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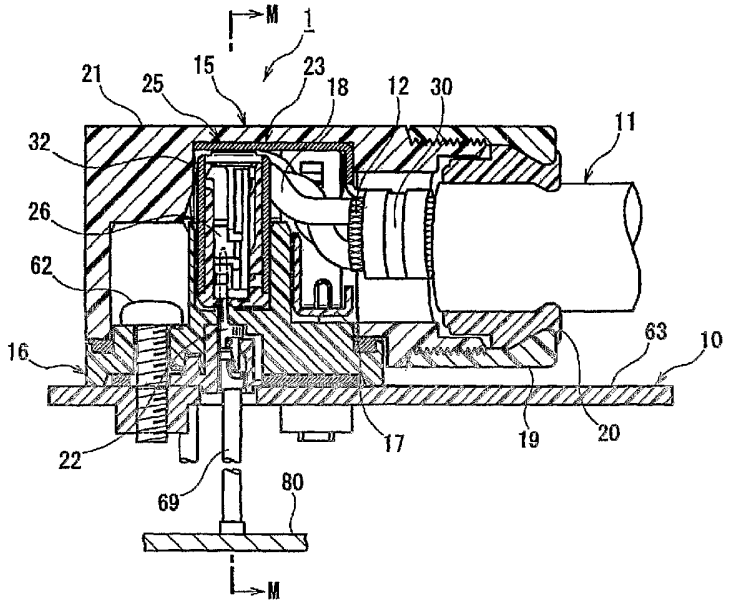

(57) Abstract: A connector which enables use of an inexpensive electrical wire having no drain wire reduces the amount of labor needed to assemble it as also leads to an improvement in reliability. A first connector portion is attached to a control cable at a braided shield thereof. The cable is intended to be connected to a servomotor having a grounding portion. The first connector portion includes a connector member that contacts a connector crimp pin and it is also connected to the cable shield and to a board that serves as a grounding portion for the servomotor. The shield and the connector crimp pin are electrically connected to each other through the first connector portion.

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CONNECTOR

Background of the Invention

The present invention relates to a connector suitable for use in connecting an electrical apparatus such as a servo motor to a wire cable.

In instances where a cable for control servo signals is connected to a servo motor, it is desirable to remove electrical noise that may be generated in the cable. Thus, it is known to use the cable arrangement shown in FIG. 29, where a wire 301 having a drain wire 311 is used, and the drain wire 311 is connected to a circuit board through a connector (not shown). The drain wire 311 used is an uninsulated electrical wire whose core wire is exposed unprotected. Also, as illustrated in FIGS. 30 and 31, a wire 401 having no drain wire is used and a braided shield thereof is connected to a circuit board. In order to connect the braided shield 412 of the wire 401, the braided shield 412 is wound into a stranded wire 413 (FIG. 30) and the stranded wire 413 is then connected to the circuit board.

Further, as shown in FIG. 31, there is also a method in which the braided shield 412 is exposed and another wire 414 is fixed onto the braided shield 412 by soldering, and the other wire 414 is then connected to the board.

However, when using the conventional wire 301 and drain wire 311 of FIG. 29, there is a problem in that the electrical wire 301 is expensive and increases the cost of the assembly. In addition, when using the wire 401 without a drain wire, it is necessary to form the stranded wire 413 in FIG. 30 from the braided shield 412 or soldering another wire 414 to the braided shield 412 as shown in FIG. 31.

These constructions increase the amount of labor necessary for connecting the wire 401 to an electrical apparatus, which increases the cost. Further, because the number of operations that are dependent on the skill of the operator is increased, the operation can be somewhat unreliable at times, resulting in a decrease in reliability.

The present invention is directed to a connector structure that overcomes the above-mentioned problems.

Summary of the Invention

It is therefore a general object of the present invention to provide a connector which enables use of an inexpensive wire without a drain wire, a reduction in the number of

assembly man-hours for the connector and the electrical wire, and an improvement in reliability.

Another object of the present invention is to provide a connector for providing a ground connection between a cable and an electrical apparatus, such as a servo motor, the connector having an elongated grounding clip having a base plate that engages an insulative connector housing and a wire clamping arm that extends from the clip to engage the exterior of a control cable that is partially received within the connector housing, the wire clamping arm engaging a shield of the control cable and the base plate being held within a cavity in the connector housing.

The present invention accomplishes these objects by way of its structure, wherein a connecting member that is incorporated in a connector is brought into contact with a braided shield of a wire to be connected to the connector and with a grounding portion of an electrical apparatus, thereby connecting the braided shield and the grounding portion to each other. Therefore, an inexpensive wire without a drain wire can be used and operations to be performed on the braided shield when assembling the connector and the wire are reduced to a minimum. Also the respective members intervening between the braided shield and the grounding portion are brought into reliable contact with each other.

