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Hamada

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(54) **CABLE CONNECTION STRUCTURE AND MANUFACTURING METHOD OF THE CABLE CONNECTION STRUCTURE**

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H01R 43/24	(2006.01)
H01R 12/63	(2011.01)
H01R 4/72	(2006.01)
H01R 43/02	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 13/5205*** (2013.01); ***H01R 4/72*** (2013.01); ***H01R 12/63*** (2013.01); ***H01R 43/005*** (2013.01); ***H01R 43/24*** (2013.01); *H01R 43/0207* (2013.01)

(58) **Field of Classification Search**

CPC H01R 13/5205; H01R 4/72; H01R 12/63; H01R 43/005; H01R 43/24; H01R 43/0207

USPC 439/271–276, 278–282

See application file for complete search history.

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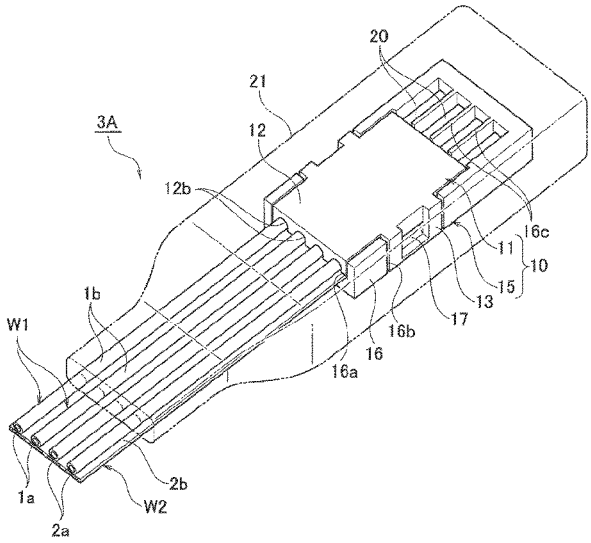
(57) **ABSTRACT**

A cable connection structure includes a round cable, a flat cable, a holder holding an end portion of the round cable and an end portion of the flat cable and pulling out the round cable and the flat cable to overlap each other in a same direction, a connecting portion in which a core wire exposed from the end portion of the round cable and a conductor exposed from the end portion of the flat cable held by the holder are connected to each other, and a mold resin portion collectively covering the outer circumference of the holder and the outer circumference of the round cable and the flat cable pulled out from the holder.

10 Claims, 20 Drawing Sheets



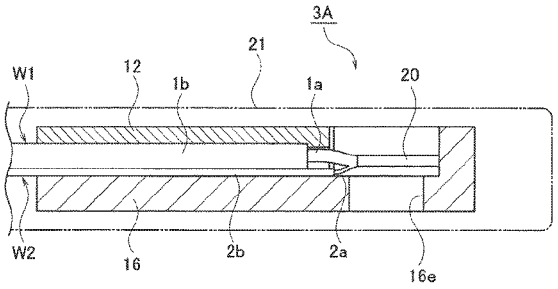


FIG. 1A

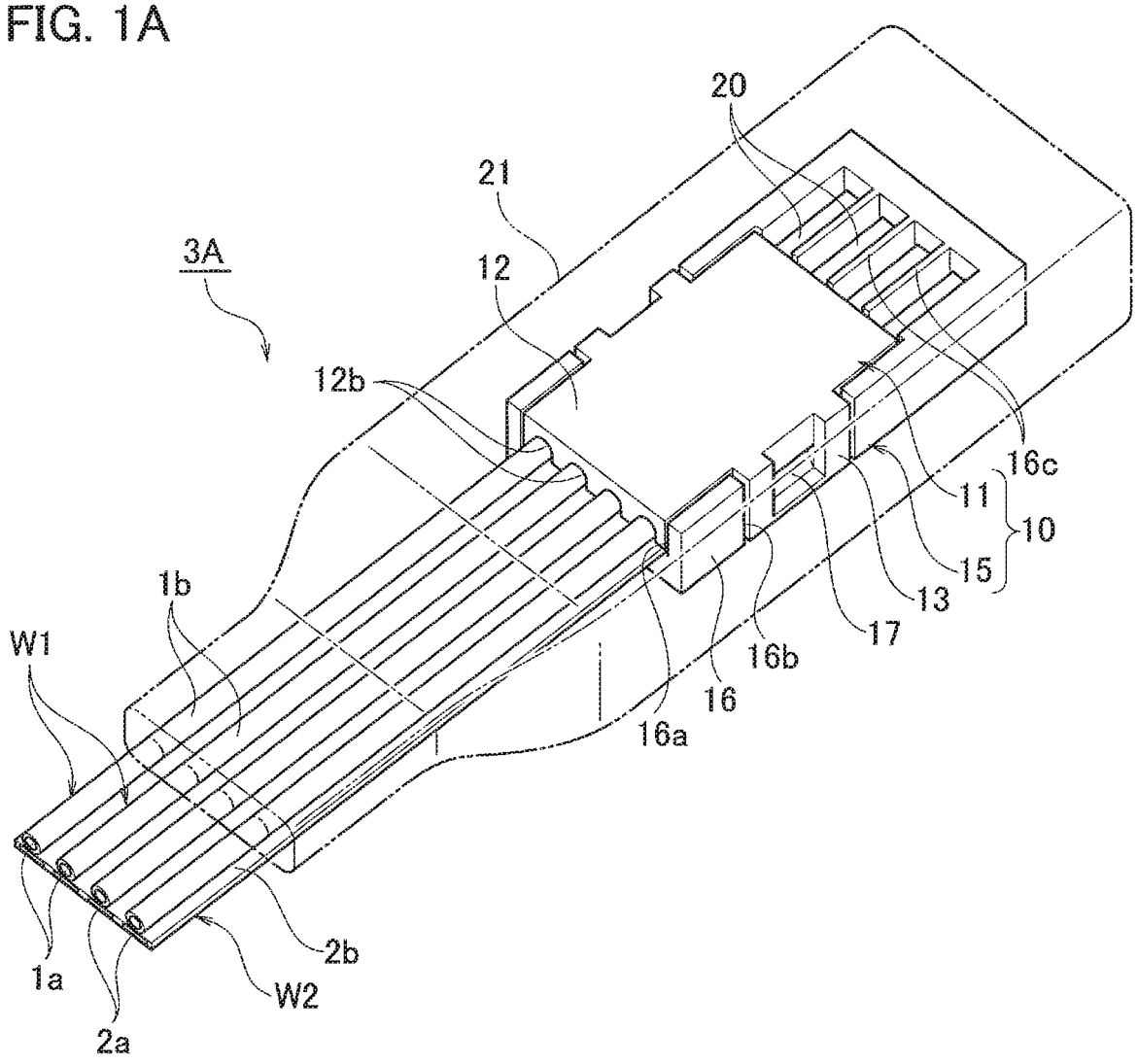
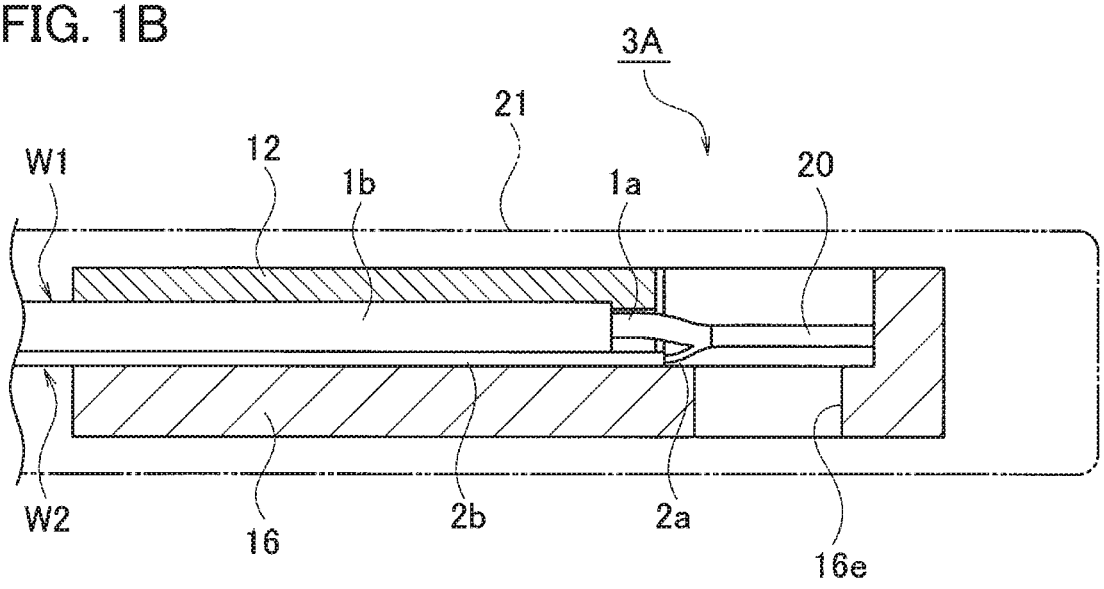

