surfaces in contact with
 each other of said intermediate insert and said pin
 rear insert.
6. The electrical connector as claimed in any one of
 claims 1 to 5, wherein said holding means is formed
 integrally with said insert nearest to the side of the
 connection portion or said pin rear insert.
7. The electrical connector as claimed in claim 6,
 wherein said holding means comprises a plurality of
 comb teeth which are bent.
8. The electrical connector as claimed in any one of
 claims 1 to 7, wherein at least one of said pin contacts
 is used as an earth pin contact, and mounted on said
 earth pin contact is an earth lug by means of which
 said earth pin contact is brought into electrical con-
 tinuity with said shell.

FIG. 1A

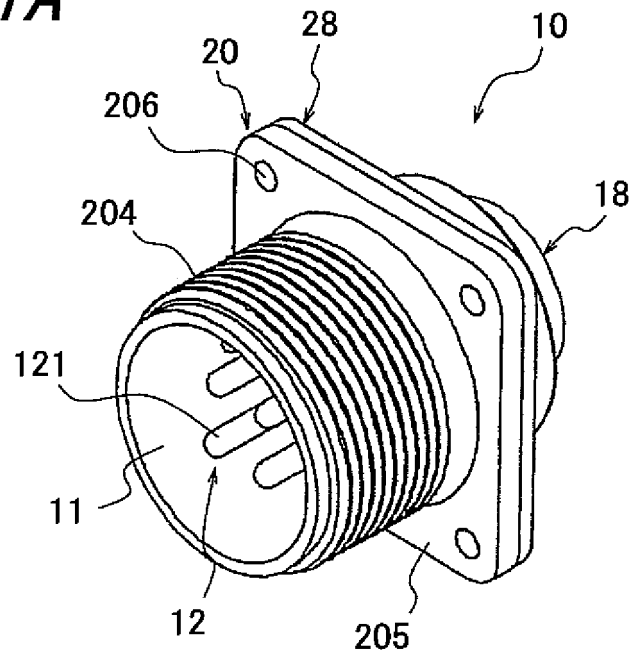


