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(54) **LINEAR CABLE CONNECTION**

(57) Conductors (2a, 2b) that compose a pair of cables (1a, 1b) to be interconnected are securely fitted to first and second conductor connectors (4, 16), respectively. First and second insulating cylinders (8, 17) enclose the ends of the first and second conductor

connectors (4, 16) and the cables (1a, 1b). The two cylinders (8, 17) are joined while the first and second conductor connectors (4, 16) are interconnected.

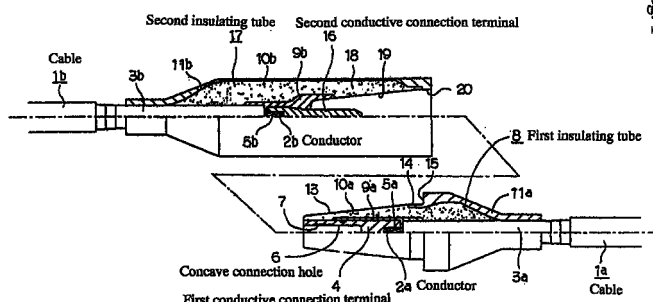


Fig. 1

Description

Field of the Invention

[0001] This invention relates to a linear cable connector which connects the ends of a pair of cables such as power cables that supply electric power to various mechanical equipment or the propulsion coil of a linear motor.

Description of the Background Art

[0002] In order to supply power to units that are separated by a long distance from the power supply, it is necessary to connect several cables together in series. Linear cable connectors that are used for these kinds of purposes have been known, for example, wound-tape type, plug-in type, or prefab type.

[0003] Of these, for the wound-tape type, the amount of time for manufacturing the linear cable connector is long and requires much skill. For the plug-in type, attaching the insulating tube requires strong force to insert it, and workability is poor. Furthermore, the prefab type has many components, increasing the weight and making it difficult to assemble and to maintain.

[0004] Taking the above problem into consideration, the objective of this invention is to provide a linear cable connector that is constructed such that it is lightweight and can be assembled easily.

Disclosure of the Invention

[0005] The linear cable connector of this invention comprises a pair of cables whose ends are to be connected, first and second conductive connection terminals, and first and second insulating tubes. Of these, the first conductive connection terminal is fastened to the end of a conductive body of one cable of the pair of cables. Moreover, the second conductive connection terminal is fastened to the end of a conductive body of the other cable of the pair of cables such that there is conduction with the first conductive connection terminal. The first insulating tube is formed such that it surrounds the end of one of the cables and the first conductive connection terminal, and the tip half is sloped in a direction such that the outer diameter becomes smaller toward the tip end, and the first conductive connection terminal is exposed at its tip end face. Furthermore, the second insulating tube is formed such that it surrounds the end of the other cable and the second conductive connection terminal and has a receiving hole on the inside of the tip half that is sloped such that the inner diameter becomes smaller toward the rear end, and the second conductive connection terminal is located at the rear end of this receiving hole.

[0006] In the linear cable connector of this invention, constructed as described above, the tip half of the first insulating tube is inserted into the receiving hole formed

on the inside of the tip half of the second insulating tube so as to connect the ends of the conductor of a pair of cables by way of the first and second conductive connection terminals as well as to insulate the connections.

Brief Description of the Drawings

[0007]

Fig. 1 is a cross-sectional view showing the unconnected state of a first example of the embodiment of the present invention.

Fig. 2 is a cross-sectional view that corresponds to the lower right section of Fig. 1, and shows another example of the connection of the first and second conductive connection terminals.

Fig. 3 is a cross-sectional view of the connected state of a second example of the embodiment of the present invention.

Fig. 4 is a cross-sectional view of the connected state of a third example of the embodiment of the present invention.

Fig. 5 is a view as seen from the side of Fig. 4 with part omitted.

Fig. 6 is substantially the same as Fig. 1 and shows a fourth example of the embodiment of the present invention.