20
21
3A
12
12b
16c
11
10
15
13
17
16b
16
16a
1b
W1
1a
2a
W2
2b

FIG. 1B


3A
21
W1
12
1b
1a
20
W2
16
2b
2a
16e

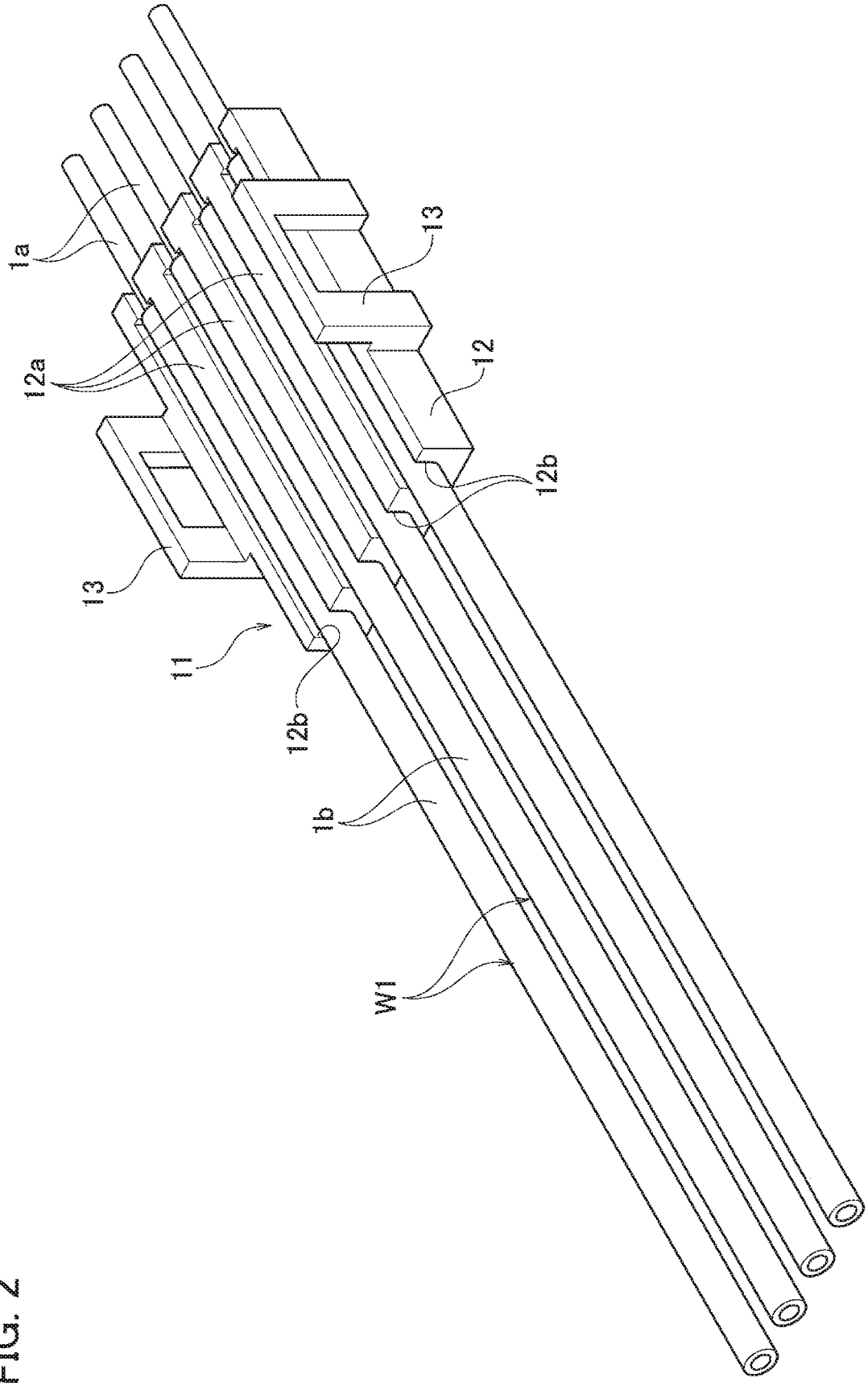


FIG. 2

FIG. 3A

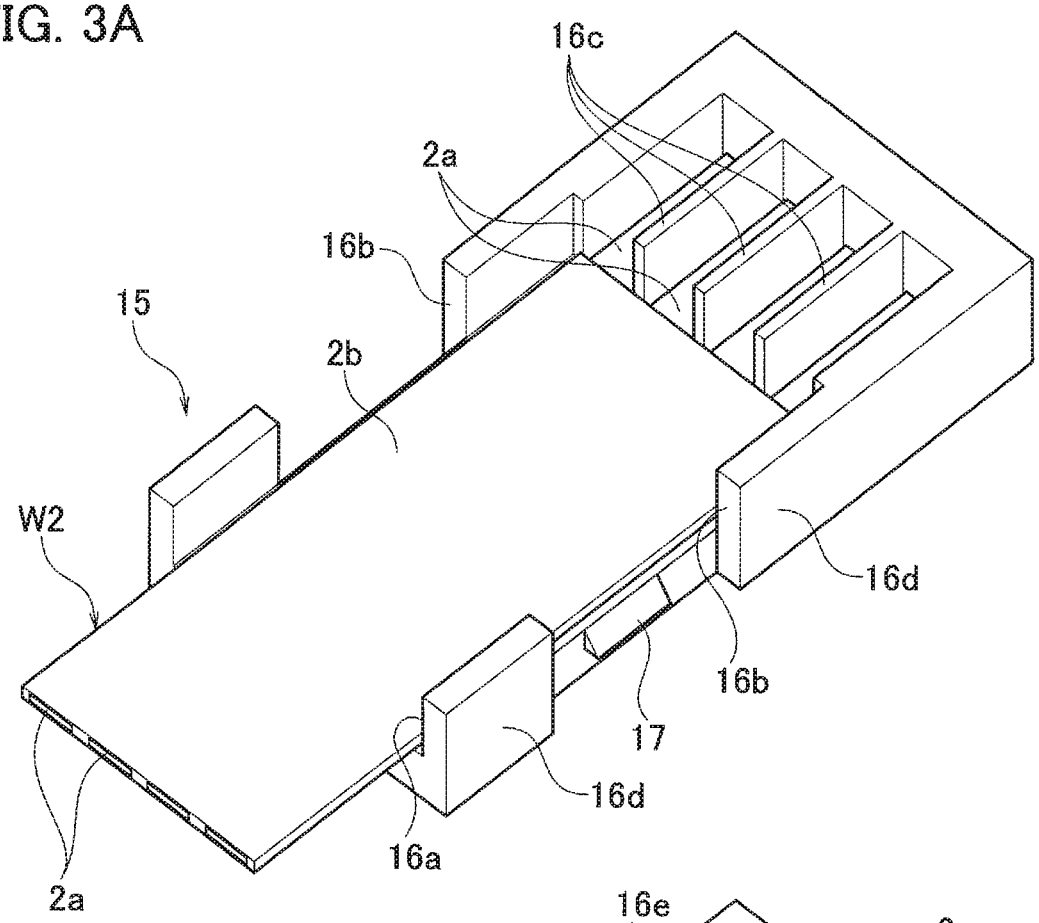
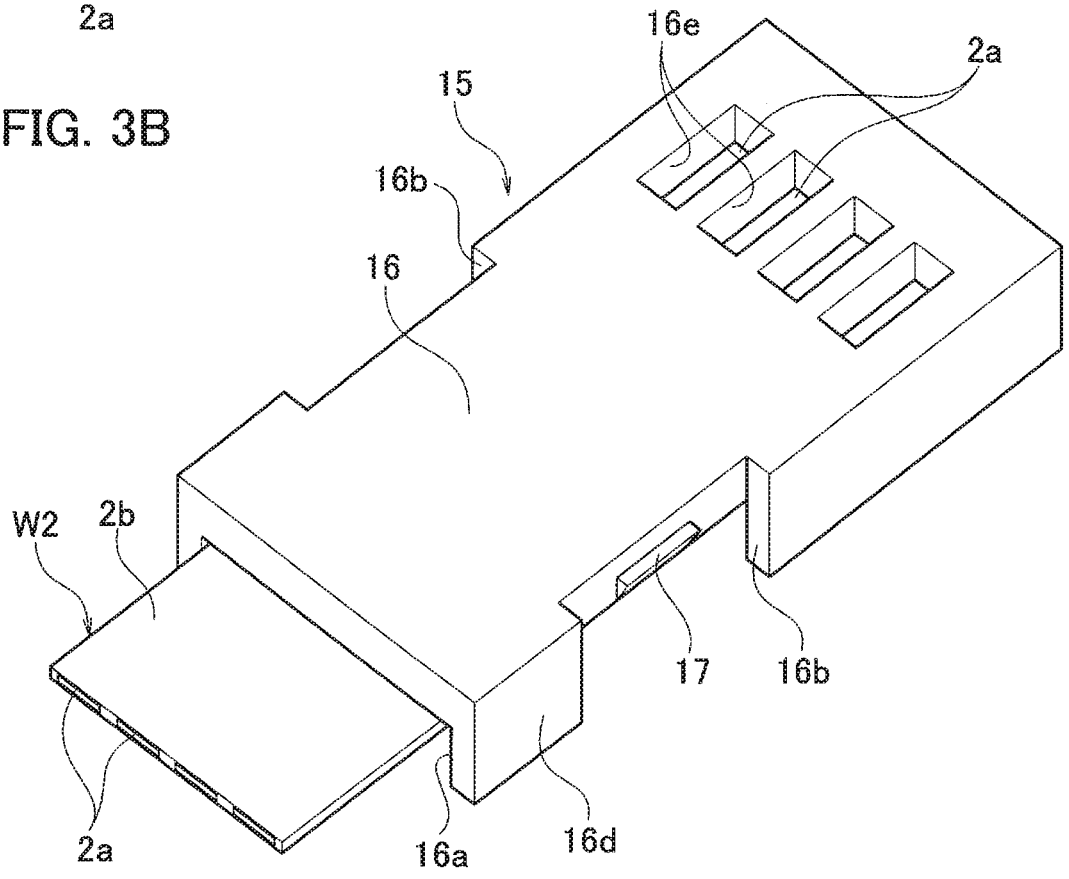

16c
2a
16b
15
2b
W2
16d
16b
17
16d
16a
2a

FIG. 3B


16e
2a
15
16b
16
W2
2b
17
16b
2a
16a
16d

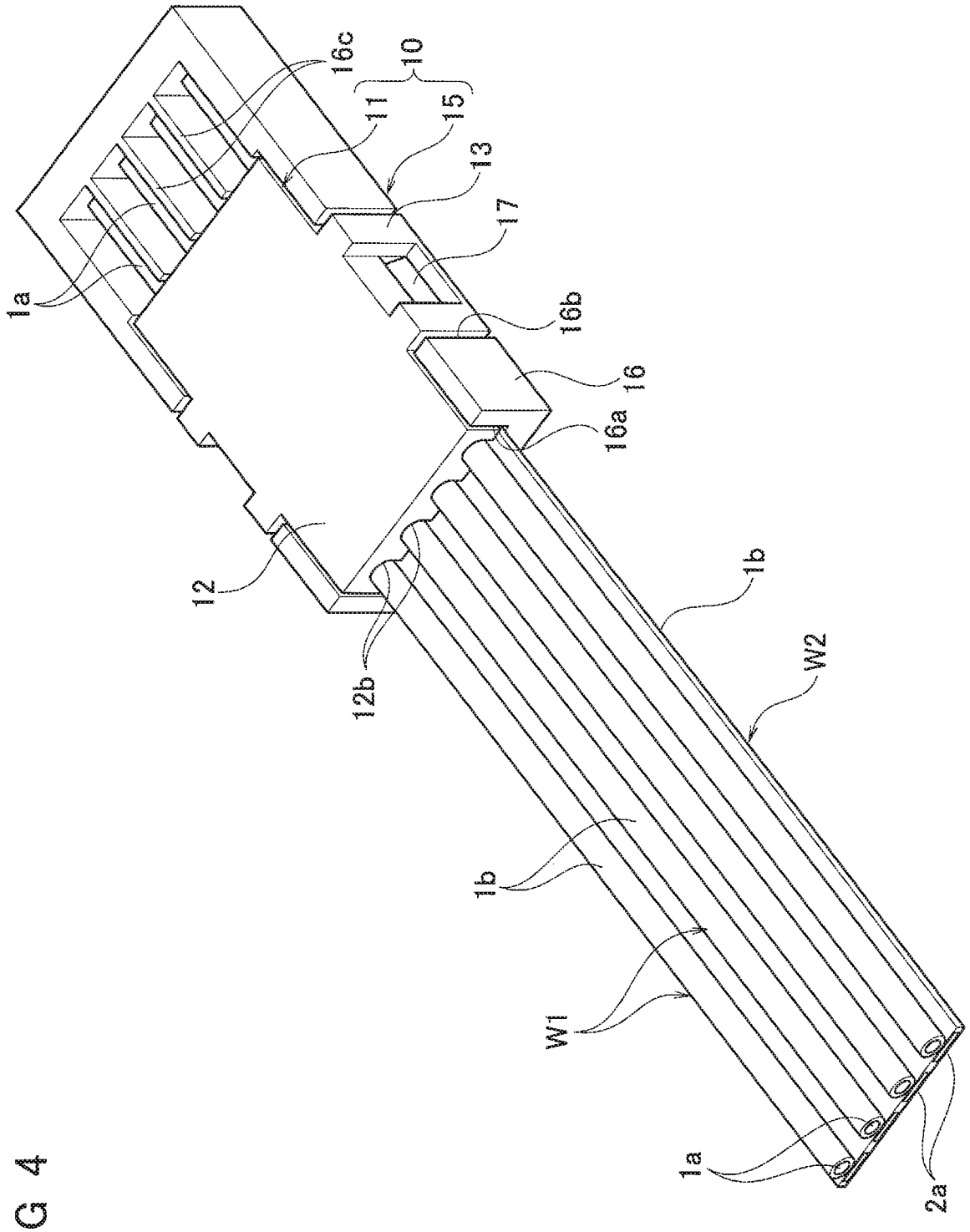
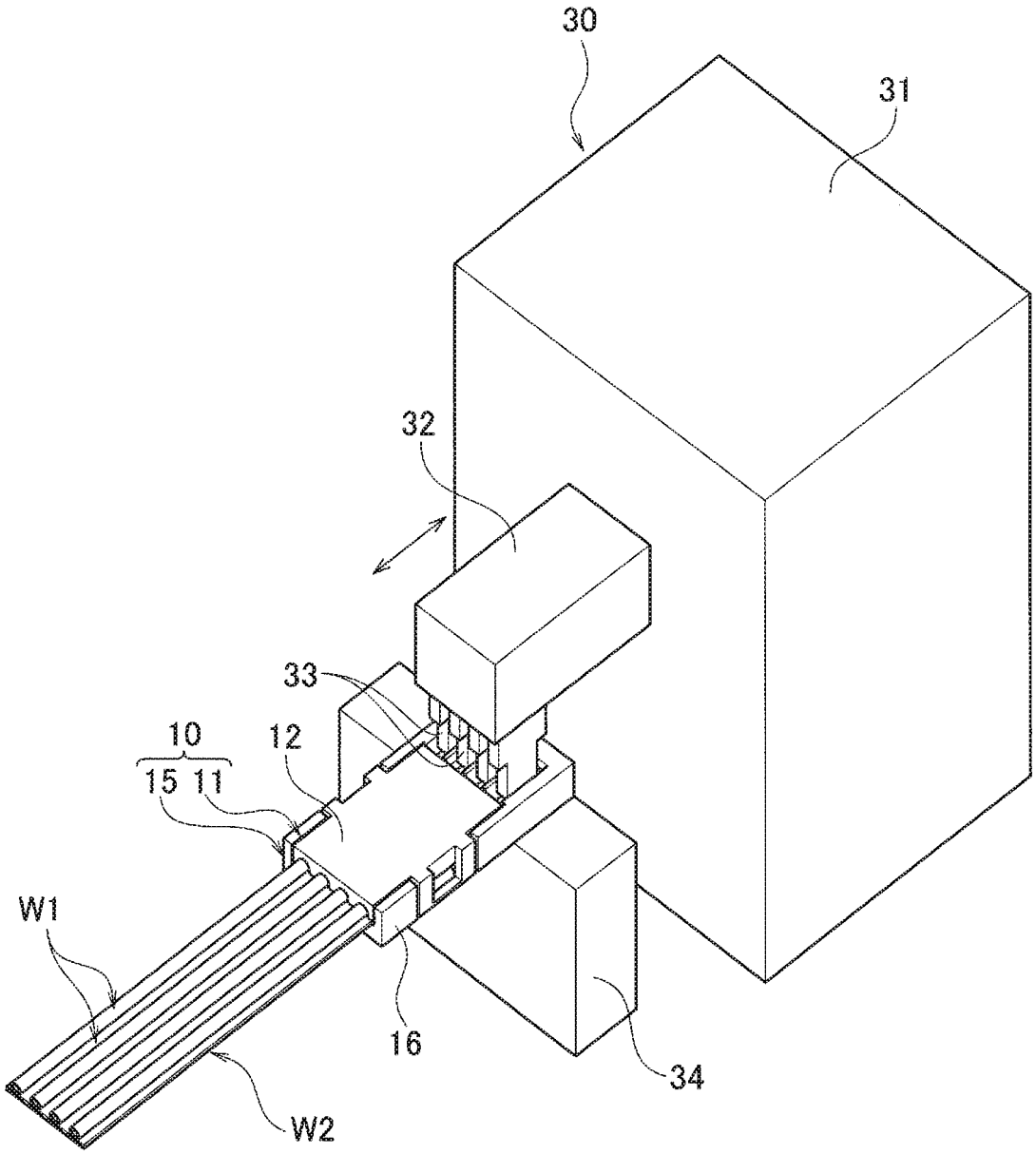