FIG. 1B

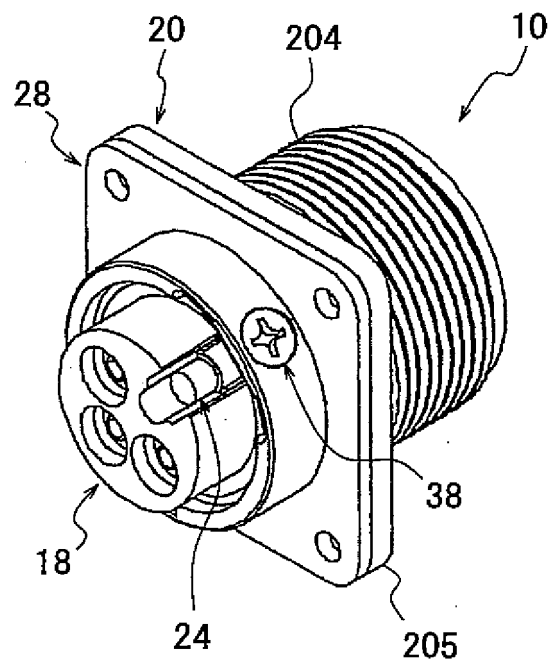


FIG. 2

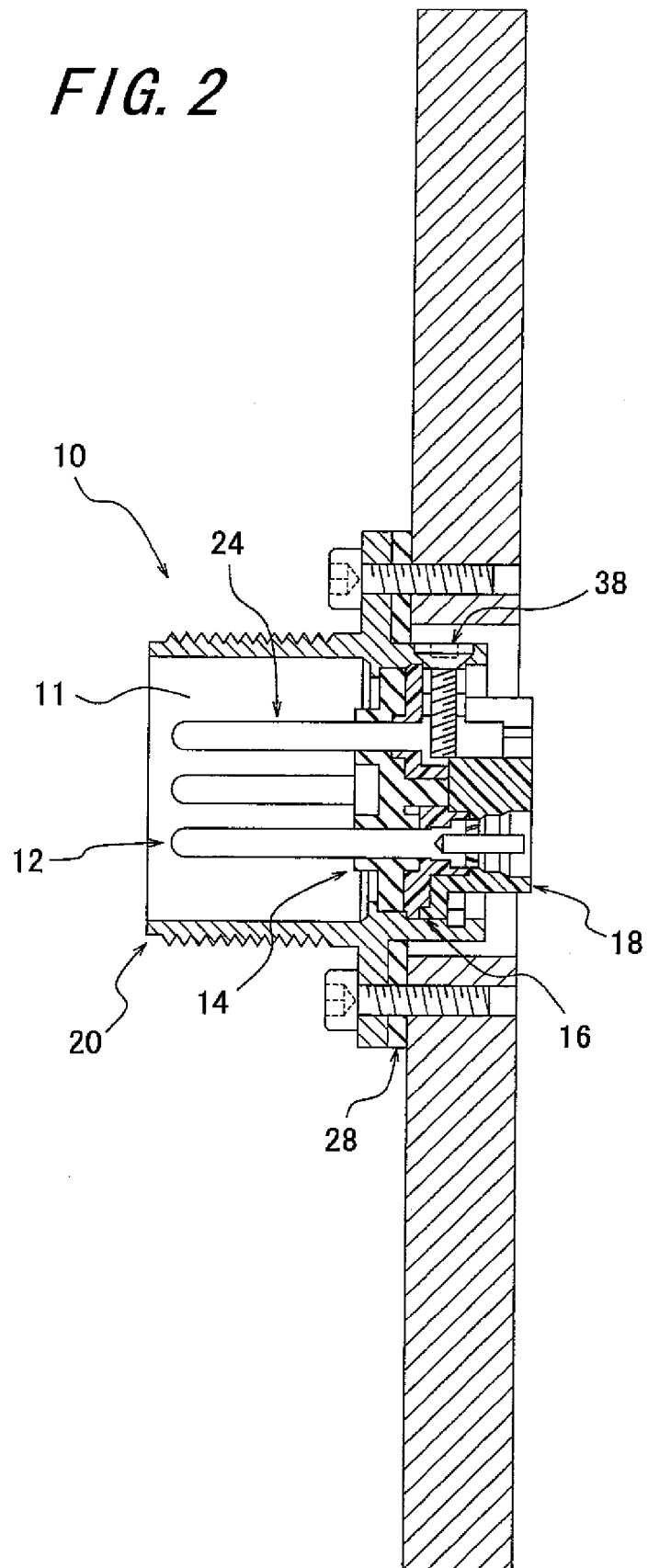


FIG. 3

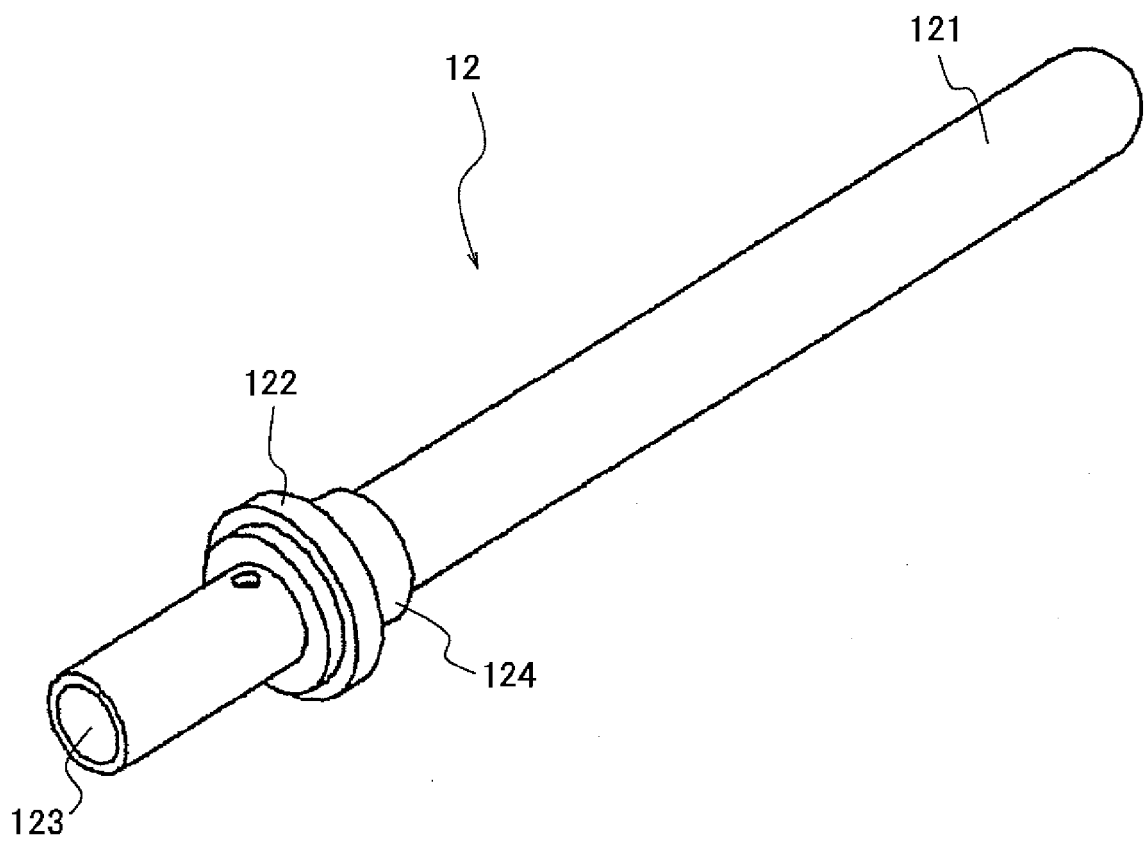


FIG. 4A

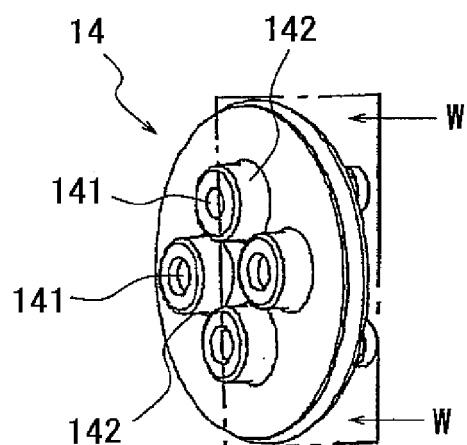


FIG. 4B

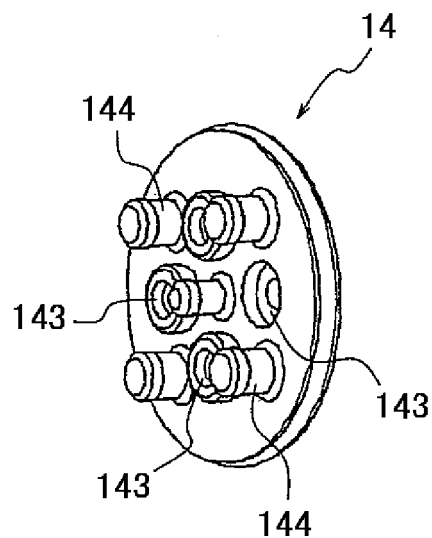