The present invention relates generally to a connector that is attached to a wire having a braided shield that is to be connected to an electrical apparatus having a grounding portion. The connector includes a conductive connecting means which contacts the braided shield of the wire and the grounding portion of the apparatus, and the braided shield and the grounding portion are connected to each other through the connecting means.

The connecting means of our connector contacts the braided shield of the wire that is attached to the connector and also contacts the grounding portion of the electrical apparatus. Thus, when assembling the connector and the electrical wire, there is no need to form a stranded wire from or soldering another electrical wire to the braided shield. It is thereby possible to reduce the number of man-hours needed to assemble the devices. Further, because operations that are dependent on the skill of the operator are eliminated, the reliability of construction is achieved. There is also no need to use an expensive cable having a drain wire, and this reduces the cost.

The connecting means and the grounding portion can be brought into contact with each other through a terminal connected to the grounding portion. The connecting means is contacted to the braided shield and the terminal under a predetermined pressure so that the

connecting means is reliably brought into contact with the braided shield and the terminal, thereby achieving a further improvement in reliability.

The connecting means may also be composed of a first connecting member that holds an outer peripheral surface of the braided shield, and a second connecting member that is pressed against the first connecting member and into which the terminal may be fitted. In this case, because the second connecting member is pressed against the first connecting member, the first and second connecting members may be reliably brought into contact with each other. The first and the second connecting may be formed separately or integrally with respect to each other.

Further, because the braided shield is held by the first connecting member of the connecting means, the connecting means may be easily and reliably brought into contact with the braided shield. The terminal connected to the grounding portion is fitted into the second connecting member so that the connecting means can be brought into contact with and the terminal easily and reliably.

The present invention further relates to a connector which includes a first connector portion attached to a wire having a braided shield for connection to the grounding portion of an apparatus and a second connector portion which is attached to the apparatus and fitted with the first connector portion. The first connector portion includes a conductive connecting that contacts the braided shield of the wire and the apparatus grounding portion. The second connector portion includes a ground terminal that contacts the connecting means at the first connector portion, and a conductive means for fixing the insulated housing to the apparatus, which contacts the ground terminal and the grounding portion. The braided shield of the wire and the grounding portion of the apparatus are electrically connected to each other through a first grounding path formed by the connecting means and a second grounding path formed by the ground terminal and the fixing means. In this manner, the braided shield of the wire is connected to the grounding portion of the apparatus via two grounding paths, so that a reliable ground occurs with the wire.

These and other objects, features and advantages of the present invention will be clearly understood through a consideration of the following detailed description.

Brief Description of the Drawings:

In the course of this detailed description, the reference will be frequently made to the attached drawings in which:

FIG. 1 is a cross-sectional view showing one embodiment of an assembly in which the connectors of the present invention may be used;

FIG. 2 is a cross-sectional view showing a first connector portion of the present invention;

FIG. 3 is a cross-sectional view taken along the line **A-A** of FIG. 2;

FIG. 4 is a bottom plan view of the assembly of FIG. 3, taken along the direction of arrow **B** in FIG. 3;

FIG. 5 is a perspective view showing the assembled states of a cable-connector shell body and an associated cable;

FIG. 6 is a side view of the cable-connector shell body of FIG. 5;

FIG. 7 is a front end view of the cable connector shell body of FIG. 6, taken along the direction of arrow **C**;

FIG. 8 is a bottom plan view of the cable connector shell body of FIG. 6, taken along the direction **D** therein;

FIG. 9 is a side elevational view of a cable-connector ground contact used in the present invention;

FIG. 10 is a top plan view of FIG. 9, taken along the direction of arrow **E** therein;

FIG. 11 is a cross-sectional view of the ground contact of FIG. 9 and taken along line **F-F** thereof;

FIG. 12 is a cross-sectional view of a cable-connector housing used in the present invention;

FIG. 13 is a bottom plan view of the cable connector housing of FIG. 12, taken in the direction of arrow **G** therein;

FIG. 14 is an end view of the cable connector housing of FIG. 12, taken along the direction of arrow **H** therein;

FIGS. 15A-C are sequential views illustrating how the first connector portion of the present invention is attached to the electrical wires, in which FIG. 15A is a side view showing how the cable insulation is removed, FIG. 15B is the same view, but with a portion of the cable braided shield removed, and FIG. 15C is the same view, but illustrating the exposed braided shield folded over onto the cable insulation;

FIGS. 16A-C are sequential views illustrating how the first connector portion of the present invention is attached to the wires, in which FIG. 16A is a side view showing how a copper foil tape is wound around the braided shield, FIG. 16B is a view showing how

insulation of the cable wires are removed, and FIG. 16C is a view showing how terminals are attached to the exposed wires;

FIG. 17 is a side view showing how the first connector portion of the present invention is attached to the electrical wires;