FIG 4

FIG. 5



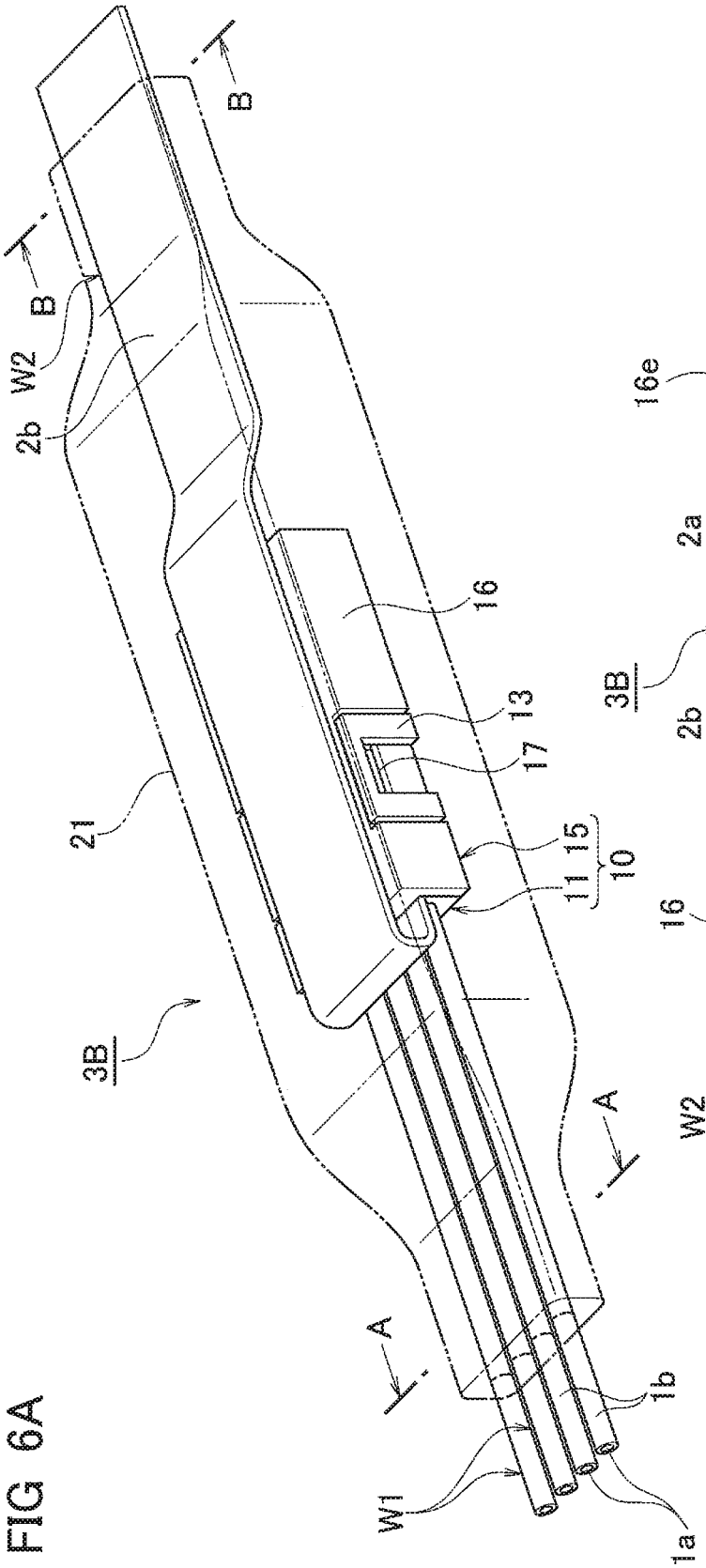

B
B
W2
2b
16
13
17
21
11 15
10
3B
A
A
1b
W1
1a

FIG 6A

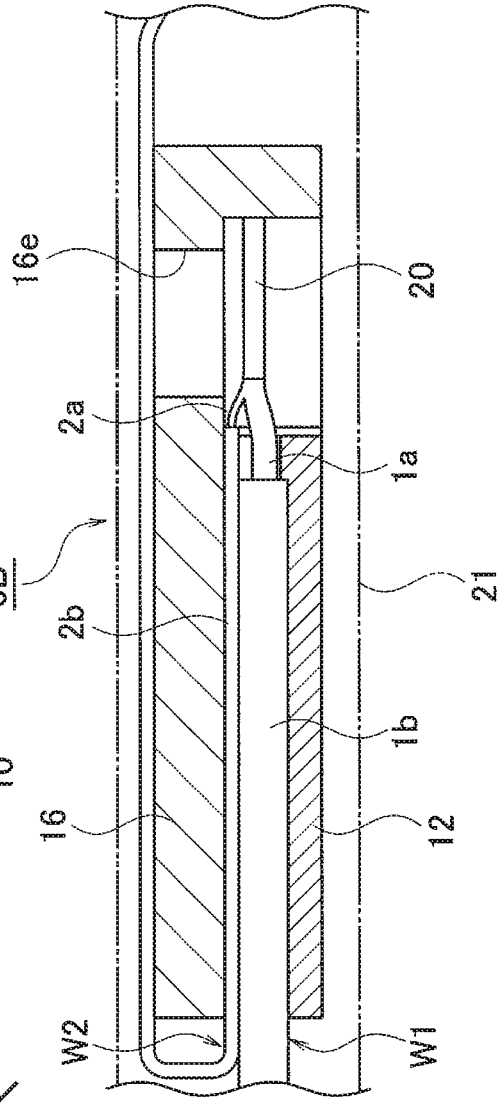

16e
20
2a
1a
3B
2b
21
1b
16
12
W2
W1

FIG 6B

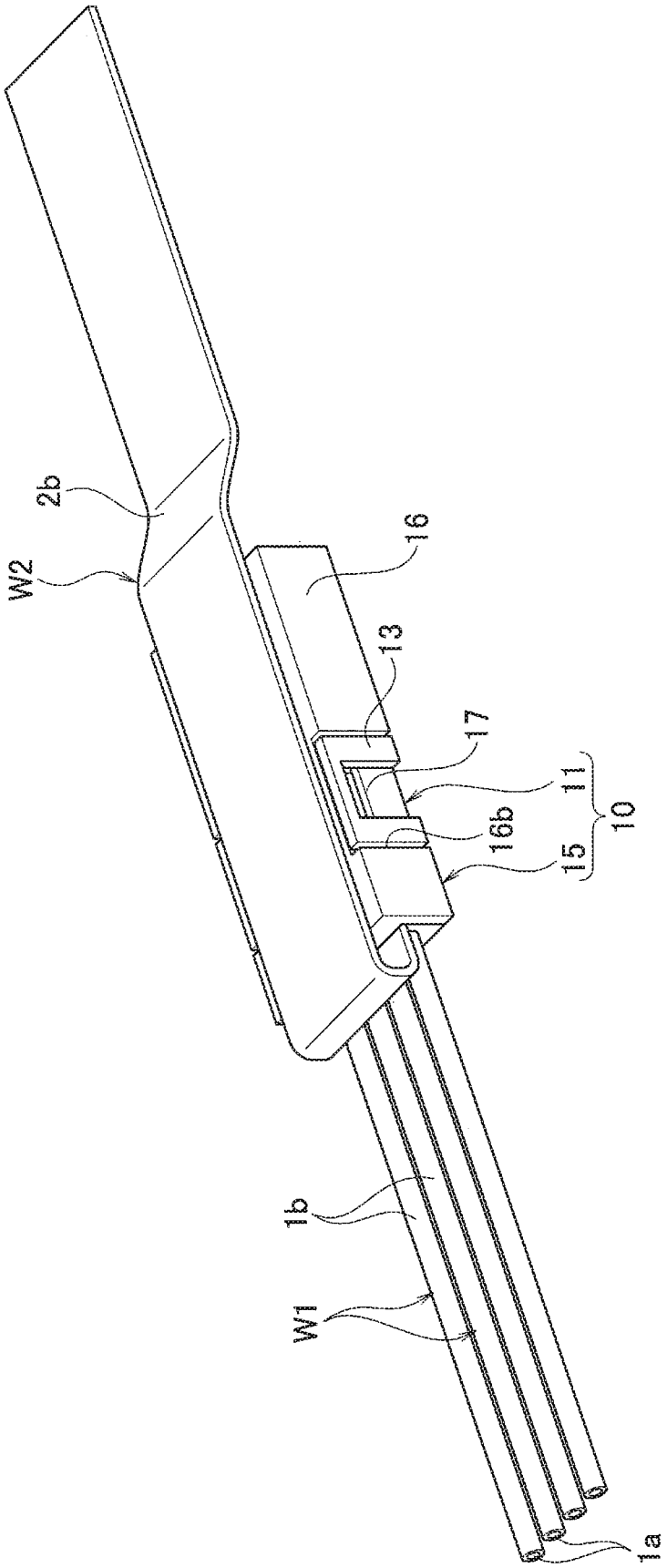


FIG. 7

FIG. 8A

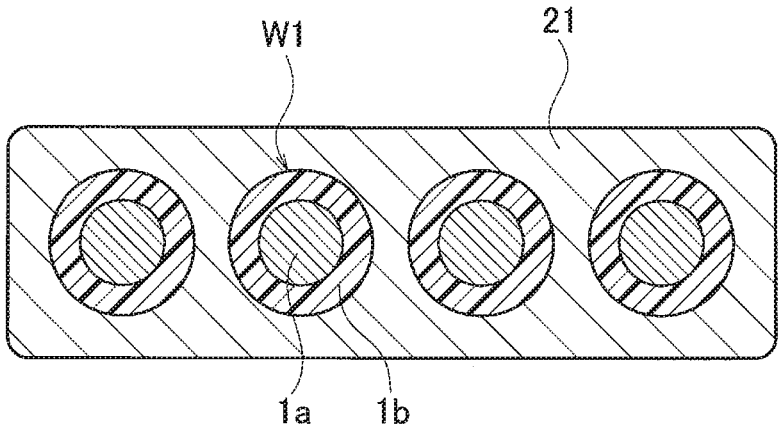


FIG. 8B

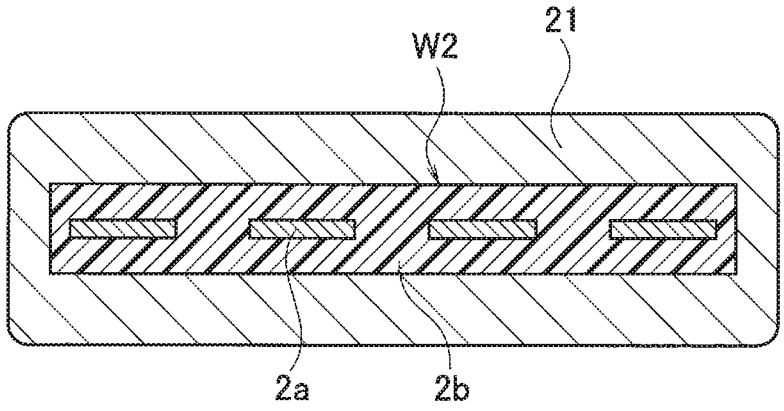


FIG. 9A

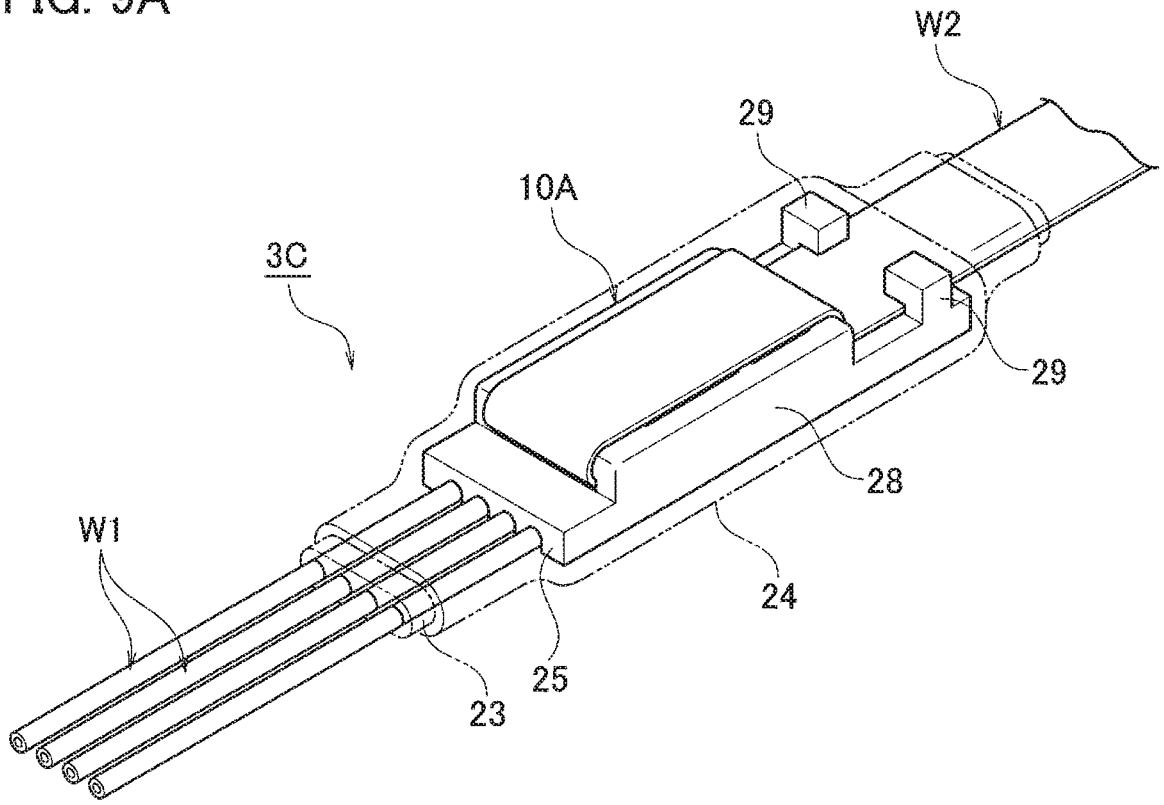

W2
29
10A
3C
29
28
W1
24
25
23

FIG. 9B

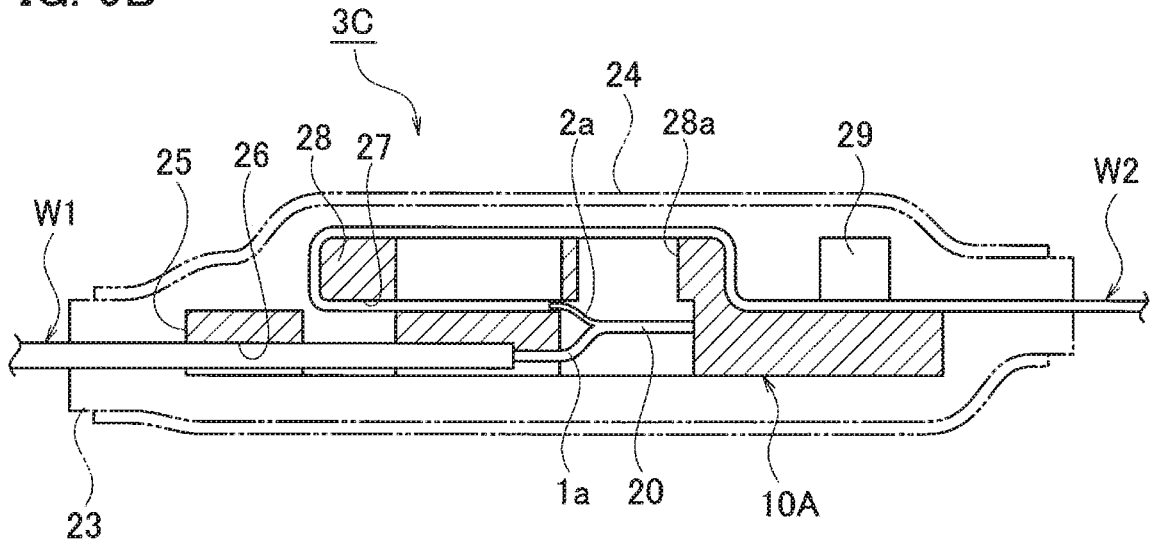

3C
24
2a
28a
29
25
26
28
27
W1
W2
23
1a
20
10A

FIG. 10A

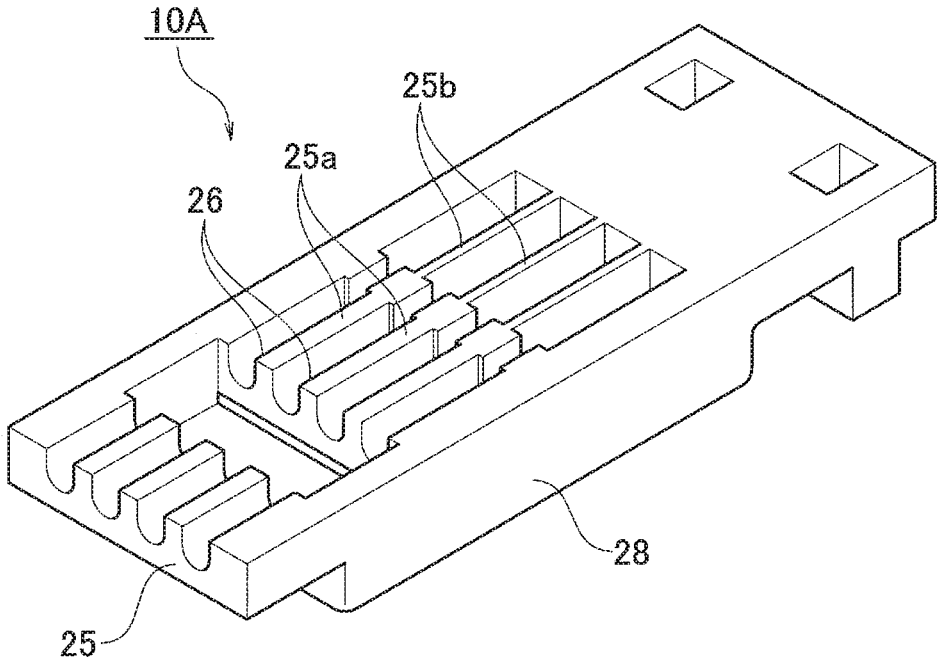
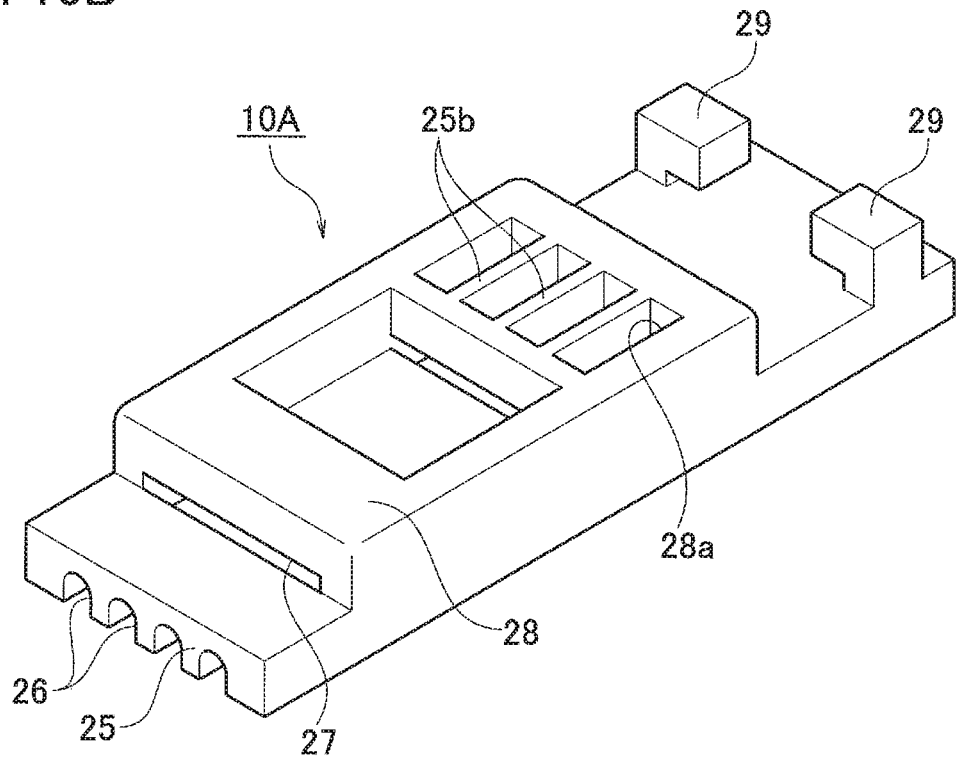