FIG. 4C

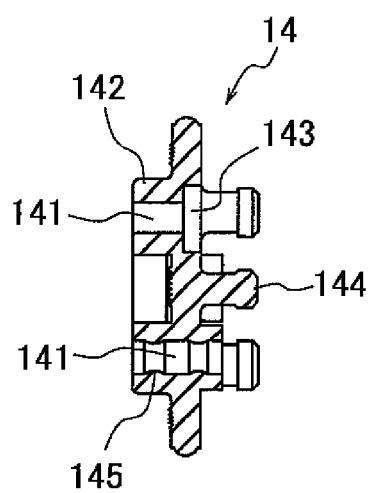


FIG. 5A

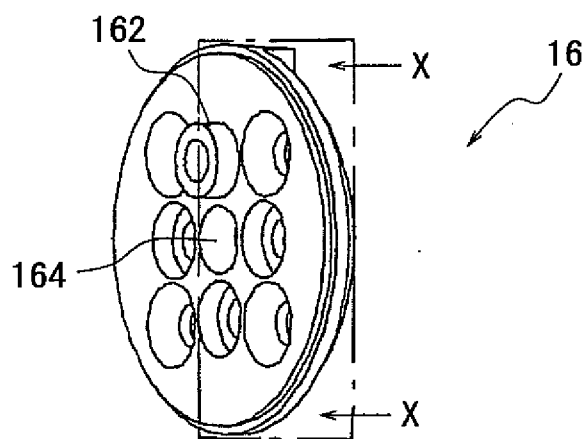


FIG. 5B

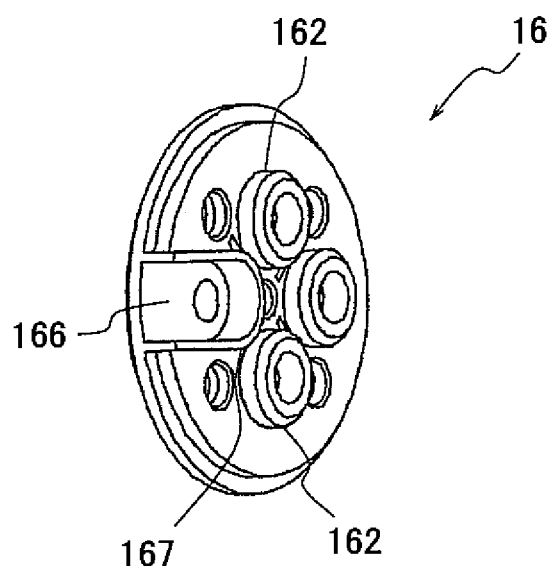


FIG. 5C

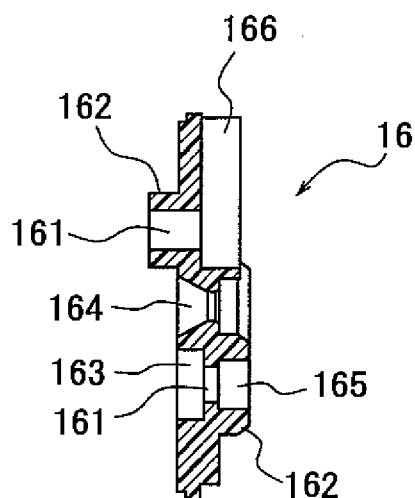


FIG. 6A

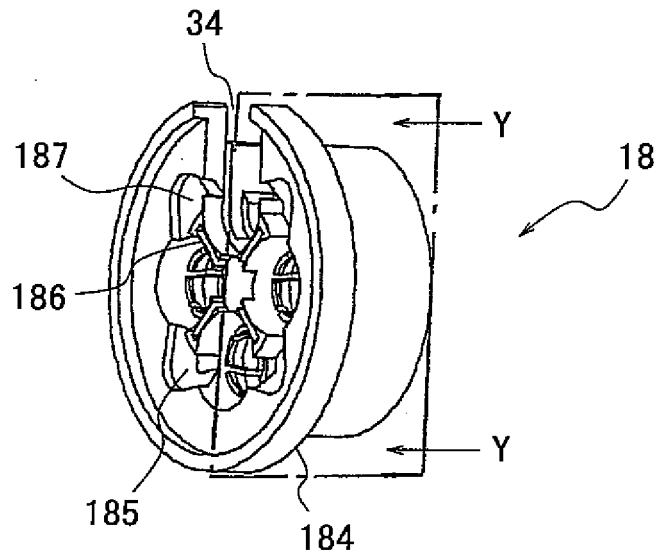