Symbols

[0008]

1a, 1b: Cable

2a, 2b: Conductor

3a, 3b: Insulation covering

4, 4a: First conductive connection terminal

5a, 5b: Concave junction hole

6: Concave connection hole

7: Contact

8, 8a: First insulating tube

9a, 9b: Inner semiconducting layer

10a, 10b: Insulation layer

11a, 11b, 11a', 11b', 11a'', 11b'': Outer semicon-

ducting layer

12: Insulating layer

13: Outer tapered surface

14: Outer cylindrical surface

15: Stepped section

16, 16a: Second conductive connection terminal

17, 17a: Second insulating tube

18: Retaining tube

19: Inner tapered surface

20: Inner cylindrical surface

21: Retaining band

22a, 22b: Flange

23: Bolt

24: Nut

25: Attachment groove

26: O-ring

27: Wedge piece

28: Spring

29: Connector

The Preferred Embodiments to Work the Invention

[0009] Fig. 1 shows a first example of the embodiment of the present invention. Of the pair of cables 1a, 1b that are to be connected together, on the end of the conductor 2a of one of the cables 1a (right lower cable in Fig. 1), in the portion that protrudes from the insulating covering 3a, there is a first conductive connection terminal 4. This first conductive connection terminal 4 is made of a good conductive metal such as copper or copper alloy, and it is formed entirely into a cylindrical shape with a concave junction hole 5a formed on the base end surface (right end surface in Fig. 1) for inserting the end of the conductor 2a. This cable 1a and first conductive connection terminal 4 are joined together by inserting the ends of the conductor 2a into the concave junction hole 5a, and then compressing the base end of the first conductive connection terminal 4 inward in the radial direction. In addition, there is a concave connection hole 6 formed on the tip half of the first conductive

connection terminal 4 such that it opens in the tip end surface of the first conductive connection terminal 4. On the inner peripheral surface of this concave connection hole 6, there is a typical known contact 7 made of good conductive metal plate such as copper.

[0010] From the outer peripheral surface on the tip end of the first conductive connection terminal 4 to the outer peripheral surface on the end of the cable 1a is covered by a first insulating tube 8. This first insulating tube 8 comprises an internal semiconducting layer 9a, an insulating layer 10a and an external semiconducting layer 11a, that are all made of an elastic material such as rubber. Of these, the internal semiconducting layer 9a covers from the end of the insulating covering 3a to the middle of the first conductive connection terminal 4. The insulating layer 10a covers from the outer peripheral surface on the tip end of the first conductive connection terminal 4 to the insulating covering 3a. The outer peripheral surface on the tip end of the insulating layer 10a (left half in Fig. 1) forms a radially outer tapered surface 13 that is inclined in a direction such that its outer diameter becomes smaller toward the tip end. The internal semiconducting layer 9a can also cover up to the tip end of the first conductive connection terminal 4, as shown in Fig. 2 and described later.

[0011] Moreover, the tip end surface of the first conductive connection terminal 4 is exposed at the tip end surface of the insulating layer 10a, and the concave connection hole 6 opens in the tip end surface of this insulating layer 10a. Furthermore, the external semiconducting layer 11a covers from the middle of the insulating layer 10a to the insulating covering 3a. On the tip end of this external semiconducting layer 11a, there is a radially outer cylindrical surface 14 in the continuous section from the base end or large-diameter end of the tapered surface 13a, and there is a stepped section 15 in the continuous section from this outer cylindrical surface 14. The portion from the base end (right end in Fig. 1) of the insulating layer 10a to the external covering of the cable 1a, is covered by a different insulating layer 12 that is formed by winding insulating tape (see Fig. 2 described later).