FIG. 10B



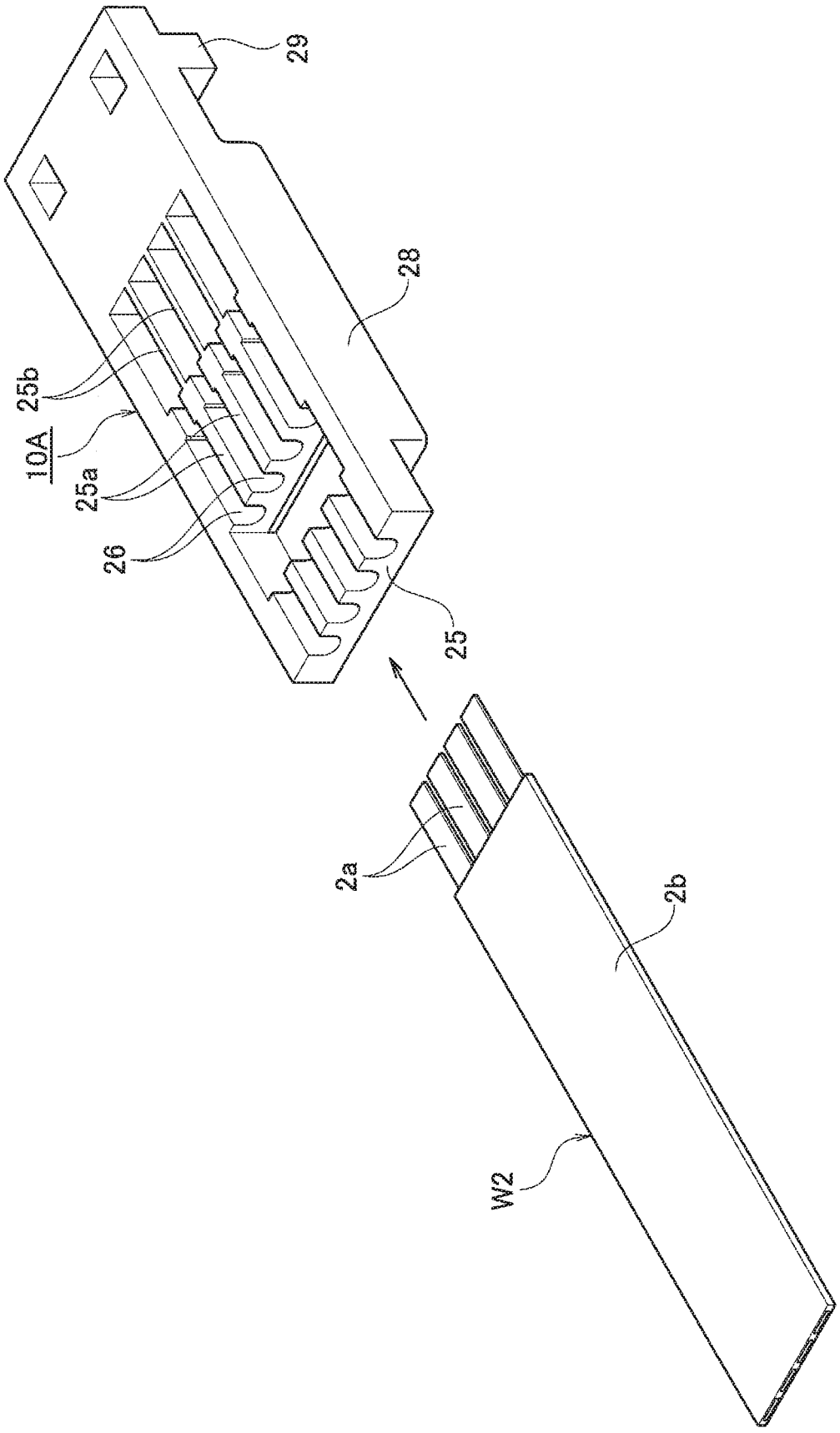


FIG. 11

FIG. 12A

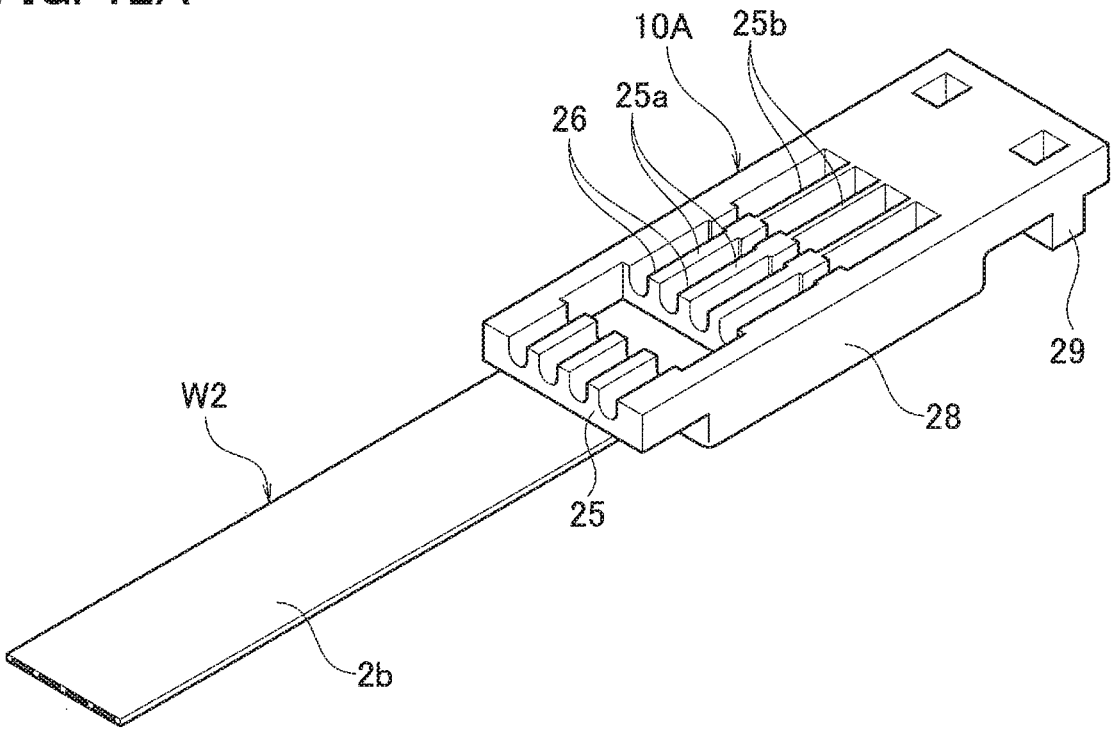


FIG 12B

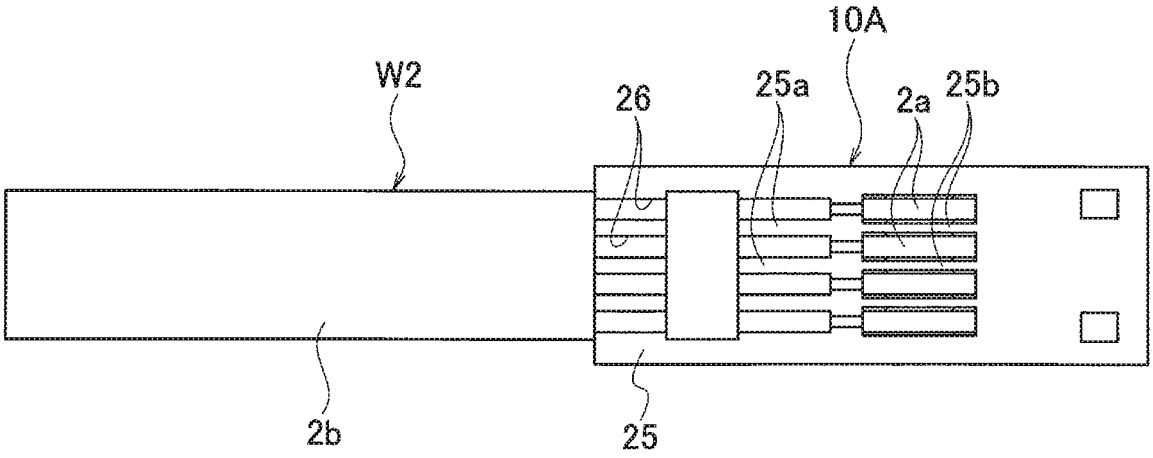


FIG. 13A

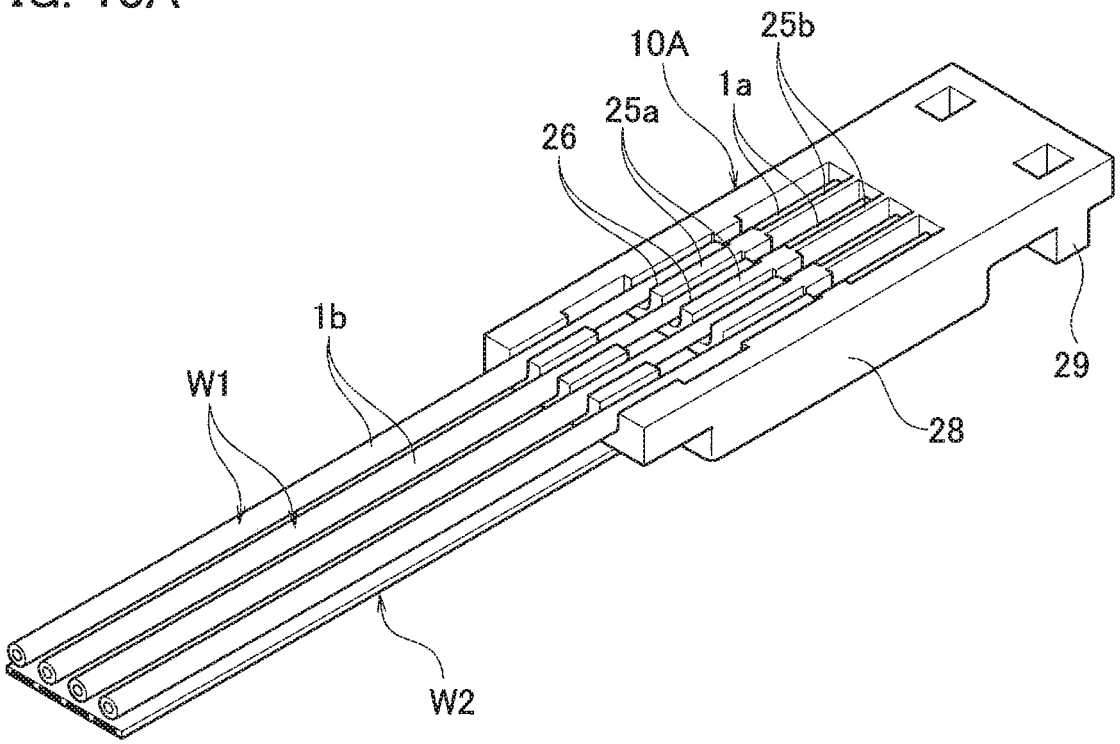
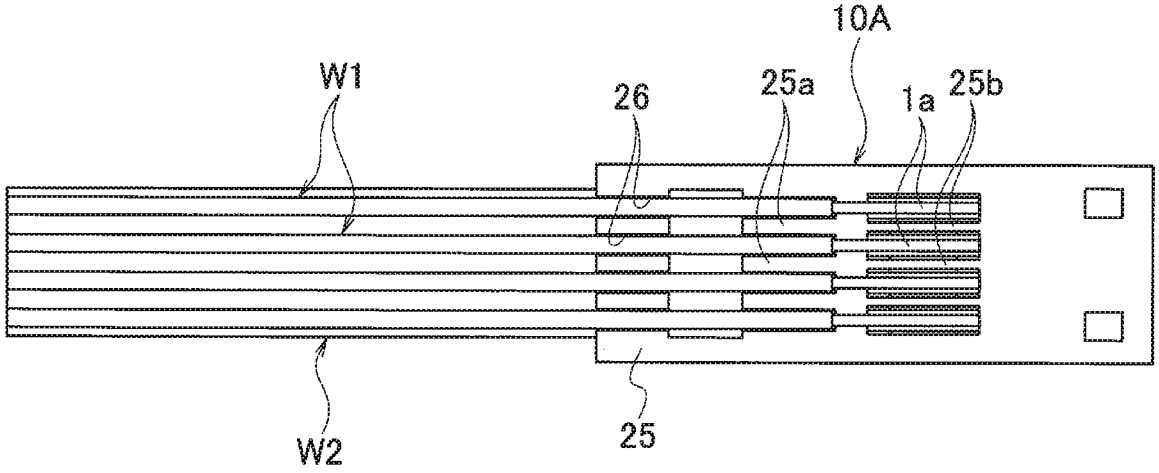