FIG. 6B

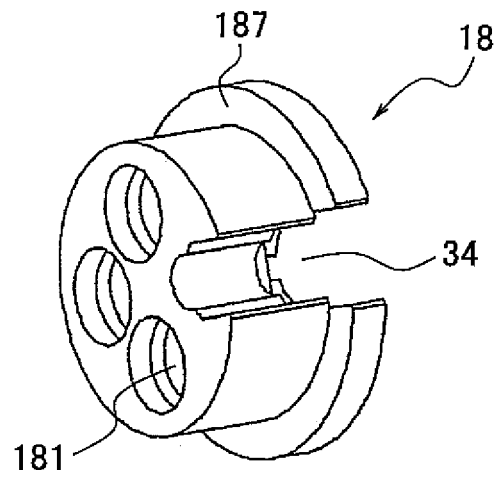


FIG. 6C

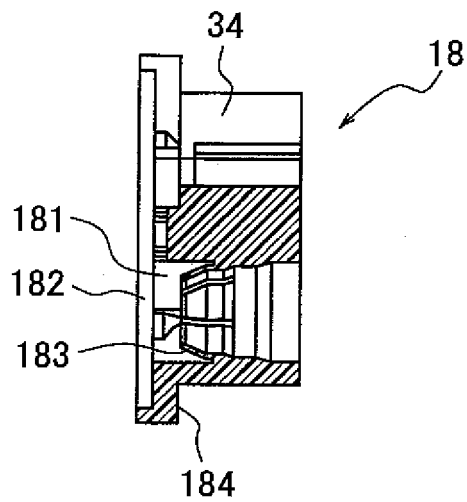


FIG. 7A

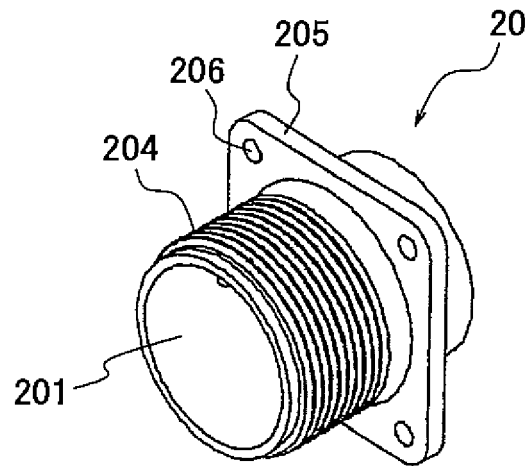


FIG. 7B

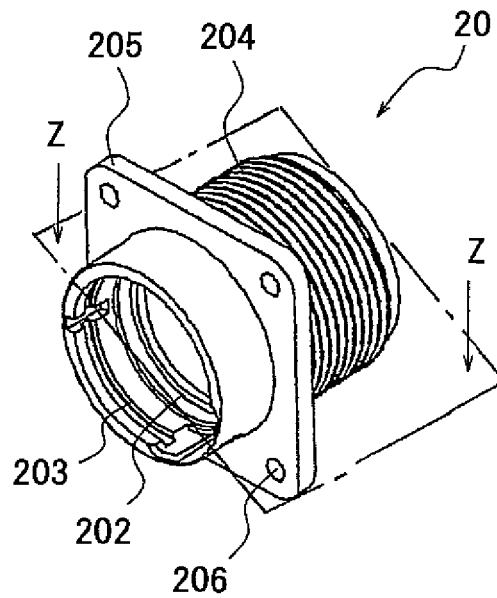


FIG. 7C

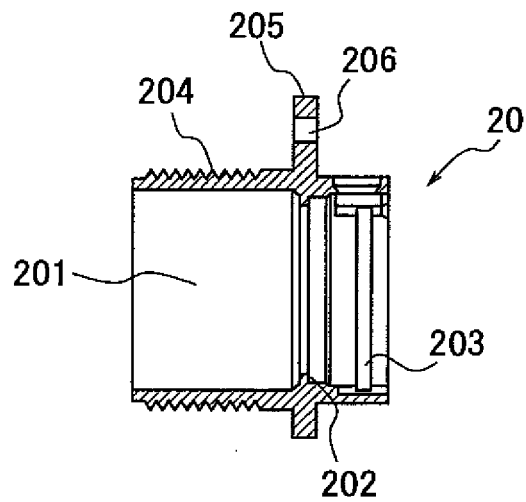