[0012] On the other hand, on the end of the conductor 2b of the other cable 1b (upper left in Fig. 1), in the section that protrudes from the insulating covering 3b, there is a second conductive connection terminal 16. This second conductive connection terminal 16 is also made of a good conducting metal, and is formed entirely in a cylindrical shape, with a concave junction hole 5b formed at the base end surface (left end surface in Fig. 1) for inserting the end of the conductor 2b into. This other cable 1b and the second conductive connection terminal 16 are joined together by inserting the end of the conductor 2b into the concave junction hole 5b, and then compressing the base end of the second conductive connection terminal 16 inward in the radial direction. Moreover, the tip end half (right half in Fig. 1) of the second conductive connection terminal 16 can be freely

inserted inside the contact 7 that is formed on the inner peripheral surface of the concave connection hole 6 that is formed in the first conductive connection terminal 4 while elastically pressing open this contact 7.

[0013] Also, from the outer peripheral surface in the middle of the second conductive connection terminal 16 to the outer peripheral surface on the end of the cable 1b, is covered by a second insulating tube 17. This second insulating tube 17 comprises an internal semiconducting layer 9b, an insulating layer 10b and an external semiconducting layer 11b, that are all made of an elastic material such as rubber. Of these, the internal semiconducting layer 9b covers from the end of the insulating covering 3b to the middle section of the second conductive connection terminal 16. The insulating layer 10b covers from the tip end of the semiconducting layer 9b to the insulating covering 3b. Moreover, on the tip half (right half in Fig. 1) of the insulating layer 10b, the portion that protrudes from the tip end edge of the internal semiconducting layer 9b forms a retaining tube 18 into which the tip end half of the insulating layer 10a of the first insulating tube 8 can be freely inserted. The inner peripheral surface of this retaining tube 18 forms a radially inner tapered surface 19 which is inclined in a direction such that its inner diameter becomes larger toward the tip end. The angle of inclination of this radially inner tapered surface 19 is equal to the angle of inclination of the radially outer tapered surface 13, and when the tip half of the insulating layer 10a is inserted inside the retaining tube 18, the both tapered surfaces 19, 13 come in very close contact with each other such that there is no space between them.

[0014] Moreover, the tip end half of the second conductive connection terminal 16 protrudes inside the retaining tube 18. Furthermore, the external semiconducting layer 11b covers from the tip end edge of the insulating layer 10b to the insulating covering 3b. The tip end edge of the second insulating tube 17 is formed by the external semiconducting layer 11b. Also, there is a radially inner cylindrical surface 20 formed on the inner peripheral surface of the opening end (right end in Fig. 1) of the retaining tube 18. This radially inner cylindrical surface 20 freely fits around the radially outer cylindrical surface 14 that is formed on the first insulating tube 8 with a slight interference fit. In addition, the portion from the base end of the insulating layer 10b (left end in Fig. 1) to the external covering 3b of the cable 1b is also covered by another insulating layer 12 (see Fig. 2 described later), which is made with insulating tape wound.

[0015] When connecting the pair of cables 1a, 1b, the tip half of the first insulating tube 8 is inserted inside the retaining tube 18 that is formed on the tip half of the second insulating tube 17 until the tip end surface of this retaining tube 18 comes in contact with or very close to the aforementioned stepped section 15. As a result, the radially inner cylindrical surface 20 fits around the radially outer cylindrical surface 14 with a slight interference fit, and the pair of tapered surfaces 19, 13 come in very

close contact with no space between them. Moreover, the tip half of the second conductive connector 16 is inserted into the concave connection hole 6 formed on the tip half of the first conductive connection terminal 4 while elastically pushing open the contact 7. As a result, the pair of cables 1a, 1b are connected by way of the first and second conductive connection terminals 4, 16 and the contact 7. As shown in Fig. 2, for the connection between this pair of conductive connection terminals 4, 16, a different connection method can be used such as using a connector 29 called a tulip connector that comprises a plurality of wedge pieces 27 that are formed in a cylindrical shape and bundled together with ring-shaped springs 28, 28. In this case, the concave connection hole 6 and contact 7 are not necessary.