FIG. 13B



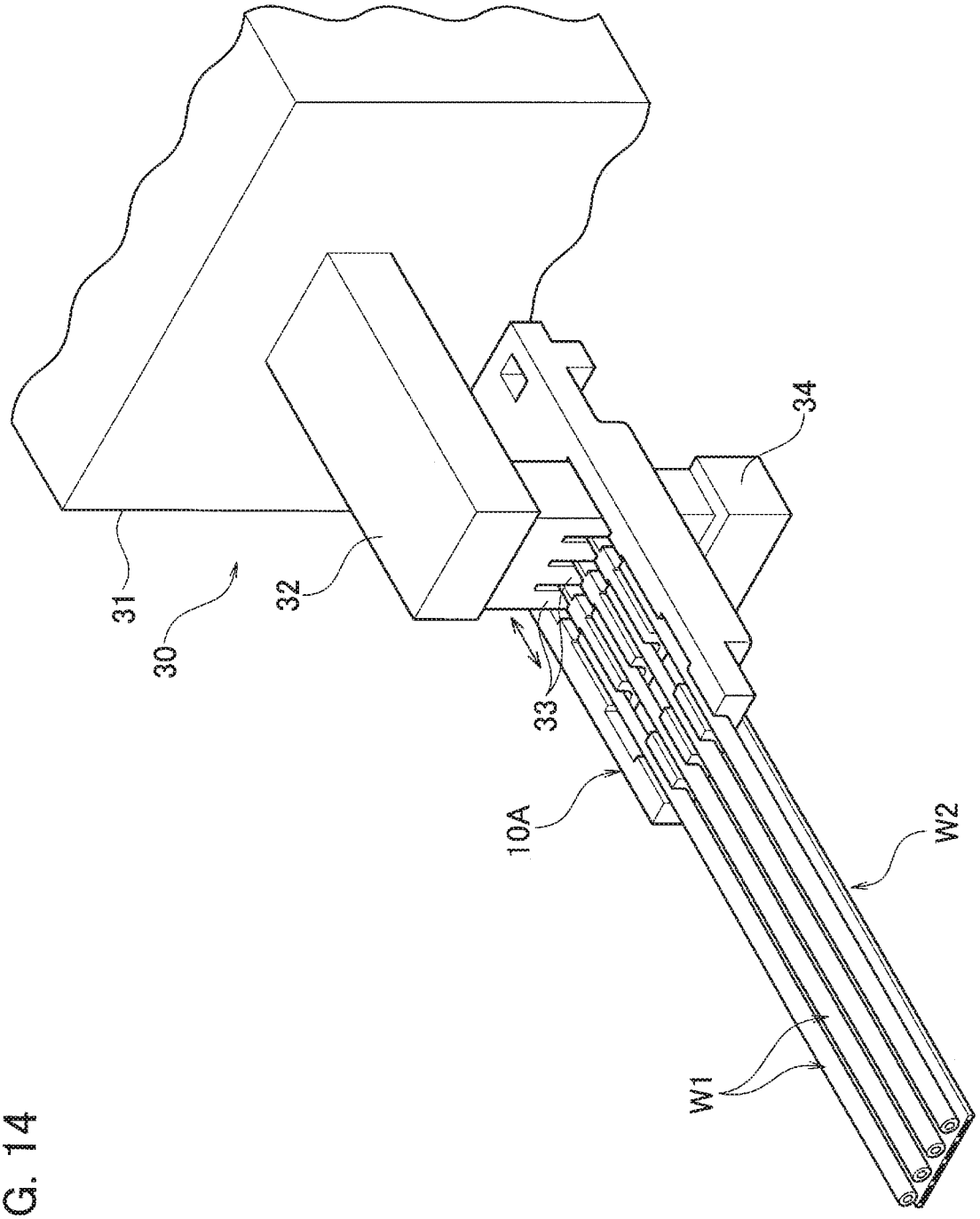


FIG. 14

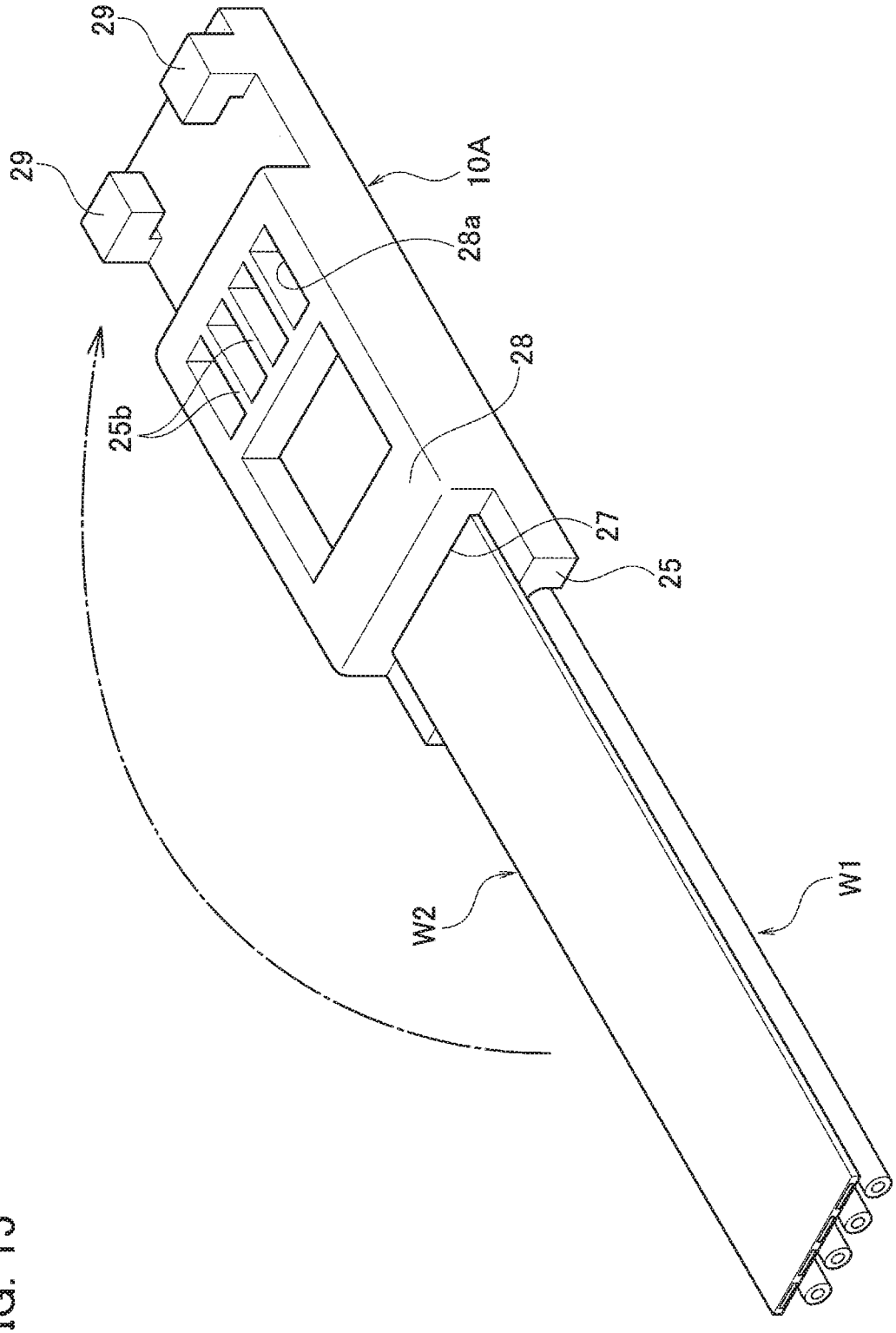


FIG. 15

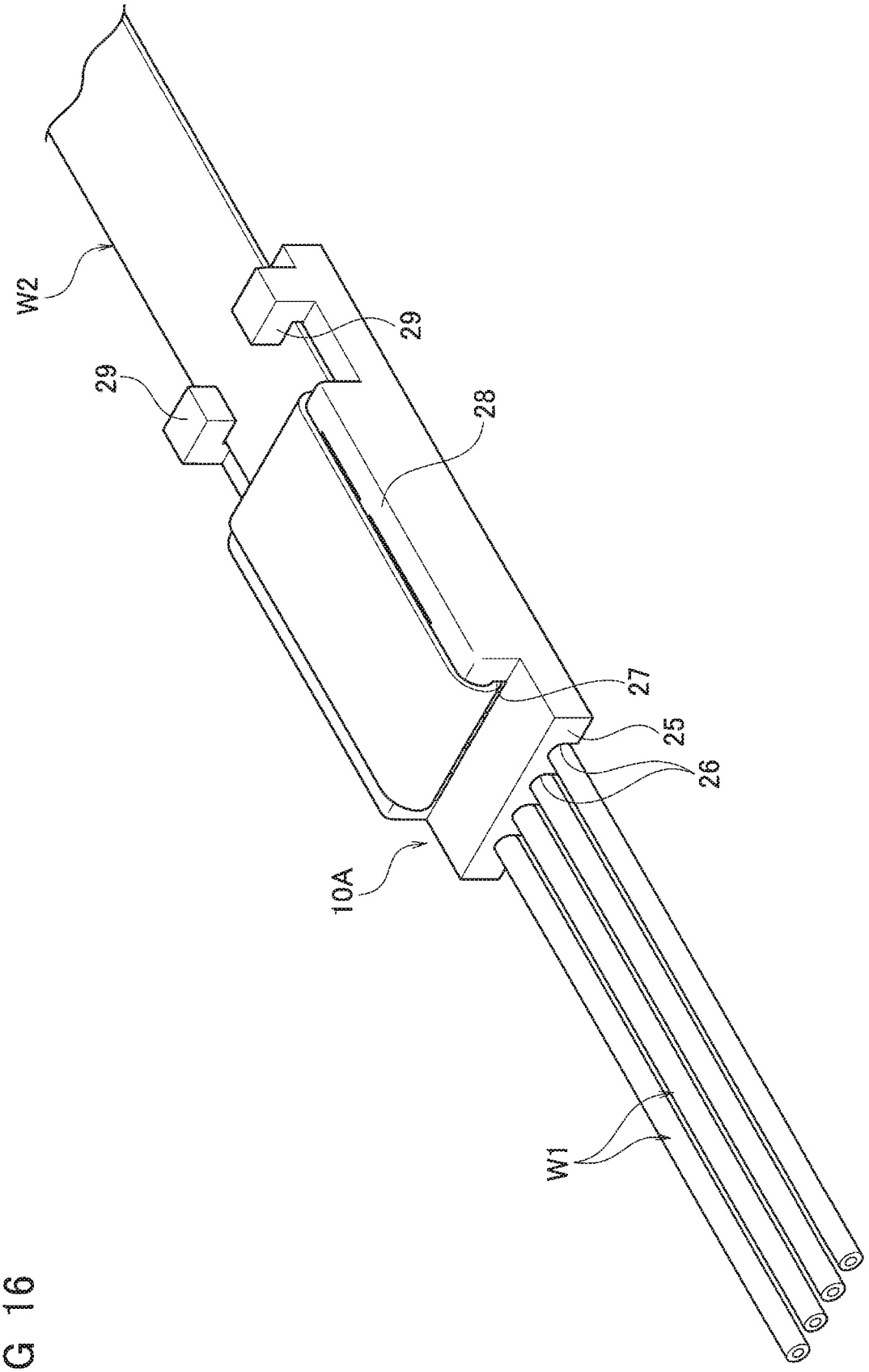


FIG 16

FIG. 17A

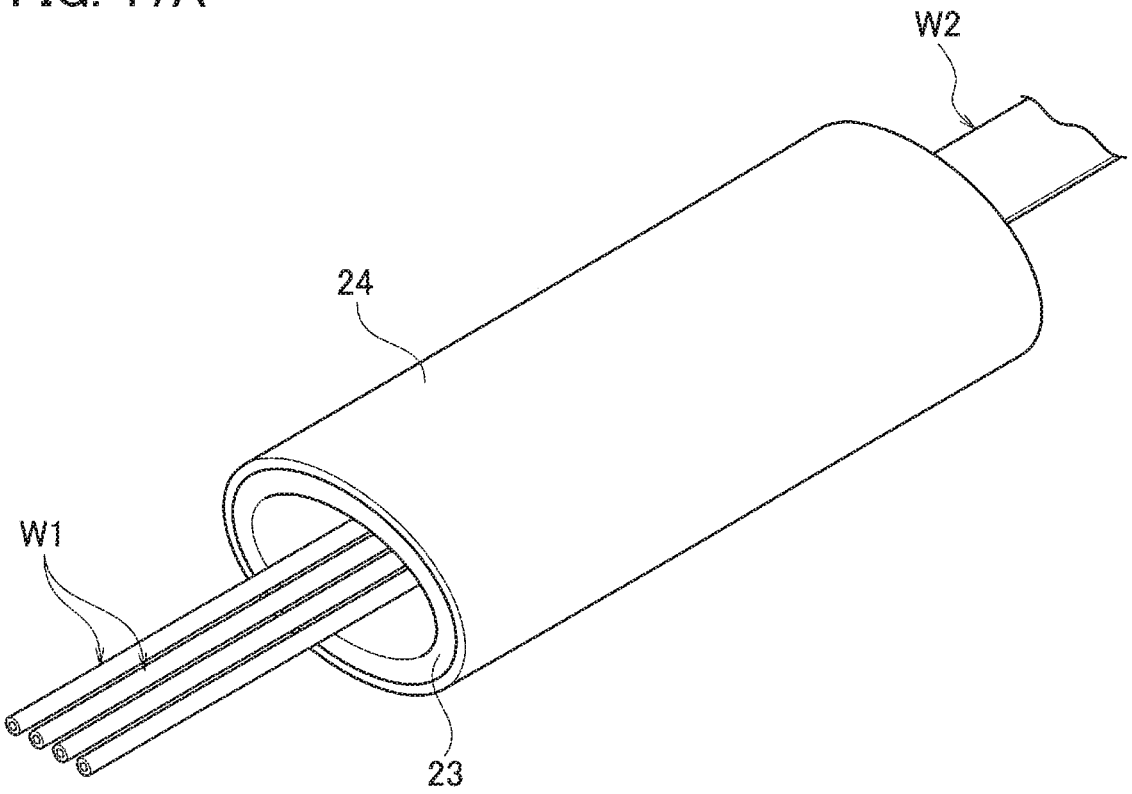
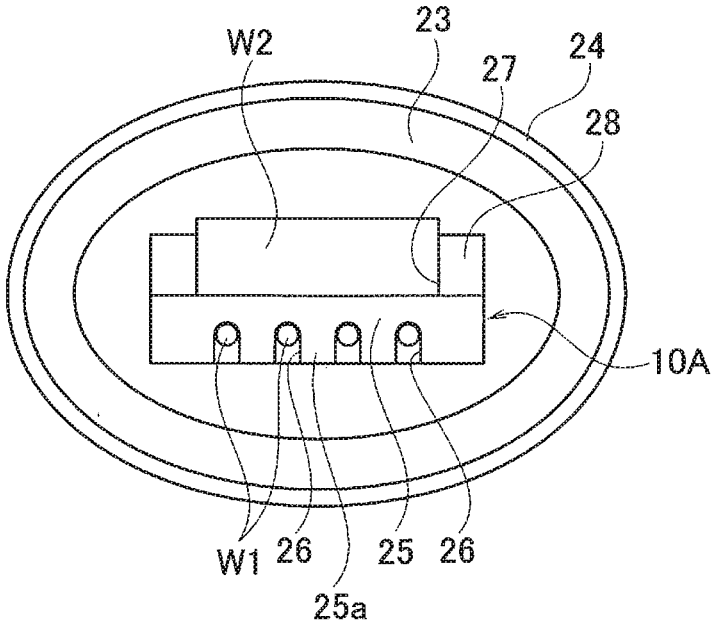