FIG. 8

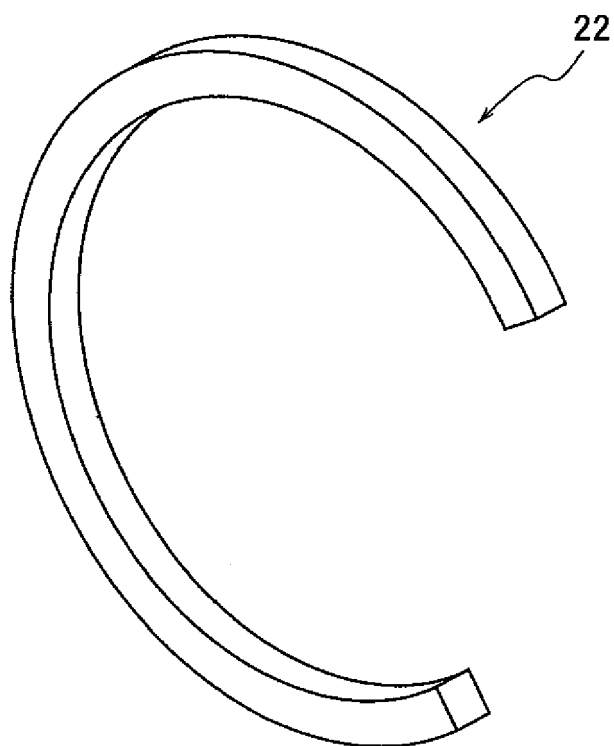


FIG. 9A

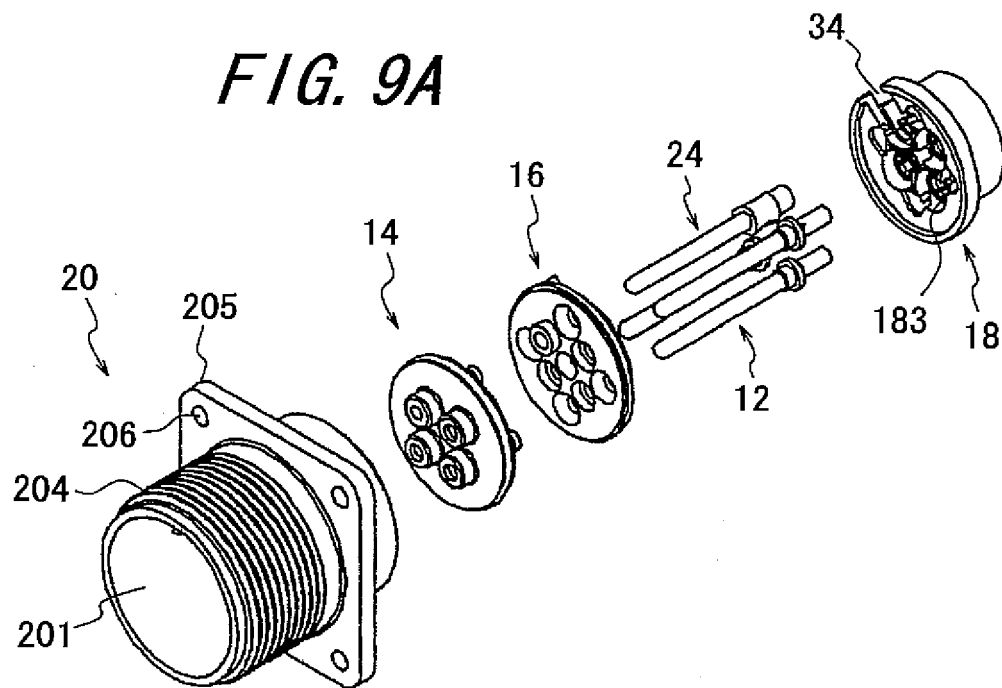


FIG. 9B

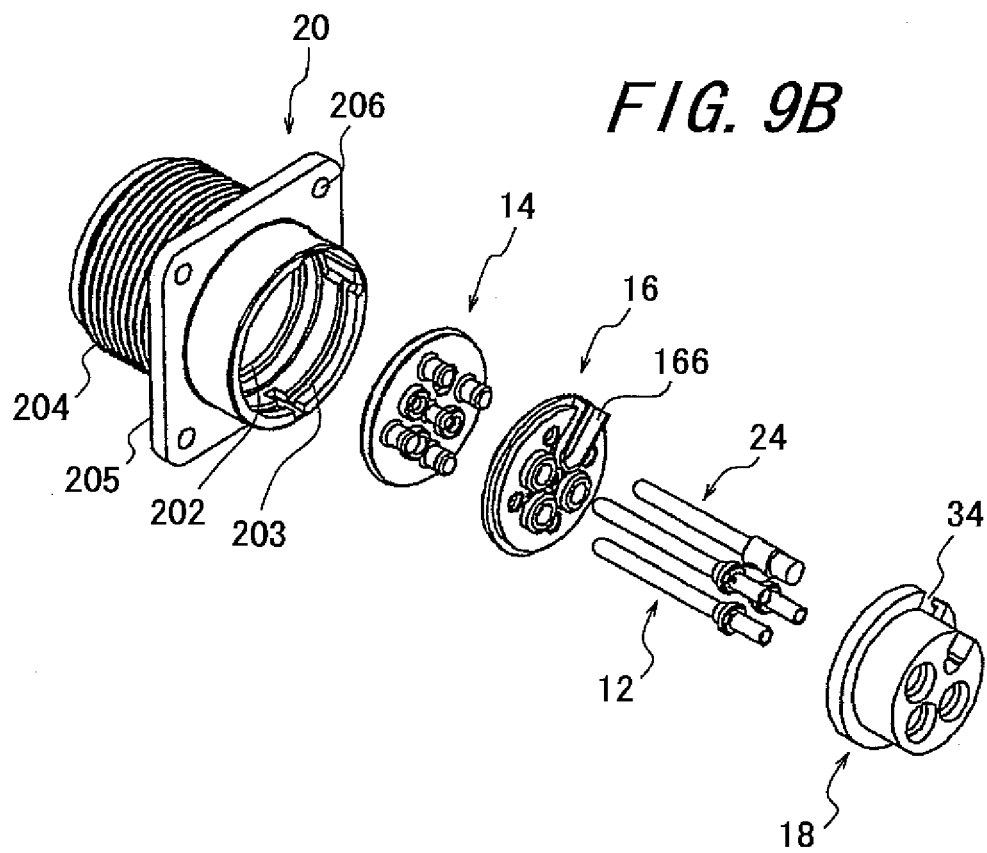


FIG. 10A

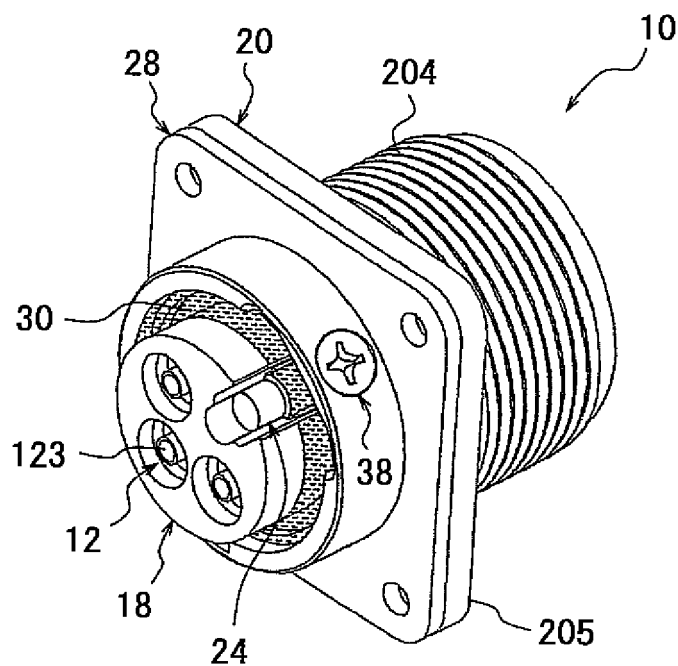


FIG. 10B