FIGS. 18A-B are sequential views illustrating how the first connector portion is attached to the electrical wires, in which FIG 18A is a side view showing how the cable-connector shell body is attached to the cable assembly, and FIG. 18B is the same view, but illustrating the cable-connector shell body attached to the cable assembly;

FIGS. 19A-B are sequential views illustrating how the first connector portion of the present invention is attached to the electrical wires, in which FIG. 19A illustrates how the cable-connector shell body is received in a cable-connector cover housing, and FIG. 19B illustrates how the cable-connector shell is attached to the cable connector cover housing;

FIG. 20 is a cross-sectional view illustrating a second connector portion of the present invention;

FIG. 21 is a cross-sectional view of the second connector portion of FIG. 20, taken along the line **J-J** thereof;

FIG. 22 is a cross-sectional view of the second connector portion of FIG. 21, taken along line **K-K** thereof;

FIG. 23 is a frontal view showing a mounting-connector ground terminal of the present invention;

FIG. 24 is a bottom plan view of the ground terminal of FIG. 23, taken along the direction of arrow **L** therein;

FIG. 25 is a cross-sectional view taken along line **M-M** of FIG. 1;

FIG. 26 is a cross-sectional view showing a first grounding path of the present invention;

FIG. 27 is a cross-sectional view showing a second grounding path of the present invention;

FIG. 28 is a diagram illustrating the first and second grounding paths of the present invention;

FIG. 29 is a side view of the free end of a known cable;

FIG. 30 is a side view of the free end of another known electrical cable with a ground drain wire extending from the body of the cable; and,

FIG. 31 is yet another side view of a known cable with a ground wire attached to an exposed portion of the cable internal braided shield.

Detailed Description of the Preferred Embodiments

FIG. 1 illustrates the present invention which, as shown, includes a connector 1 for connecting a servo motor 10 and a control cable 11 to each other. The connector 1 has a first connector portion 15 that is attached to the control cable 11, and a second connector portion 16 that may be attached to the servo motor 10 and fitted to the first connector portion 15. The control cable 11 has a braided shield 12 that encircles interior wires 18 of the cable 11. In FIG. 1, a cable-connector shell cover 17 is shown which protects the wires 18 of the control cable 11. Reference number 19 identifies a cap, while reference number 20 identifies a bushing.

The first connector portion 15 will now be described. As shown in FIG. 2, the first connector portion 15 includes an insulative cable connector cover, or housing 21, and a conductive connecting means 23 which is incorporated in the cable-connector cover 21 and which contacts with both the braided shield 12 of the cable 11 and a mounted-connector crimp pin 22 that serves as a terminal connected to a circuit board 80 (FIG. 1) of the servo motor 10 which serves to ground the cable to the servo motor.

The connector means 23 is provided with a first connecting member that takes the form of a conductive cable-connector shell body 25 that clamps to an outer peripheral surface of the cable braided shield 12, and the connector means 23 further includes a cable-connector ground contact 26 that acts as a second connecting member which is in contact with the cable-connector shell body 25 under a predetermined pressure and into which the mounted-connector crimp pin 22 may be fitted. The cable-connector ground contact 26 is disposed inside of the connecting means 23 while being received in a cavity of the cable-connector housing 27. (FIG. 27.)

As shown in FIG. 3, the connecting means 23 is incorporated in a side end portion inside of a cavity of the cable-connector cover, or housing 21. Incorporated by the side of the connecting means 23 are cable-connector crimp terminals 28 that are attached to respective individual wires 18 of the control cable 11. As shown in FIG. 4, which is a bottom plan view of the cable connector assembly, the cable-connector ground contact 26 and the cable-connector crimp terminals 28 are illustrated as arranged in two spaced apart rows or lines.

FIG. 5 is a perspective view illustrating where the cable-connector shell body 25 of the connection means 23 is attached to the control cable 11. As shown in FIG. 6, the cable-connector shell body 25 includes: (1) a band-like clamping portion 30 that may be applied to the outer peripheral surface of the braided shield 12 by being clamped therearound; (FIGS. 1 & 5); (2) a box-like retaining portion, or channel 31 that is received within a cavity of the

cable connector cover and which encloses the cable-connector ground contact 26 and the cable-connector crimp terminals 28; and, (3) a lid 32 that is bent so as to close the end opening of the box-like retaining portion 31. This retaining portion extends transversely to the end and the axis of the control cable.

A connector ground terminal 70 that is mounted to the exterior casing of the servo motor, as shown in FIG. 25, is brought into contact with the side plate portions 31a that are disposed on both sides of the box-like retaining portion 31, as will be described later in greater detail. After the cable-connector ground contact 26 and the cable-connector crimp terminals 28 are incorporated into the retaining portion 31, the lid 32 thereof is bent from its base portion so as to close the space between the two side portions 31a to give the grounding clip its box-like configuration and to hold the terminals and their associated housing 45 in place therein . A protective portion 33 is provided for enclosing and protecting the wires 18 of the control cable 11. (FIG. 6.)