FIG. 17B



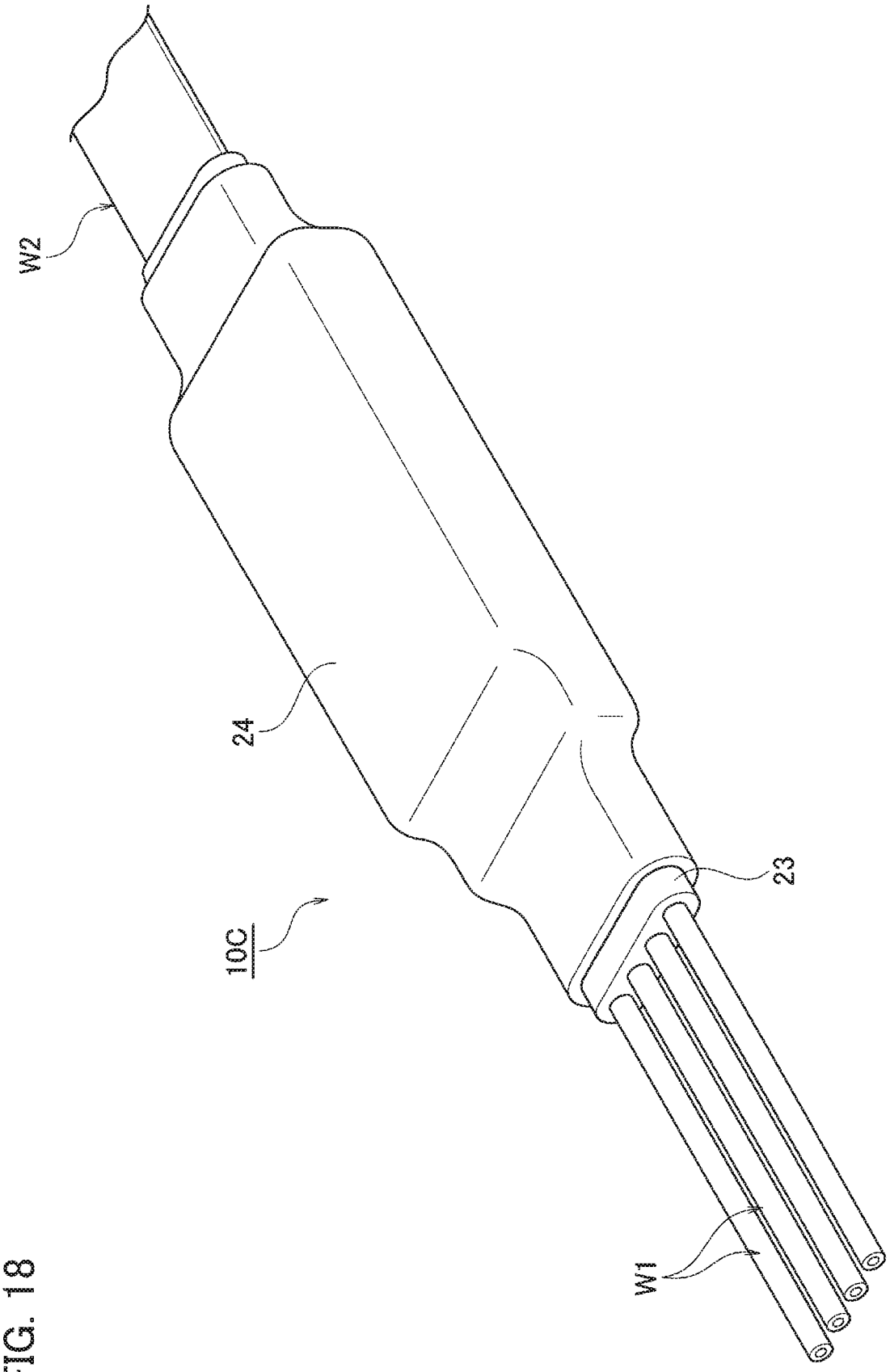


FIG. 18

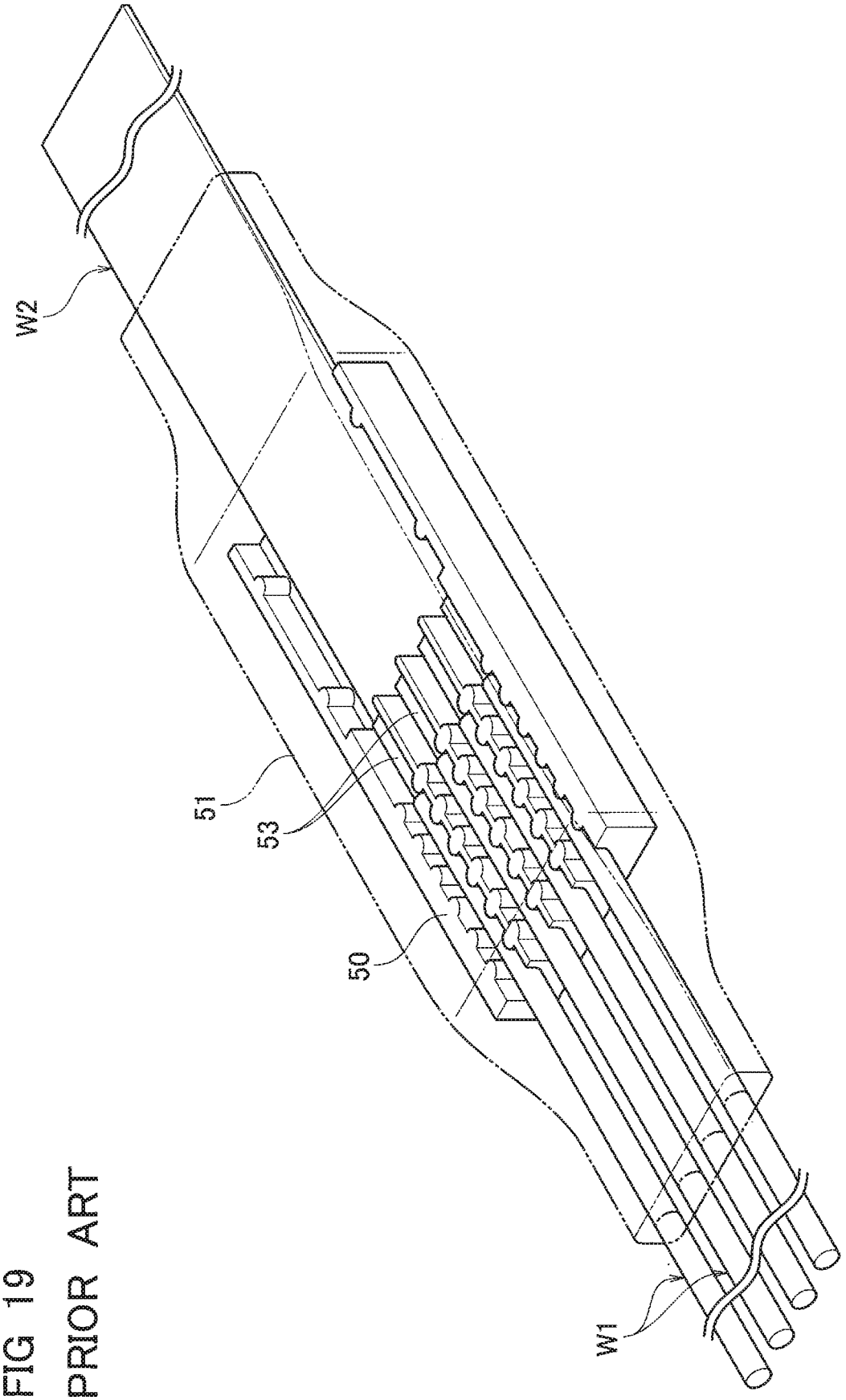
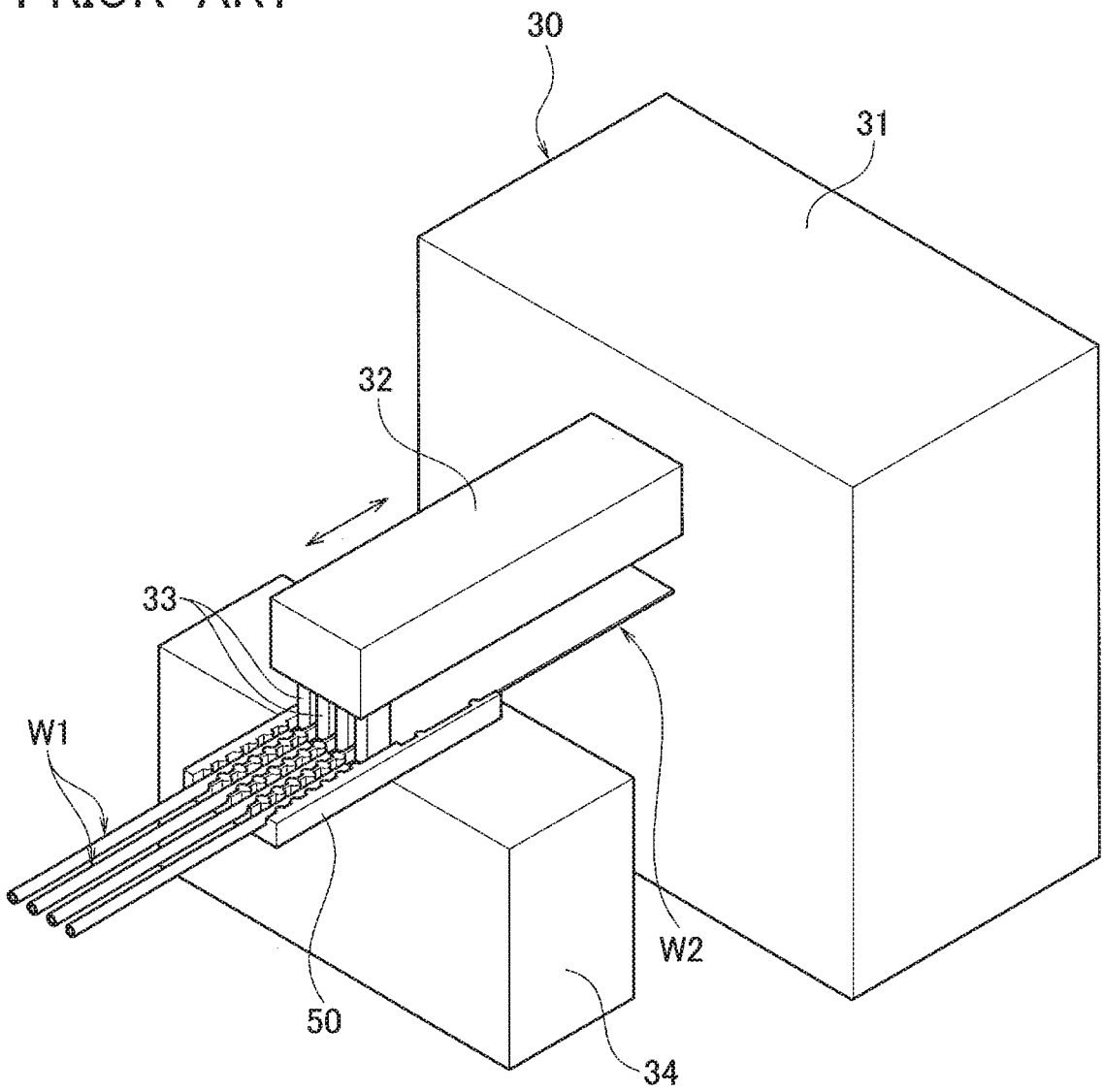


FIG 19
PRIOR ART

FIG. 20
PRIOR ART



CABLE CONNECTION STRUCTURE AND MANUFACTURING METHOD OF THE CABLE CONNECTION STRUCTURE

CROSS REFERENCE TO RELATED APPLICATION

The present application is based on, and claims priority from Japanese Patent Application No. 2018-043944, filed Mar. 12, 2018, the disclosure of which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present application relates to a cable connection structure for connecting a round cable and a flat cable and a manufacturing method of the cable connection structure.

BACKGROUND ART

A conventional cable connection structure of this kind is illustrated in FIG. **19**. In FIG. **19**, the conventional cable connection structure includes a holder **50**, a plurality of round cables W**1** held by the holder **50**, a flat cable W**2** held by the holder **50**, and a mold resin portion **51** covering the outer circumference of the holder **50**.

The plurality of round cables W**1** and the flat cable W**2** held by the holder **50** overlap each other at the end portions thereof, and are pulled out in mutually opposite directions. Core wires (not illustrated) at end portions of the round cables W**1** and conductors (not illustrated) at an end portion of the flat cable W**2** are connected to each other by connecting portions **53** formed by ultrasonic welding or the like.

The mold resin portion **51** collectively covers the holder **50** and the round cables W**1** and the flat cable W**2** pulled out from the holder **50**. Accordingly, the portion including the connecting portions **53** is waterproofed by the mold resin portion **51**.

The core wires (not illustrated) of the round cables W**1** and the conductors (not illustrated) of the flat cable W**2** are connected by, for example, ultrasonic welding using an ultrasonic welding device **30**, as illustrated in FIG. **20**. The ultrasonic welding device **30** includes an anvil **34** that places the holder **50** in a positioned state, and a horn **33** that applies, while applying pressure, ultrasonic vibration (in the direction of the arrow in FIG. **10**) to the position in which the core wires (not illustrated) of the round cables W**1** and the conductors (not illustrated) of the flat cable W**2** overlap each other. The horn **33** is provided at the distal end of an arm portion **32** whose base end portion is supported by a device main body **31**.

Incidentally, when the holder **50** holding the round cables W**1** and the flat cable W**2** is set in the ultrasonic welding device **30**, the round cables W**1** may have to be set away from the ultrasonic welding device **30**, and the flat cable W**2** may have to be set in the space between the horn **33** and the device main body **31** in some cases. For example, in a case where the round cables W**1** compose a long wire harness (not illustrated), the wire harness (not illustrated) may not be set in the space between the horn **33** and the device main body **31**.

SUMMARY

Although the flat cable W**2** is excellent in flexibility in the direction of bending the flat surface, it can hardly be bent in the direction orthogonal to the flat surface (lateral direction).

Therefore, there is a problem that it is difficult to perform ultrasonic welding in a case where the flat cable W**2** is sufficiently longer than the distance between the horn **33** and the device main body **31**. There is a similar problem with a connecting device other than the ultrasonic welding device **30**.

The present application has been conceived to solve the problem described above, and an object of the present application is to provide a cable connection structure, as well as a manufacturing method of the cable connection structure, capable of being manufactured using a connecting device such as an ultrasonic welding device regardless of a length of a flat cable.

A cable connection structure according to a first aspect of the present application includes: a round cable having a round cross section and including a core wire and a round insulating sheath covering the outer circumference of the core wire; a flat cable having a cross section in a flat rectangular shape and including a tabular conductor and a flat insulating sheath covering the conductor; a holder holding the end portion of the round cable and the end portion of the flat cable and pulling out the round cable and the flat cable in the same direction in an overlapped state; a connecting portion in which the core wire exposed from an end portion of the round cable and the conductor exposed from an end portion of the flat cable held by the holder are connected to each other; and a waterproof exterior portion collectively covering the outer circumference of the holder and the outer circumference of the round cable and the flat cable pulled out from the holder.