[0016] With the pair of cables 1a, 1b in a connected state like this, the cables 1a, 1b will not accidentally become separated since there is a good fit between the radially inner cylindrical surface 20 and radially outer cylindrical surface 14. Both of the cylindrical surfaces 20, 14 are first fitted together in the final stage of the connection process, so the amount of force required to connect the cables 1a, 1b does not become uselessly larger. Moreover, when separating these cables 1a, 1b, it is possible to easily separate them by pulling the first and second insulating tubes 8, 17 with a strong force in the direction of separation.

[0017] Next, Fig. 3 shows a second example of the embodiment of the present invention. In this embodiment, the openings on the tip ends of the external semiconducting layers 11a', 11b' of the first and second insulating tubes 8a, 17a fit together in a land and recess fitting, and the outer peripheral surface of the land and recess fitting is further held together with a retaining band 21. In the case of this example, the first and second insulating tubes 8a, 17a are securely prevented from separation. The construction and function of all other parts are substantially the same as those explained for the first example, so drawings and explanations of identical parts are omitted.

[0018] Next, Figs. 4 and 5 show a third example of the embodiment of the present invention. In this example, the openings on the tip ends of the external semiconducting layers 11a", 11b" of the first and second insulating tubes 8a, 17a are joined together by flanges 22a, 22b. Therefore, there are flanges 22a, 22b formed generally circumferentially on the openings on the tip ends of the external semiconducting layers 11a", 11b". These flanges 22a, 22b are made of metal such as steel, or a synthetic resin, such as high-functional plastic, and formed in a ring shape with an L-shape cross section. These flanges 22a, 22b are molded and thermally bonded to the tip ends of the external semiconducting layers 11a", 11b" when forming the external semiconducting layers 11a", 11b" (for metal flanges 22a, 22b), or are separately formed and attached later. In either case, the contact surface between the flanges 22a, 22b and the external semiconducting layers 11a",

11b" fit closely all the way around to form a complete seal.

[0019] The shape of the outer peripheral edges of these flanges 22a, 22b is square with the four corners having a 1/4 arc shape. On the other hand, the outer peripheral surface on the tip end of these external semiconducting layers 11a", 11b" is cylindrical. The four corners of both flanges 22a, 22b protrude further outward in the radial direction than the outer peripheral surface on the tip ends of the external semiconducting layers 11a", 11b" as shown in Fig. 5. Holes are formed in the four corners of both flanges 22a, 22b in alignment, and bolts 23, 23 are inserted through those holes. Nuts 24 are screwed onto the tip ends of these bolts 23, 23 on the part that protrudes from the outside surface of one of the flanges 22b, and by tightening these nuts 24, the flanges 22a, 22b are securely fastened together.

[0020] Moreover, of the two surfaces of the flange 22a, on the surface that faces the other flange 22b, there is an attachment groove 25 that is formed all the way around in the portion that is further on the radially inside than the aforementioned holes, and an O-ring 26 is attached to this attachment groove 25. When the flanges 22a, 22b are fastened together by the bolts 23, 23 and nuts 24, this O-ring 26 is elastically compressed between the side surface of the flange 22b and the bottom surface of the attachment groove 25, and seals the abutment surfaces. The other construction and functions of this example are substantially the same as those for the first example, so the same symbols are used for identical parts, and any redundant explanation is omitted.

[0021] Next, Fig. 6 shows a fourth example of the embodiment of this invention. In this example, in contrast to the first example shown in Fig. 1, the first conductive connection terminal 4a that is formed on the side of the first insulating tube 8 is a male side, and the second conductive connection terminal 16a that is formed on the side of the first insulating tube 17 is a female side. In addition, on the tip end surface of this second conductive connection terminal 16a, there is a concave connection hole 6 for inserting the tip end of the first conductive connection terminal 4a into. The other construction and functions of this example are substantially the same as those for the first example, so the same symbols are used for identical parts, and any redundant explanation is omitted.