As shown in FIG. 7, the cable clamping portion 30 is formed in an inverted U-shape and this clamping portion 30 is shown in FIG. 8 as formed in a side end portion of the retaining portion 31. In the cable-connector shell body 25, after the exposed braided shield 12 of the control cable 11 (FIG. 1) is inserted into the clamping portion 30, the clamping portion 30 is bent, such as by crimping, over the braided shield 12. As a result, the braided shield 12 and the clamping portion 30 are brought into contact with each other over a wide area and under a pressure not lower than a certain predetermined level. The clamping portion 30 is spaced from the area 31 where the signal and ground terminals are held to provide room for manipulation of the cable wires, if desired.

As shown in FIG. 9, the cable-connector ground contact 26 of the cable connector shown in FIG. 2 has two contact portions associated with it. The first contact portion 34 is in contact with the lid or interior top surface 32 (FIG. 1) of the cable-connector shell body 25 at a desired, preselected pressure. The second contact portion 35 is formed on the end portion side of the first contact portion 34 and forms a receptacle contact for contacting the above-mentioned mounted-connector ground crimp pin (terminal) 22 (FIG. 1).

The first contact portion 34 is formed in a substantially inverted U-shape and extends from the body of the ground contact in a cantilevered fashion, and elasticity is imparted between arm portions 36 and 37 on both sides thereof. A projection 38 is formed at the forward end of the arm portion 36 provided on one side of the first contact portion 34 and projects outwardly. This projection 38 is pressed against the lid 32 (FIG. 1) of the first connecting member 25 clip by an elastic force that acts between both of the arm portions 36

and 37. As shown in FIG. 10, the first contact portion 38 may have two arms and the second contact portion 35 may include a pair of cylindrical portions 40 & 41 which are formed on the upper and lower sides thereof, so as to be spaced apart from each other. Each of those cylindrical portions 40 and 41 has a notch 42 provided along the center axis thereof. (FIG. 10.)

As shown in FIG. 11, a narrowed portion 43 having a smaller inner diameter than the respective inner diameters of the cylindrical portions 40 and 41 is formed on the second contact portion 35 and are fitted in a recess 22a (FIG. 25) that is formed in the above-mentioned mounted-connector crimp pin 22. This prevents the mounted-connector crimp pin 22 from becoming accidentally dislodged.

As shown in FIG. 12, the cable-connector second housing 27 of FIG. 2 is provided with a closed-end first receiving portion 45 for receiving the cable-connector ground contact 26. The bottom portion of the first receiving portion 45 contains a hole 46 into which the mounted-connector crimp pin 22 is inserted. As shown in FIG. 13, a second receiving portion 47 is provided for receiving the cable-connector crimp terminals 28 and it is formed near the side of the first receiving portion 45. The first receiving portion 45 and the second receiving portion 47 are formed in a stepped arrangement as shown best in FIG. 13. As shown in FIG. 14, the cable-connector ground contact 26 received in the first receiving portion 45 and the cable-connector crimp terminals 28 received in the second receiving portion 47 are arranged in two substantially linear lines. This second housing 27 is inserted into the cable connector first housing 21.

Next, a procedure for assembling the first contact portion 15 will be described. Note that, although a case where a copper foil tape 51 is wound around the braided shield 12 will be described in this example, the copper foil tape 51 need not be provided. First, as shown in FIG. 15(a), a given length of the outer insulation 50 of the control cable 11 is removed from an end portion thereof. Next, as shown in FIG. 15(b), the exposed braided shield 12 is removed while leaving a part thereof. Then, as shown in FIG. 15(c), the braided shield 12 is folded over in order to cover the top of the cable outer insulation 50.

As shown in FIG. 16(a), the copper foil tape 51 may be then wound around the braided shield 12. Then, as shown in FIG. 16(b), the insulation on the end portions of the cable wires 18 are removed so as to expose their inner core wires 52. Subsequently, as shown in FIG. 16(c), the exposed core wires 52 are then crimped to the terminals 53. As shown in FIG. 17, the terminals 53 are then placed into the second receiving portion 47 of the cable-connector second housing 27.

Next, as shown in FIG. 18(a), the cable-connector second housing 27 is inserted into the retaining portion 31 of the cable-connector shell body 25. The portion of the control cable 11 around which the copper foil tape 51 is wound is then inserted into the winding portion 30 of the cable-connector shell body 25. Then, the lid 32 of the cable-connector shell body 25 is bent from its base portion. As shown in FIG. 18(b), the clamping portion 30 of the cable-connector shell body 25 is subsequently bent to contact, under pressure, the exterior surface of the copper foil tape 51 that is wound around the braided shield 12 of the control cable 11.