A manufacturing method of a cable connection structure according to a second aspect of the present application includes: a cable setting step of holding, in a state in which a round cable and a flat cable are pulled out in a same direction in an overlapped state, the end portion of the round cable and the end portion of the flat cable in a holder; a connecting step of connecting a core wire exposed from the end portion of the round cable held by the holder and a conductor exposed from the end portion of the flat cable held by the holder; and an exterior forming step of forming a waterproof exterior portion covering, with an insulating resin, the holder, the round cable pulled out from the holder, and the flat cable pulled out from the holder.

According to the aspects of the present application, in the connecting step of connecting the core wire exposed from the end portion of the round cable and the conductor exposed from the end portion of the flat cable, the round cable and the flat cable are pulled out from the holder in the same direction, whereby it can be manufactured using a connecting device such as an ultrasonic welding device regardless of a length of the flat cable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a perspective view of a cable connection structure according to a first embodiment (a mold resin portion is illustrated by a virtual line), and FIG. **1**B is a cross-sectional view of a main part of the cable connection structure according to the first embodiment.

FIG. **2** is a perspective view of round cables set in a round cable holder in the cable connection structure according to the first embodiment.

FIG. **3**A is a perspective view of a flat cable set in a flat cable holder in the cable connection structure according to the first embodiment, and FIG. **3**B is a perspective view as seen from the opposite side of FIG. **3**A.

FIG. **4** is a perspective view of the round cable holder and the flat cable holder in a combined state in the cable connection structure according to the first embodiment.

FIG. **5** is a perspective view illustrating a state of ultrasonic welding in the cable connection structure according to the first embodiment.

FIG. **6**A is a perspective view of a cable connection structure according to a second embodiment (a mold resin portion is illustrated by a virtual line), and FIG. **6**B is a cross-sectional view of a main part of the cable connection structure according to the second embodiment.

FIG. **7** is a perspective view illustrating a state in which a flat cable is folded back in the cable connection structure according to the second embodiment.

FIG. **8**A is a cross-sectional view taken along line A-A in FIG. **6**A, and FIG. **8**B is a cross-sectional view taken along line B-B in FIG. **6**A.

FIG. **9**A is a perspective view of a cable connection structure according to a third embodiment (an exterior formation portion is illustrated by a virtual line), and

FIG. **9**B is a cross-sectional view of a main part of the cable connection structure according to the third embodiment.

FIG. **10**A is a perspective view of a holder of the cable connection structure according to the third embodiment, and FIG. **10**B is a perspective view of the holder as seen from the opposite side of FIG. **10**A.

FIG. **11** is a perspective view of a flat cable before being set in the holder in the cable connection structure according to the third embodiment.

FIG. **12**A is a perspective view of the flat cable set in the holder in the cable connection structure according to the third embodiment, and FIG. **12**B is a plan view of the state in FIG. **12**A.

FIG. **13**A is a perspective view of the flat cable and round cables set in the holder in the cable connection structure according to the third embodiment, and FIG. **13**B is a plan view of the state in FIG. **13**A.

FIG. **14** is a perspective view illustrating a state of ultrasonic welding in the cable connection structure according to the third embodiment.

FIG. **15** is a perspective view illustrating a state after the ultrasonic welding in the cable connection structure according to the third embodiment.

FIG. **16** is a perspective view illustrating a state in which the flat cable is folded back in the cable connection structure according to the third embodiment.

FIG. **17**A is a perspective view illustrating a state in which the holder is arranged in a heat shrinkable tube in the cable connection structure according to the third embodiment, and FIG. **17**B is a front view illustrating the state in which the holder is arranged in the heat shrinkable tube in the cable connection structure according to the third embodiment.

FIG. **18** is a perspective view illustrating a state in which a hot melt adhesive is cured due to thermal action and the heat shrinkable tube is shrunk in the cable connection structure according to the third embodiment.

FIG. **19** is a perspective view of a conventional cable connection structure.

FIG. **20** is a perspective view illustrating a state of ultrasonic welding in the conventional cable connection structure.

DETAILED DESCRIPTION

Hereinafter, embodiments will be described with reference to the drawings.

First Embodiment

FIGS. **1**A to **5** illustrate a first embodiment. A cable connection structure **3**A according to the first embodiment includes a plurality of round cables W**1**, a flat cable W**2**, a holder **10** for holding end portions of the plurality of round cables W**1** and the end portion of the flat cable W**2**, connecting portions **20** in each of which a core wire **1***a* of each of the round cables W**1** and a corresponding conductor **2***a* of the flat cable W**2** are connected, and a mold resin portion **21** that is a waterproof exterior portion covering an outer circumference of the holder **10**.

Each of the round cables W**1** has a round cross section, and includes the core wire **1***a* and an insulating sheath **1***b* covering the outer circumference of the core wire **1***a*. The core wire **1***a* is exposed from the insulating sheath **1***b* at an end portion of each of the round cables W**1**.

The flat cable W**2** has a cross section in a flat rectangular shape, and includes a plurality of tabular conductors **2***a* arranged in parallel at intervals, and an insulating sheath **2***b* collectively covering the plurality of tabular conductors **2***a*. Each of the conductors **2***a* is exposed from the insulating sheath **2***b* at an end portion of the flat cable W**2**.

The holder **10** includes a round cable holder **11** for holding the end portions of the round cables W**1**, and a flat cable holder **15** for holding the end portion of the flat cable W**2**.

The round cable holder **11** is formed of an insulating material. As illustrated in FIG. **2**, the round cable holder **11** includes a round cable holder main body **12** in which a plurality of round cable arrangement grooves **12***b* partitioned by dividing walls **12***a* is formed in parallel with each other, and a pair of lock frames **13** protruding from the side end portions of the round cable holder main body **12**. Each of upper surfaces of the dividing walls **12***a* of the round cable holder main body **12** is an abutting surface. Each of the round cables W**1** is arranged in the round cable arrangement groove **12***b* in such a manner that the core wire **1***a* exposed at the end portion protrudes from the round cable holder **11**.

The flat cable holder **15** is formed of an insulating material. As illustrated in FIGS. **3**A and **3**B, the flat cable holder **15** includes a flat cable holder main body **16** in which a flat cable arrangement chamber **16***a* is formed, and a pair of lock claws **17** provided on surfaces exposed by cutout portions **16***b* of the flat cable holder main body **16**. The distal end side of the flat cable arrangement chamber **16***a* of the flat cable holder main body **16** in the crosswise direction is partitioned by a plurality of partition walls **16***c*. An upper surface of a side wall **16***d* of the flat cable holder main body **16** is a flush surface. The portion of the flat cable arrangement chamber **16***a* partitioned by the partition wall **16***c* is opened to the outside in the state of the holder **10** in which the round cable holder **11** and the flat cable holder **15** are joined together. At the time of ultrasonic welding, a horn **33** of an ultrasonic welding device **30** is inserted from the portion opened to the outside of the holder **10**. On the back side of the flat cable holder main body **16**, a plurality of through holes **16***e* opened to the position of the flat cable arrangement chamber **16***a* partitioned by the partition wall **16***c* is formed. At the time of ultrasonic welding, an anvil **34** of the ultrasonic welding device **30** is inserted from the through hole **16***e*. The flat cable W**2** is arranged in the flat cable arrangement chamber **16***a* in such a manner that respective conductors **2***a* exposed at the end portion of the flat cable W**2** are positioned at respective portions partitioned by the partition walls **16***c*.

As illustrated in FIG. **4**, the round cable holder **11** and the flat cable holder **15** are joined together by abutting the upper surfaces of the dividing walls **12***a* of the round cable holder main body **12** and a surface of the flat cable W**2** arranged in the flat cable arrangement chamber **16***a*. Accordingly, the round cable holder **11** and the flat cable holder **15** are joined together in such a manner that the round cables W**1** from the round cable holder **11** and the flat cable W**2** from the flat cable holder **15** overlap with each other and are pulled out in the same direction. Further, the end portions of the round cables W**1** and the end portion of the flat cable W**2** are arranged to overlap each other, and are exposed to the outside.

The mold resin portion **21** is formed of an insulating resin. The mold resin portion **21** collectively covers, with no gap left, the outer exposed surface of the round cable holder **11**, the outer exposed surface of the flat cable holder **15**, the outer circumference of each of the round cables W**1** pulled out from the round cable holder **11**, and the outer circumference of the flat cable W**2** pulled out from the flat cable holder **15**.

In the cable connection structure **3**A according to the first embodiment, the mold resin is firmly attached onto, with no gap left, the outer circumference surface of each of the round cables W**1** and the outer circumference surface of the flat cable W**2** at the positions of the round cables W**1** pulled out from the mold resin portion **21** to the outside and the position of the flat cable W**2** also pulled out from the mold resin portion **21** to the outside, thereby securing waterproof property of the connecting portion **20**.

The holder **10** includes the round cable holder **11** and the flat cable holder **15**, and the round cables W**1** are held by the round cable holder **11** while the flat cable W**2** is held by the flat cable holder **15**, thereby achieving good workability of holding cables with the holder **10**.

Next, a manufacturing method of the cable connection structure **3**A according to the first embodiment will be described. The manufacturing method of the cable connection structure **3**A is performed in the order of a cable setting step, a connecting step, and an insert resin molding step that is an exterior forming step. The cable setting step includes a cable holding step and a holder combining step. Hereinafter, the manufacturing method of the cable connection structure **3**A will be described in order.

In the cable holding step, the round cables W**1** are held in the round cable holder **11**, and the flat cable W**2** is held in the flat cable holder **15**. Specifically, as illustrated in FIG. **2**, a plurality of round cables W**1** is arranged in the round cable arrangement grooves **12***b* of the round cable holder **11** in such a manner that the core wire **1***a* exposed from the end portion of each of the round cables W**1** protrudes outside the round cable holder **11** (round cable holding step). Further, as illustrated in FIGS. **3**A and **3**B, the flat cable W**2** is arranged in the flat cable arrangement chamber **16***a* in such a manner that the conductors **2***a* exposed from the end portion of the flat cable W**2** are positioned at the flat cable arrangement chamber **16***a* partitioned by the partition walls **16***c* (flat cable holding step). The round cable holding step with respect to the round cable holder **11** and the flat cable holding step with respect to the flat cable holder **15** may be performed in no particular order, and may be performed simultaneously.

In the holder combining step, the round cable holder **11** and the flat cable holder **15** are joined together. Specifically, as illustrated in FIG. **4**, the upper surfaces of the dividing walls **12***a* of the round cable holder main body **12** and the surface of the flat cable W**2** arranged in the flat cable arrangement chamber **16***a* are abutted each other, and the lock claws **17** are locked to the lock frames **13**. In the state where the round cable holder **11** and the flat cable holder **15** are joined together, the core wires **1***a* exposed from the end portions of the plurality of round cables W**1** and the conductors **2***a* exposed from the end portion of the flat cable W**2** are arranged to overlap each other, and are exposed to the outside. The round cables W**1** and the flat cable W**2** from the combined round cable holder **11** and the flat cable holder **15** are pulled out to overlap each other in the same direction.

In the connecting step, the round cables W**1** and the flat cable W**2** are electrically connected by ultrasonic welding using the ultrasonic welding device **30**. As illustrated in FIG. **5**, the ultrasonic welding device **30** includes the anvil **34**, and the horn **33** arranged at the position facing the anvil **34**. The horn **33** is provided at the distal end of an arm portion **32** whose base end portion is supported by a device main body **31**.

Specifically, in the connecting step, the round cables W**1** and the flat cable W**2** pulled out from the combined round cable holder **11** and the flat cable holder **15** are not arranged in the space between the horn **33** and the device main body **31**, but are arranged in the open space on the opposite side, in such a manner that the combined round cable holder **11** and the flat cable holder **15** are positioned on the anvil **34**. Then, by the branched horn **33**, ultrasonic vibration is applied (in the direction of the arrow in FIG. **5**) to, while pressure is applied, the position in which the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** overlap each other. As a result, the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** are connected by the ultrasonic welding, respectively.

In the insert resin molding step, insert resin molding is performed with the round cable holder **11**, the flat cable holder **15**, the round cables W**1** pulled out from the round cable holder **11**, and the flat cable W**2** pulled out from the flat cable holder **15** serving as inserts, and the mold resin portion **21** is molded. In this manner, the cable connection structure **3**A as illustrated in FIGS. **1**A and **1**B is produced.

As described above, the cable connection structure **3**A according to the first embodiment includes the round cables W**1** each having a round cross section and including the core wire **1***a* and the round insulating sheath **1***b* covering the outer circumference of the core wire **1***a*, the flat cable W**2** having a cross section in a flat rectangular shape and including the tabular conductors **2***a* and the flat insulating sheath **2***b* covering the conductors **2***a*, the holder **10** holding the end portions of the round cables W**1** and the end portion of the flat cable W**2** and pulling out the round cables W**1** and the flat cable W**2** in the same direction in an overlapped state, the connecting portions **20** in which the core wires **1***a* exposed from the end portions of the round cables W**1** and the conductors **2***a* exposed from the end portion of the flat cable W**2** held by the holder **10** are connected, and the mold resin portion **21** as a waterproof exterior portion that collectively covers the outer circumference of the holder **10** and the outer circumference of the round cables W**1** and the flat cable W**2** pulled out from the holder **10**. In the step of connecting the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2**, the round cables W**1** and the flat cable W**2** are pulled out from the holder **10** in the same direction, whereby it can be manufactured using a connecting device such as the ultrasonic welding device **30** regardless of a length of the flat cable W**2**.

Second Embodiment

FIGS. **6**A to **8**B illustrate a second embodiment. A cable connection structure **3**B according to the second embodi-

ment is different from the cable connection structure **3**A according to the first embodiment in the following points. That is, as illustrated in FIGS. **6**A and **6**B, in the cable connection structure **3**B according to the second embodiment, a flat cable W**2** is bent to be guided in the direction different from the pulled-out direction from a flat cable holder **15**, specifically, in the diametrically opposite pulled-out direction. Round cables W**1** and the flat cable W**2** are pulled out from a mold resin portion **21** in different directions, specifically, in the directions diametrically opposed to each other.

Other configurations in the second embodiment are the same as those in the first embodiment, and the same constituent elements are denoted by the same reference signs to omit redundant descriptions.

As illustrated in FIGS. **8**A and **8**B, in the cable connection structure **3**B according to the second embodiment, mold resin is firmly attached onto, with no gap left, the outer circumference surface of each of the round cables W**1** and the outer circumference surface of the flat cable W**2** at the position of the round cables W**1** pulled out from the mold resin portion **21** to the outside and the position of the flat cable W**2** also pulled out from the mold resin portion **21** to the outside, thereby securing waterproof property of the connecting portions **20**.