Industrial Applicability

[0022] This invention is constructed and functions as described and makes it possible for a linear cable connector that is lightweight and that can be assembled easily, as well as makes it possible to improve the efficiency of the work of installing wiring for supplying electrical power to all kinds of mechanical devices.

Claims

1. A linear cable connector comprising a pair of cables comprising a conductive body and having ends to be connected to each other, first and second conductive connection terminals, and first and second insulating tubes, the first conductive connection terminal being fastened to the end of the conductive body of one cable of the pair of cables, the second conductive connection terminal being fastened to the end of the conductive body of the other cable of the pair of cables such that there is conduction with the first conductive connection terminal, the first insulating tube being formed such that it surrounds the end of one of the cables and the first conductive connection terminal, and having a tip half that is sloped in a direction such that the outer diameter becomes smaller toward the tip end, and that the first conductive connection terminal is exposed at the tip end surface of the first insulating tube, and the second insulating tube being formed such that it surrounds the end of the other cable and the second conductive connection terminal and having a tip half formed with a receiving hole on the inside of the tip half, and the receiving hole sloped such that the inner diameter becomes smaller toward the rear end, and that the second conductive connection terminal is located at the rear end of this receiving hole.

Fig. 1

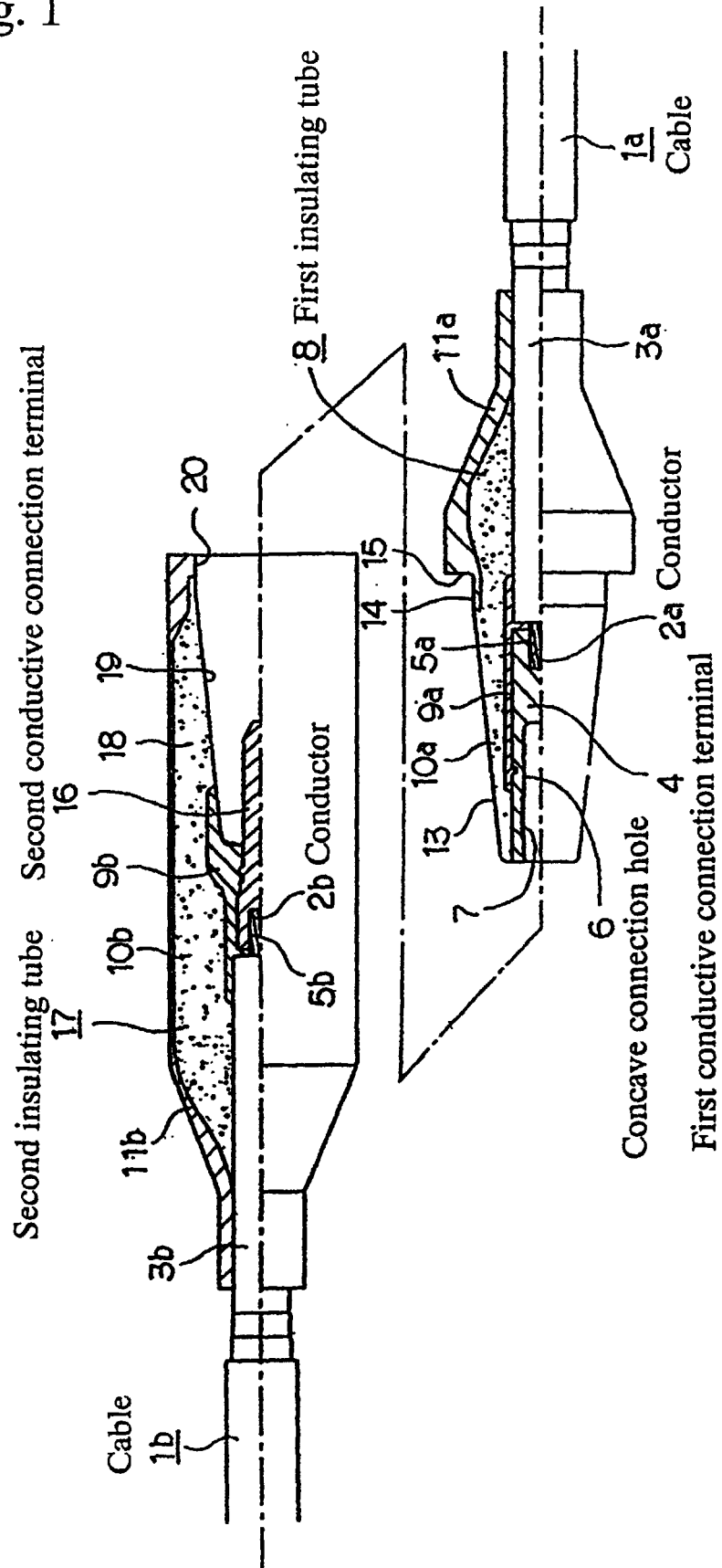


Fig. 2

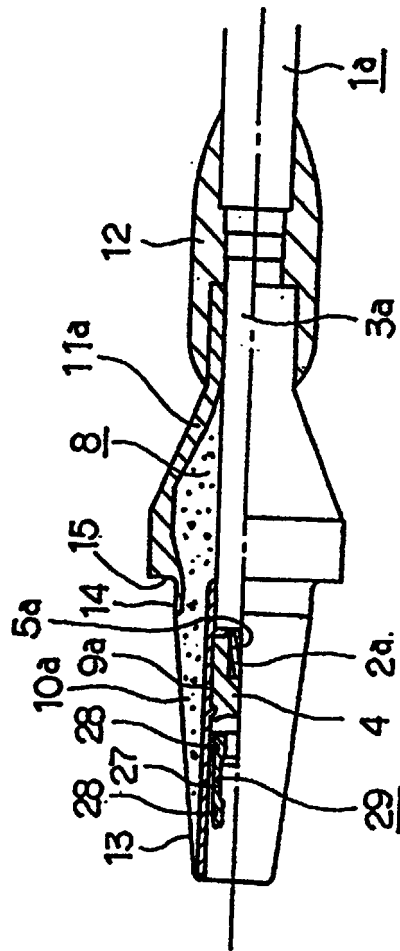


Fig. 3

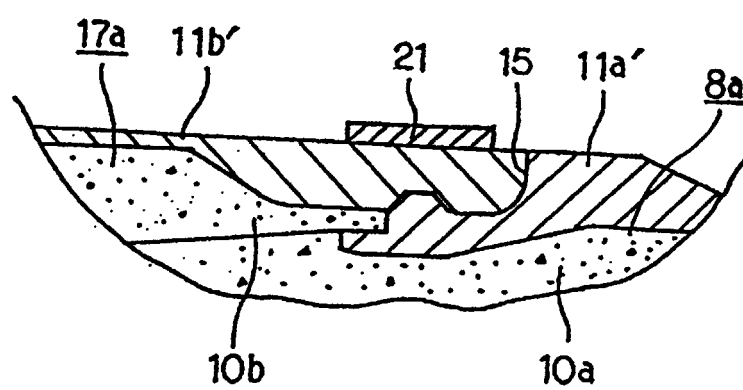


Fig. 4

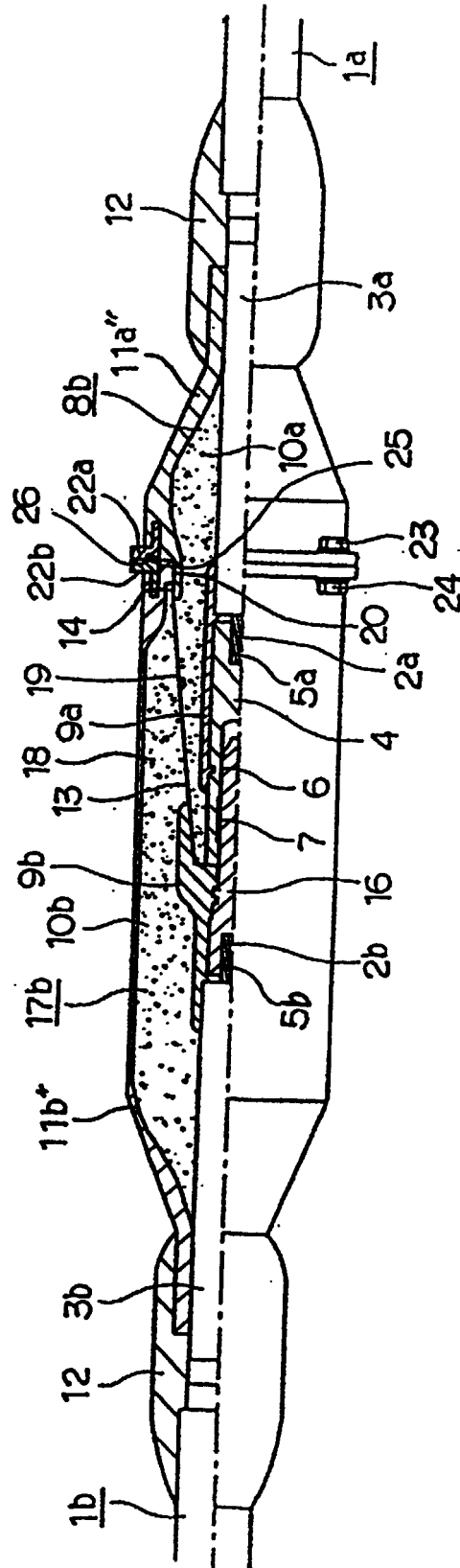


Fig. 5

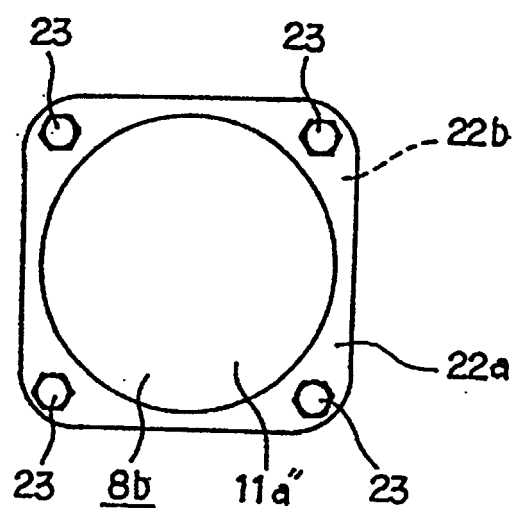
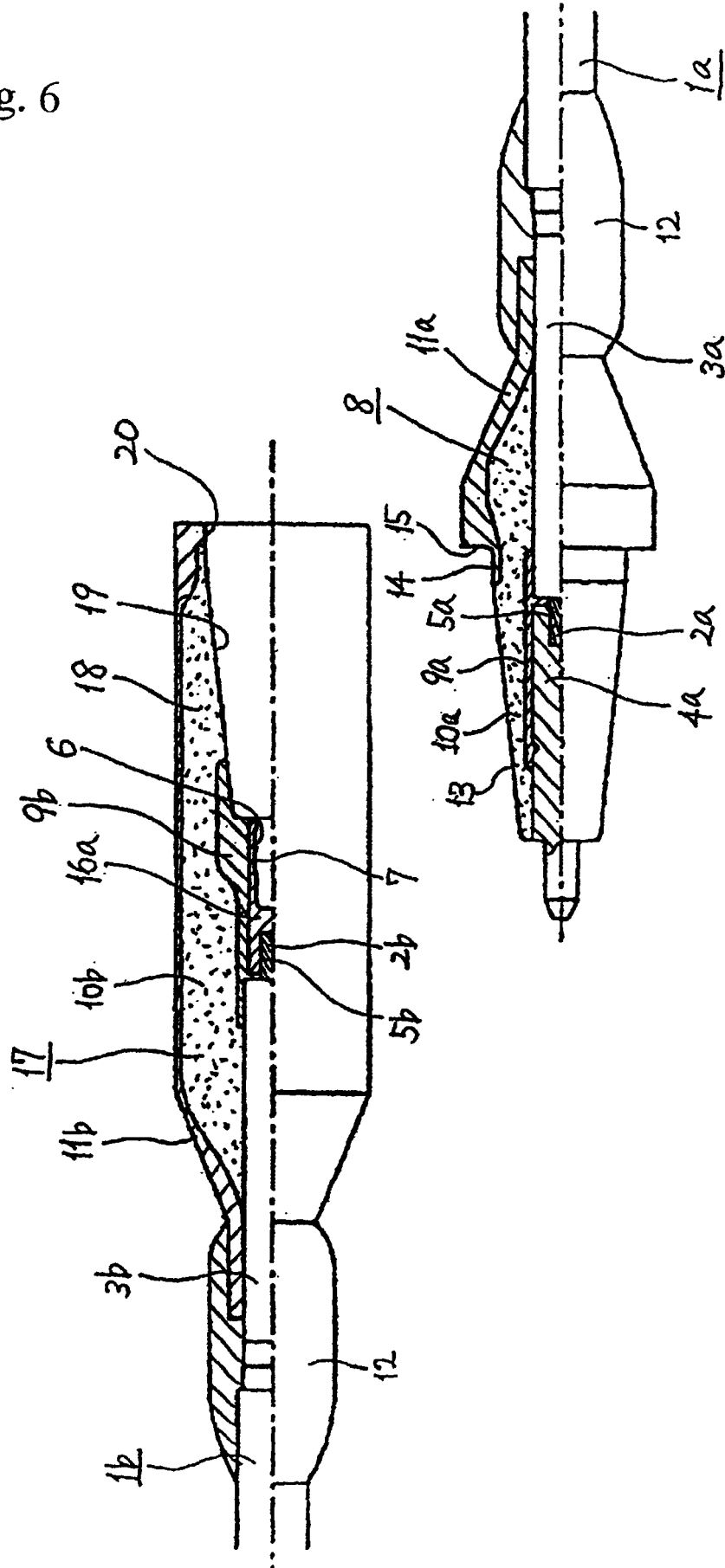


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/02284

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ H01R 13/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ H01R13/00-13/74, H01R11/00-11/32 H02G15/00-15/196		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1940-2000 Toroku Jitsuyo Shinan Koho 1994-2000 Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 8-7996, A (Chubu Electric Power Co. Inc.), 12 January, 1996 (12.01.96), Fig. 1 (Family: none)	1
Y	JP, 53-115090, A (Hitachi Cable, Ltd.), 07 October, 1978 (07.10.78), Fig. 1 (Family: none)	1
Y	JP, 09-247839, A (Mitsubishi Cable Industries, Ltd.), 19 September, 1997 (19.09.97), Fig. 1 (Family: none)	1
Y	JP, 48-392, U (Sumitomo Electric Industries, Ltd.), 06 January, 1973 (06.01.73), Fig. 1 (Family: none)	1
Y	JP, 06-153361, A (The Furukawa Electric Co., Ltd.), 31 May, 1994 (31.05.94), Fig. 1 (Family: none)	1
Y	JP, 51-40278, B1 (RTE Corporation), 02 November, 1976 (02.11.76),	1
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 23 June, 2000 (23.06.00)		Date of mailing of the international search report 04 July, 2000 (04.07.00)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/02284

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Fig. 1 (Family: none) JP, 09-505942, A (Alcatel Cable), 10 June, 1997 (10.06.97), Fig. 11 & WO, 96/10851, A & US, 5908332, A & EP, 731994, B1	1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)