Next, as shown in FIG. 19(a), the control cable 11 is drawn into the interior from an opening on one side of the cable-connector cover 21 and through an opening on the other side thereof. Then, the cable-connector shell body 25 is inserted into the cable-connector cover 21. Thereafter, as shown in FIG. 19(b), the cable-connector shell cover 17, the cap 19, and the bushing 20 are attached. This completes the assembly of the first connector portion 15, namely the cable connector component.

Next, the second connector portion 16, or the apparatus connector component of FIG. 1 will be described. As shown in FIG. 20, this second connector portion 16 includes a mounted connector member that is attached to the surface of the apparatus 10, and includes its own insulative mounted-connector housing 61. This mounted-connector housing 61 is fixed to a frame 63 (typically, a metal housing of the apparatus) that serves as a ground for the servo motor 10 and the housing 61 is fixed to the frame 63 by a conductive screw 62. This second housing 61 has a first recess 64 that receives the cable-connector shell body 25 that is incorporated in the first connector portion 15. It also includes a second recess 65 that receives a mounted-connector crimp housing 67 with a mounted-connector crimp pin 22 incorporated therein, and the two recesses are vertically aligned with each other.

A hole 66 is disposed in the border wall separating the first recess 64 and the second recess 65. The mounted-connector crimp pin 22 passes through this hole. In FIG. 20, an O-ring 68 is further shown as wound around the entire outer periphery of the mounting-connector housing 61 and this O-ring maintains a hermetic seal between the first connector portion 15 and the second connector portion 16, when they are assembled together. The wire 69 connects the mounted-connector crimp pin 22 to the board 80 of the servo motor 10 (FIG. 1). Mounted to the side of the mounted-connector crimp pin 22 in the first recess 64 is a conductive mounting-connector ground terminal 70 that contacts the cable-connector shell body 25.

As best shown in FIG. 21, this mounting-connector ground terminal 70 may be attached to the opposing sides, or ends, of the interior of the first recess 64. Arranged between these mounting-connector ground terminals 70 and 70 are the mounted-connector crimp pin 22 for grounding, and a plurality of mounted-connector crimp pins 71 for connecting each wire 18 of the cabtire cable 11 (FIG. 1) and the board 80 to each other. A elastomeric support, such as rubber gasket 72 is interposed between the housing 61 and the base 63. Wire 73 electrically connects the mounted-connector crimp pin 71 and the board 80 together. As shown in FIG. 22, the screw 62 contacts the mounting-connector ground terminal 70 and the frame 63 of the servo motor 10, so that the mounting-connector ground terminal 70 and the frame 63 are electrically connected to each other through the screw 62. The mounting-connector housing 61 has a hole 74 into which the screw 62 is inserted, and the frame 63 has a screw hole 63a which the screw 62 threadedly engages.

As shown in FIG. 23, the mounting-connector ground terminal 70 has a first contact portion 75 which is in contact with the cable-connector shell body 25 (FIG. 27) of the first connector portion 15, a second contact portion 76 arranged at the opening edge of the hole 76 for the screw 62, and a connecting portion 77 that connects the first contact portion 75 and the second contact portion 76 together. FIG. 23 shows the state in which the mounting-connector ground terminal 70 has not been inserted into the mounting-connector housing 61 yet.

The first contact portion 75 of the ground terminal is formed as a substantially rectangular plate having at its center a notch 75a that extends longitudinally in the plate. This notch 75a permits elastic deformation of the first contact more easily than if no notch were present. The second contact portion 76 is formed as a substantially elliptical ring, which extends substantially parallel to the first contact portion 75 from the end edge of the connecting portion 77. The second contact portion 76 protrudes on either side of the connecting portion 77.

As shown in FIG. 24, upper and lower arcuate portions 76a and 76b of the second contact portion 76 are bent substantially at right angles with respect to the connecting portion 77. As shown in FIG. 22, these arcuate portions 76a and 76b are arranged at the opening edge of the hole 74. The portion between the upper arcuate portion 76b and the lower arcuate portion 76a is arranged in a groove 74a formed in the inner peripheral surface of the hole 74.

Next, the function of the connectors 1 of the invention shall be described. As shown in FIG. 25, in the state in which the first connector portion 15 and the second connector portion 16 are engaged with each other, the mounted-connector crimp pin 22 for grounding

attached to the second connector portion 16 and the other mounted-connector crimp pins 71 are respectively fitted into the cable-connector ground contact 26 of the connecting means 19 in the first connector portion 15 and the cable-connector crimp terminal 28 attached to each wire 18 of the control cable 11. The cable-connector ground terminals 70 and 70 mounted to both sides of the second connector portion 16 elastically or resiliently contact the side plate portions 31c of the retaining portion 31 in the cable-connector shell body 25 of the first connector portion 15.