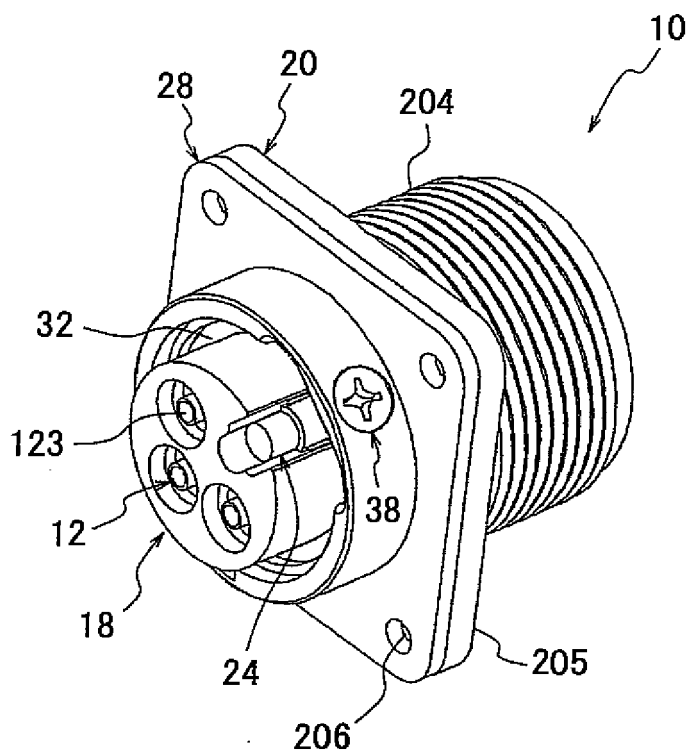


FIG. 11A

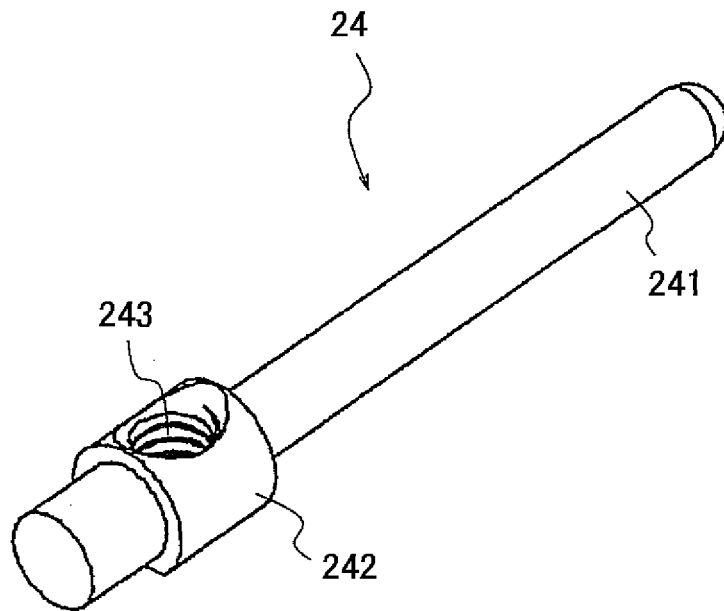
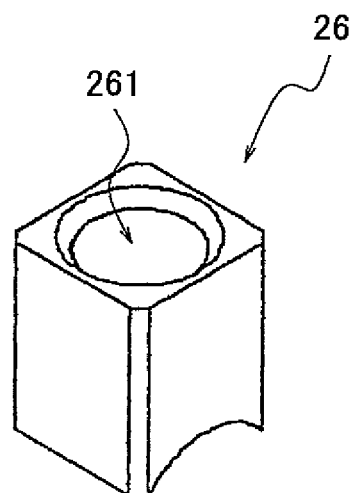


FIG. 11B



REFERENCES CITED IN THE DESCRIPTION

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- JP H10223297 B [0003] [0006] [0007]