Next, a manufacturing method of the cable connection structure **3**B according to the second embodiment will be described. In the manufacturing method of the cable connection structure **3**B according to the second embodiment, a cable setting step (cable holding step and holder combining step) and a connecting step are performed in a similar manner to those in the first embodiment, and thus descriptions thereof will be omitted. The manufacturing method of the cable connection structure **3**B according to the second embodiment is different from the first embodiment only in an insert resin molding step. That is, as illustrated in FIG. **7**, in the insert resin molding step, insert resin molding is performed in such a manner that the flat cable W**2** is bent to be guided in the direction different from the pulled-out direction from the flat cable holder **15**, specifically, set in the diametrically opposite pulled-out direction, and the mold resin portion **21** is molded. In this manner, the cable connection structure **3**B according to the second embodiment as illustrated in FIGS. **6**A and **6**B is produced.

Third Embodiment

FIGS. **9**A to **18** illustrate a third embodiment. A cable connection structure **3**C according to the third embodiment includes a plurality of round cables W**1**, a flat cable W**2**, a holder **10**A for holding end portions of the plurality of round cables W**1** and the end portion of the flat cable W**2**, connecting portions **20** in which core wires **1***a* of the round cables W**1** and conductors **2***a* of the flat cable W**2** are connected respectively, and a heat shrinkable tube **24** to which a hot melt adhesive (thermoplastic adhesive) **23** is attached and which is a waterproof exterior portion covering the outer circumference of the holder **10**A.

Each of the round cables W**1** has a round cross section, and includes the core wire **1***a* and an insulating sheath **1***b* covering the outer circumference of the core wire **1***a*. The core wire **1***a* is exposed from the insulating sheath **1***b* at the end portion of each of the round cables W**1**.

The flat cable W**2** has a cross section in a flat rectangular shape, and includes a plurality of tabular conductors **2***a* arranged in parallel at intervals, and an insulating sheath **2***b* collectively covering the plurality of tabular conductors **2***a*. Each of the conductors **2***a* is exposed from the insulating sheath **2***b* at the end portion of the flat cable W**2**.

The holder **10**A is formed of an insulating material. As illustrated in FIGS. **10**A and **10**B, the holder **10**A includes a plurality of round cable arrangement grooves **26** provided on one side of a base wall **25**, and a flat cable arrangement chamber **27** provided on the other side of the base wall **25**.

The upper side of each of the round cable arrangement grooves **26** is opened. The round cable arrangement grooves **26** are partitioned by dividing walls **25***a* in the crosswise direction. The distal end side of each of the round cable arrangement grooves **26** in the crosswise direction is partitioned by partition walls **25***b*. At the time of ultrasonic welding, the horn **33** of the ultrasonic welding device **30** is inserted from the opening portions above the partition walls **25***b*. Each of the round cables W**1** is arranged in the corresponding round cable arrangement groove **26** in such a manner that the core wire **1***a* exposed at the end portion is positioned at the portion partitioned by the partition walls **25***b*.

The flat cable arrangement chamber **27** is formed to be surrounded by the base wall **25** and a surrounding wall **28** covering the lower part of the base wall **25**. The partition walls **25***b* extend toward the distal end side of the flat cable arrangement chamber **27** in the crosswise direction. The distal end side of the flat cable arrangement chamber **27** is partitioned in the crosswise direction by the partition walls **25***b*. A plurality of through holes **28***a* opened to the flat cable arrangement chamber **27** is formed at the position on the surrounding wall **28** where the partition walls **25***b* are positioned. At the time of ultrasonic welding, the anvil **34** of the ultrasonic welding device **30** is inserted from the through holes **28***a*. The flat cable W**2** is arranged in the flat cable arrangement chamber **27** in such a manner that the conductors **2***a* exposed at the end portion are positioned at the portions partitioned by the partition walls **25***b*.

On the base wall **25**, a pair of hooking claws **29** is provided to protrude from the position on the side opposite to the direction in which the flat cable W**2** is inserted into the flat cable arrangement chamber **27**.

The round cables W**1** and the flat cable W**2** held by the holder **10**A are pulled out from the holder **10**A in the same direction. The end portion of each of the round cables W**1** and the end portion of the flat cable W**2** are arranged to overlap each other.

On the inner circumference surface of the heat shrinkable tube **24**, the hot melt adhesive (insulating resin) **23**, which is a thermoplastic adhesive, is attached over the entire region. The hot melt adhesive **23** is thermally melted by heating to the heat shrinkable tube **24** to collectively cover the outer exposed surface of the holder **10**A and the outer circumference of the round cables W**1** and the flat cable W**2** pulled out from the holder **10**A with no gap left, and is solidified. The heat shrinkable tube **24** is made in the shrunk state, and covers the outer circumference of the solidified hot melt adhesive **23** with no gap left.

In the cable connection structure **3**C according to the third embodiment, the hot melt adhesive (insulating resin) **23** is firmly attached to, with no gap left, the outer circumference surface of each of the round cables W**1** and the outer circumference surface of the flat cable W**2** at the position of the round cables W**1** pulled out from the hot melt adhesive **23** to the outside and the position of the flat cable W**2** also pulled out from the hot melt adhesive **23** to the outside, thereby securing waterproof property of the connecting portion **20**.

Next, a manufacturing method of the cable connection structure **3**C according to the third embodiment will be described. The manufacturing method of the cable connection structure **3**C according to the third embodiment is performed in the order of a cable setting step, a connecting step, and a tube shrinking step that is an exterior forming step. Hereinafter, the manufacturing method of the cable connection structure **3**C according to the third embodiment will be described in order.

In the cable setting step, as illustrated in FIG. **11**, the end portion of the flat cable W**2** as an insertion distal end is inserted into the flat cable arrangement chamber **27** of the holder **10**A. Then, as illustrated in FIGS. **12**A and **12**B, the end portion of the flat cable W**2** is arranged in the flat cable arrangement chamber **27** in such a manner that the conductors **2***a* exposed at the end portion of the flat cable W**2** are positioned at the positions exposed from the upper openings of the partition walls **25***b* (positions above the through holes).

Next, the round cables W**1** are inserted into the round cable arrangement grooves **26** from above the holder **10**A. Then, as illustrated in FIGS. **13**A and **13**B, the round cables W**1** are arranged in the round cable arrangement grooves **26** such that the core wires **1***a* exposed at the end portions of the round cables W**1** are positioned to be exposed from the upper openings of the partition walls **25***b* (positions above the conductors **2***a*). The flat cable W**2** and the round cables W**1** may be set in the holder **10**A in no particular order. They may be set simultaneously.

The core wires **1***a* exposed at the end portions of the round cables W**1** and the conductors **2***a* exposed at the end portion of the flat cable W**2** are arranged to overlap each other, and the overlapping portions are exposed from the holder **10**A to the outside. The round cables W**1** and the flat cable W**2** are pulled out from the holder **10**A to overlap each other in the same direction.

In the connecting step, the round cables W**1** and the flat cable W**2** are electrically connected by ultrasonic welding using the ultrasonic welding device **30**. As illustrated in FIG. **14**, the ultrasonic welding device **30** includes the anvil **34**, and the horn **33** arranged at the position facing the anvil **34**. The horn **33** is provided at the distal end of an arm portion **32** whose base end portion is supported by a device main body **31**.

As illustrated in FIG. **14**, in the connecting step, the round cables W**1** and the flat cable W**2** pulled out from the holder **10**A are not arranged in the space between the horn **33** and the device main body **31**, but are arranged in the open space on the opposite side, in such a manner that the holder **10**A is positioned on the anvil **34**. Then, by the branched horn **33**, ultrasonic vibration is applied (in the direction of the arrow in FIG. **14**) to, while pressure is applied, the position in which the core wires **1***a* exposed at the end portions of the round cables W**1** and the conductors **2***a* exposed at the end portion of the flat cable W**2** overlap each other. As a result, the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** are connected by the ultrasonic welding.

In the tube shrinking step, first, the flat cable W**2** is bent in the direction indicated by the broken line arrow in FIG. **15**, and then made in the state of being guided in the direction different from the pulled-out direction from the holder **10**A, specifically, in the diametrically opposite pulled-out direction as illustrated in FIG. **16**. Then, as illustrated in FIGS. **17**A and **17**B, the holder **10**A with the round cables W**1** and the flat cable W**2** pulled out from mutually different directions is inserted into the heat shrinkable tube **24**.

Next, the heat shrinkable tube **24** and the hot melt adhesive **23** are heated. Then, as illustrated in FIG. **18**, the heat shrinkable tube **24** shrinks while the hot melt adhesive **23** melts (fluidizes). The molten hot melt adhesive **23** is firmly attached onto, with no gap left, the outer exposed surface of the holder **10**A, the connecting portions **20** in which the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** held by the holder **10**A are connected, the outer circumference of the holder **10**A, and the outer circumference of the round cables W**1** and the flat cable W**2** pulled out from the holder **10**A, and is solidified by cooling in the adhered state. As a result, the solidified hot melt adhesive **23** collectively covers the outer exposed surface of the holder **10**A, the connecting portions **20** in which the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** held by the holder **10**A are connected, the outer circumference of the holder **10**A, and the outer circumference of the round cables W**1** and the flat cable W**2** pulled out from the holder **10**A, and the heat shrinkable tube **24** covers the outer circumference of the hot melt adhesive **23** with no gap left. In this manner, the cable connection structure **3**C according to the third embodiment as illustrated in FIGS. **9**A and **9**B is produced.

As described above, the cable connection structure **3**C according to the third embodiment includes the round cables W**1** each having a round cross section and including the core wire **1***a* and the round insulating sheath **1***b* covering the outer circumference of the core wire **1***a*, the flat cable W**2** having a cross section in a flat rectangular shape and including the tabular conductors **2***a* and the flat insulating sheath **2***b* covering the conductors **2***a*, the holder **10**A holding the end portions of the round cables W**1** and the end portion of the flat cable W**2** and pulls out the round cables W**1** and the flat cable W**2** in the same direction in an overlapped state, the connecting portions **20** in which the core wires **1***a* exposed from the end portions of the round cables W**1** and the conductors **2***a* exposed from the end portion of the flat cable W**2** held by the holder **10**A are connected, and the heat shrinkable tube **24** to which the hot melt adhesive **23** is attached as a waterproof exterior portion that collectively covers the outer circumference of the holder **10**A and the outer circumference of the round cables W**1** and the flat cable W**2** pulled out from the holder **10**A. In the step of connecting the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2**, the round cables W**1** and the flat cable W**2** are pulled out from the holder **10** in the same direction, whereby it can be manufactured using a connecting device such as the ultrasonic welding device **30** regardless of a length of the flat cable W**2**.

(Variation)

In the cable connection structure **3**A according to the first embodiment and the cable connection structure **3**B according to the second embodiment, the holder **10** is divided into the round cable holder **11** and the flat cable holder **15**. However, it may be one component.

In the cable connection structure **3**C according to the third embodiment, the holder **10**A is one component. However, the holder **10**A may be two components as in the cable connection structure **3**A according to the first embodiment and the cable connection structure **3**B according to the second embodiment.

In the cable connection structure **3**C according to the third embodiment, the tube shrinking step is performed in such a manner that the flat cable W**2** is bent to be guided in the

direction different from the pulled-out direction from the holder **10**A and set. However, as in the first embodiment, the flat cable W**2** may not be bent, and the tube shrinking step (heating with respect to heat shrinkable tube **24** and hot melt adhesive **23**) may be performed while the flat cable W**2** and the round cables W**1** are pulled out from the holder **10**A in the same direction.

In the cable connection structure **3**C according to the third embodiment, the heat shrinkable tube **24** that changes its shape by thermal action is used. However, it may be a shrinkable tube that changes its shape by the action of light or the like.

In the first to third embodiments, the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2** are connected by ultrasonic welding using the ultrasonic welding device **30**. However, it is only necessary to use a connecting device capable of electrically connecting the core wires **1***a* of the round cables W**1** and the conductors **2***a* of the flat cable W**2**, which may be, for example, a resistance welding device.

What is claimed is:

1. A cable connection structure, comprising:

a round cable having a round cross section and including a core wire and a round insulating sheath covering an outer circumference of the core wire;

a flat cable having a cross section in a flat rectangular shape and including a tabular conductor and a flat insulating sheath covering the conductor;

a holder holding an end portion of the round cable and an end portion of the flat cable and pulling out the round cable and the flat cable in a same direction in an overlapped state;

a connecting portion in which the core wire exposed from the end portion of the round cable and the conductor exposed from the end portion of the flat cable held by the holder are connected to each other; and

a waterproof exterior portion collectively covering, with an insulating resin, an outer circumference of the holder and an outer circumference of the round cable and the flat cable pulled out from the holder.

2. The cable connection structure according to claim **1**, wherein

the flat cable is bent to be guided in a direction different from a direction in which the flat cable is pulled out from the holder, and

the round cable and the flat cable are pulled out from the waterproof exterior portion in different directions.

3. The cable connection structure according to claim **1**, wherein

the waterproof exterior portion is a mold resin portion.

4. The cable connection structure according to claim **1**, wherein

the waterproof exterior portion is a heat shrinkable tube to which a thermoplastic adhesive is attached, and

the thermoplastic adhesive is in a solidified state, and the heat shrinkable tube in a shrunk state covers an outer circumference of the thermoplastic adhesive.

5. The cable connection structure according to claim **1**, wherein

the holder includes a round cable holder that holds the end portion of the round cable and a flat cable holder that holds the end portion of the flat cable, and

the round cable holder and the flat cable holder are capable of being joined together in such a manner that the round cable from the round cable holder and the flat cable from the flat cable holder are pulled out in the same direction in the overlapped state.

6. A manufacturing method of a cable connection structure, comprising:

a cable setting step of holding, in a state in which a round cable and a flat cable are pulled out in a same direction in an overlapped state, an end portion of the round cable and an end portion of the flat cable in a holder;

a connecting step of connecting a core wire exposed from the end portion of the round cable held by the holder and a conductor exposed from the end portion of the flat cable held by the holder; and

an exterior forming step of forming a waterproof exterior portion covering, with an insulating resin, the holder, the round cable pulled out from the holder, and the flat cable pulled out from the holder.

7. The manufacturing method according to claim **6**, wherein

in the exterior forming step, exterior forming processing is performed while the flat cable is set in a state where the flat cable is bent to be guided in a direction different from a direction in which the flat cable is pulled out from the holder.

8. The manufacturing method according to claim **6**, wherein

the exterior forming step is an insert resin molding step in which a mold resin portion is molded by insert resin molding using, as inserts, the holder, the round cable pulled out from the holder, and the flat cable pulled out from the holder.

9. The manufacturing method according to claim **6**, wherein

the exterior forming step is a tube shrinking step in which the holder, the round cable pulled out from the holder, and the flat cable pulled out from the holder are arranged in a heat shrinkable tube with thermoplastic adhesive attached to an inner surface of the heat shrinkable tube, and a waterproof exterior portion is formed by changing a shape of the thermoplastic adhesive and the heat shrinkable tube by heating the heat shrinkable tube.

10. The manufacturing method according to claim **6**, wherein

the holder includes a round cable holder that holds the end portion of the round cable and a flat cable holder that holds the end portion of the flat cable, and

the cable setting step includes:

a cable holding step of holding the end portion of the round cable in the round cable holder and of holding the end portion of the flat cable in the flat cable holder; and

a holder combining step of combining the round cable holder and the flat cable holder in such a manner that the round cable from the round cable holder and the flat cable from the flat cable holder are pulled out in the same direction in the overlapped state.

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