And, as shown in FIG. 26, a first grounding path **A** is formed by the braided shield 12 of the cabtire cable 11, the cable-connector shell body 25 and the cable-connector ground contact 26 of the connecting means 23 in the first connector portion 15, the mounted-connector crimp pin 22, the electric wire 69, and the internal board 80 of the servo motor. As shown in FIG. 27, a second grounding path **B** is formed by the braided shield 12 of the cabtire cable 11, the cable-connector shell body 25 of the connecting means 23 in the first connector portion 16, the mounting-connector ground terminal 70 in the second connector portion 16, the screw 62, and the frame 63.

This connector 1 is provided with the first grounding path **A** extending from the braided shield 12 of the cable 11 to the board 80 of the servo motor 10, and the second grounding path **B** extending from the braided shield 12 of the cabtire cable 11 to the frame 63 of the servo motor 10. In this way, in the first connector portion 15 of the present invention, the cable-connector shell body 25 of the connecting means 23 thereof contacts the braided shield 12 of the cabtire cable 11 attached to the first connector portion 15, while the cable-connector ground contact 26 of the connecting means 23 contacts the board 80, which acts as the grounding portion for the servo motor 10. When the first connector portion 15 and the control cable 11 are assembled, there is no need to forming the braided shield 12 into a stranded wire for connection, nor is there a need to solder another wire to the braided shield 12. It is thus possible to reduce the amount of labor required in assembly and reduce the cost. Furthermore, this assembly process does not require great skill of the operator, and an improvement in reliability is achieved. Further, since there is no need to use an expensive electrical wire having a drain wire, it is possible to achieve a reduction in cost.

The outer peripheral surface of the braided shield 12 is held by the clamping portion 30 of the cable-connector shell body 25 so that the connecting means 19 and the braided shield 12 contact each other with a large contact area and at a desired pressure. The mounted-connector crimp pin 22 is fitted into the cylindrical portions 40 and 41 and the narrowed portion 43 of the cable-connector ground contact 26 in the connecting means 23, so

that the cable-connector ground contact 26 and the mounted-connector crimp pin 22 contact each other at a similar contact pressure. Thus, the braided shield 12 and the mounted-connector crimp pin 22 are reliably connected to each other through the connecting means 23, so that it is possible to achieve a further improvement in reliability.

The cable-connector shell body 25 of the connecting means 23 is also designed so that the connecting means 23 can be brought into contact with the braided shield 12 easily and reliably solely by winding its clamping portion 30 around the outer surface of the braided shield 12, thereby achieving an improvement in terms of operability.

Further, by fitting the mounted-connector crimp pin 22 which is connected to the board 80 into the cylindrical portions 40 and 41 and the narrowed portion 43, the cable-connector ground contact 26 can be brought into contact with the mounted-connector crimp pin 22 easily and reliably, to achieve a further improvement in operability. The braided shield 12 of the control cable 11 is grounded through the two distinct grounding routes, namely, grounding paths A and B, so that it is possible to reliably eliminate noise or the like generated in the controlP cable 11.

While in the above-described embodiment the present invention is applied to the connector 1 which connects the cabtire cable 11 and the servo motor 10 to each other, this should not be construed restrictively. The present invention is also applicable, for example, to connectors for connecting various electric apparatuses and electrical wires. Also, while in the preferred embodiment, electrical noise generated in the different portions of the assembly is discharged to the ground through the braided shield 12 of the control cable 11, the frame 63 of the servo motor 11, and the board 80, but the present invention may also be applicable to instances where the potentials of the different portions are maintained the same or a case in which the motor FG is guided to the exterior.

According to the present invention, the connecting means of the connector contacts both the braided shield of the electrical wires attached to the connector and the board serving as the grounding portion for an electrical apparatus. Therefore, when assembling the connector and its associated wire, there is no need to perform such operations as forming the braided shield as a stranded wire or soldering another electrical wire onto the braided shield.

Therefore, it is possible to achieve a reduction in operation man-hours. Further, operations that are dependent on the skill of the operator are eliminated, whereby improved reliability is achieved. Further, there is no need to use expensive wire having a drain wire, thereby allowing a reduction in cost.

CLAIMS:

What is claimed is:

1. A connector assembly for connecting a shielded cable to an electrical apparatus, the cable having a plurality of wires surrounded by an outer shield member and the outer shield member being covered with an insulation, a portion of the insulation being removed to expose a portion of said shield member and the apparatus having an internal ground member, comprising:

a first connector for attaching to the shielded cable, the first connector including a first insulative housing with a cavity formed therein, an inner shell member supported by the first housing, the inner shell member defining a conductive receptacle that is received in the first housing cavity, said inner shell member further including a clamping portion for clamping to the exposed shield member of said cable, the clamping portion being integrally formed with the conductive receptacle and spaced apart therefrom, said first connector further including an insulative terminal housing supported in said conductive receptacle, the terminal housing supporting a plurality of signal terminals and at least one ground terminal, the signal terminals having body portions with terminating ends for terminating to individual wires of said cable and mating ends spaced apart from the terminating ends, the ground terminal having a body portion, a terminating end and a mating end spaced from the terminating end, said terminal housing including a slot through which the ground terminal terminating end extends into contact with a portion of said inner shell member; and,

a second connector for attaching to said apparatus, the second connector being mateable with said first connector, the second connector including a second insulative housing supporting a plurality of signal terminals and at least one ground terminal therein in a , the second connector signal terminals having mating ends for engaging said first connector signal terminal mating ends when said first and second connectors are mated together, the second connector ground terminal having a mating end for engaging said first connector ground terminal mating end when said first and second connectors are mated together, said second connector further including an inner conductive member having a body portion with a fixed engagement portion and a contact portion, the contact portion contacting said first connector inner shell member when said first and second connectors are engaged together, the fixed engagement portion contacting a ground member of said apparatus, whereby, when said first and

second connectors are mated together two distinct grounding paths are formed, the first grounding path extending from said cable shield through said inner shell and through said first and second connector ground terminals, and the second grounding path extending from said cable shield through said inner shell and through said second connector inner conductive member to the apparatus grounding member.

2. The connector assembly of claim 1, wherein said second connector inner conductive member contact portion includes a flexible contact arms extending therefrom and into contact with said first connector inner shell member when said first and second connectors are mated together.

3. The connector assembly of claim 1, wherein said second connector inner conductive member fixed engagement portion includes a circular flange that contacts a fastener for mounting said second connector to said apparatus.

4. The connector assembly of claim 1, wherein said inner shell member has a body portion and a plurality of walls extending therefrom and bent to form said conductive receptacle.

5. The connector assembly of claim 4, wherein shell member receptacle includes a channel portion in which said terminal housing is received., and said first connector ground terminal terminating end contacts said channel portion..

6. The connector assembly of claim 1, wherein first connector ground terminal terminating end is cantilevered from said body portion and includes a spring arm portion that biases it away from said body portion into contact with said inner shell member.

7. The connector assembly of claim 6, wherein said first connector ground terminal terminating end includes a pair of spaced apart contact arms.

9. A connector for a cable containing a plurality of individual signal wires and a grounding shield at least partially encompassing the wires, the connector comprising:

a first insulative housing having a cavity defined in a surface thereof and a passage through a side of the first housing which permits an end of the cable to be inserted the first housing cavity;

a conductive shell member disposed within said first housing cavity, the shell member defining a receptacle that partially encloses the cable end and ends of wires of said cable, the shell member having a base portion and wall portions folded to form walls of said receptacle, said shell member further including a cable clamp portion integrally formed with said base portion and spaced apart therefrom for clamping around said cable shield; and

a second insulative housing disposed within said shell member receptacle, the second housing having a body portion with a plurality of openings formed therein, each of the opening including a conductive terminal, the terminals arranged in signal terminals and at least one ground terminal, each of the signal terminals including an terminating end for terminating to one of said cable signal wires, said signal terminal being further insulated from contact with said shell member, the ground terminal having a mating end for mating with an opposing connector ground terminal and a contact end protruding from said second housing into contact with said shell member so as to establish a grounding path from said cable shield to the ground terminal mating end by way of said shell member.

10. The connector of claim 9, wherein said shell member receptacle includes a channel portion in which said second housing is received.

11. The connector of claim 10, wherein said channel extends transversely to an axis of said cable.

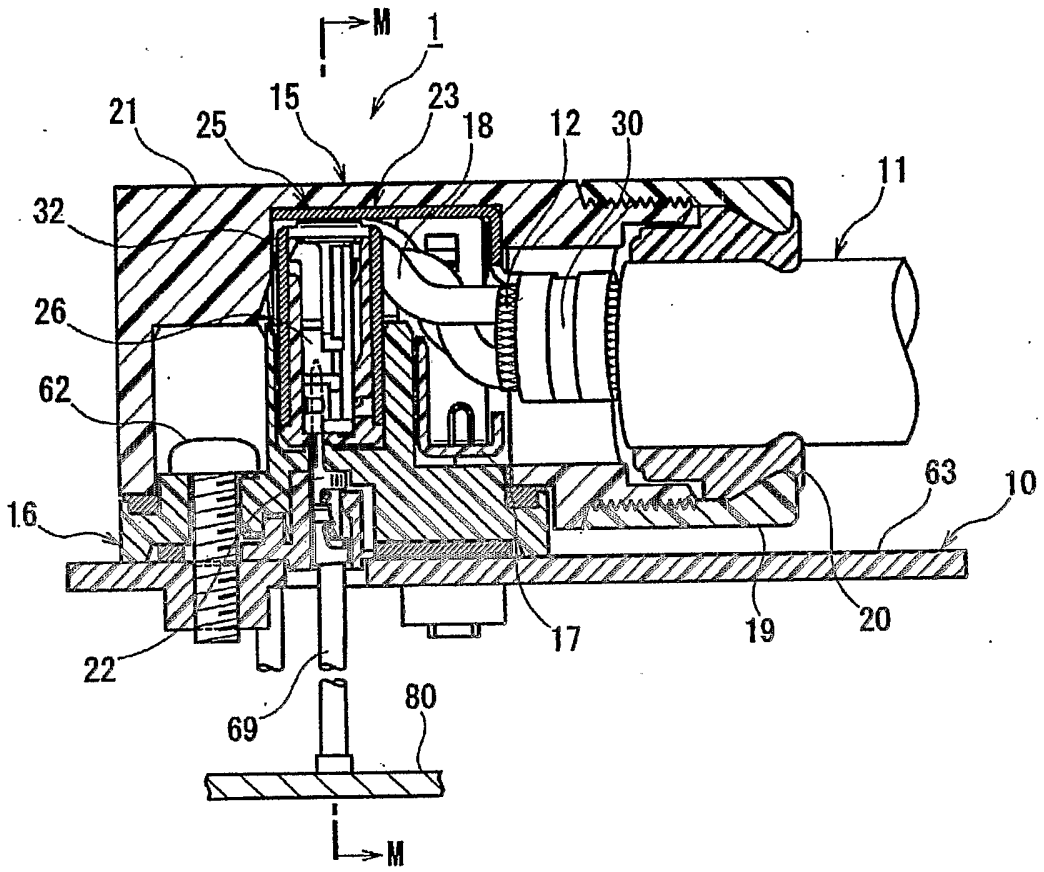
12. The connector of claim 9, wherein said ground terminal includes a body portion, the mating end being disposed at one end of the body portion and the contact end being disposed at an opposite end of said ground terminal.

13. The connector of claim 12, wherein said contact portion is cantilevered from said body portion.

14. The connector of claim 13, wherein said contact portion includes a pair of spaced-apart contact arms that are cantilevered from said body portion.

15. The connector of claim 14, wherein said contact arms extend through a slot formed in said second housing and into contact with at least one sidewall of said shell member receptacle.

FIG. 1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62
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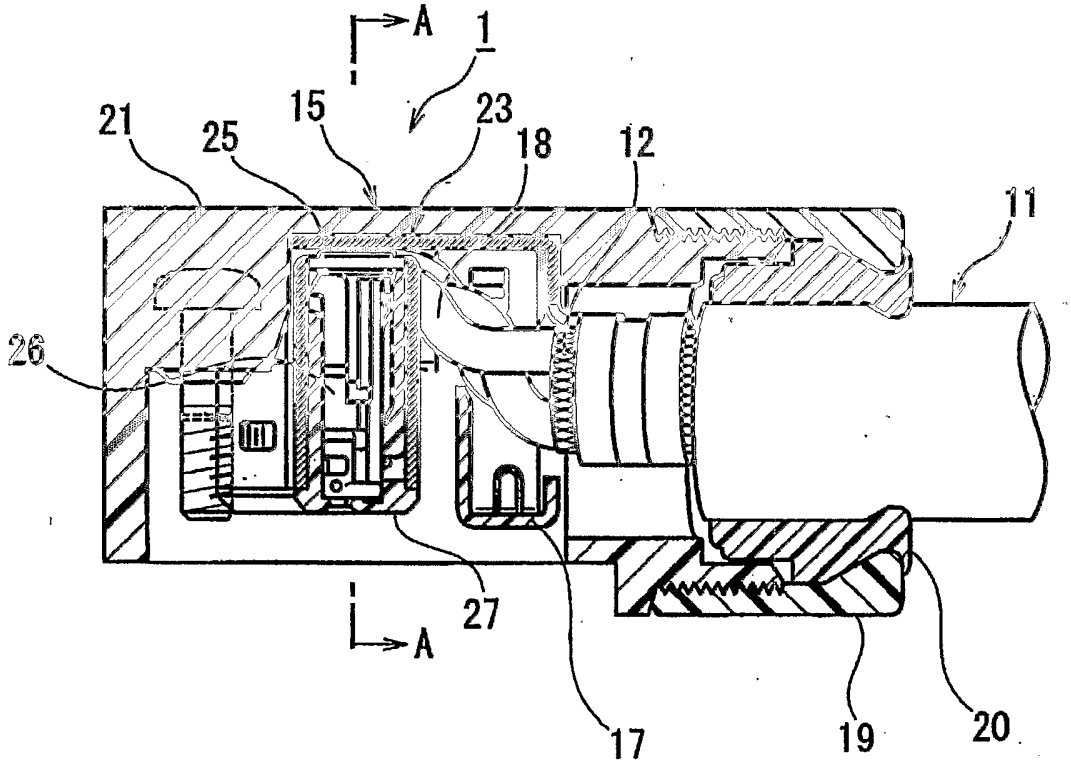
69
80
M

FIG. 2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A
17
19
20

FIG. 3

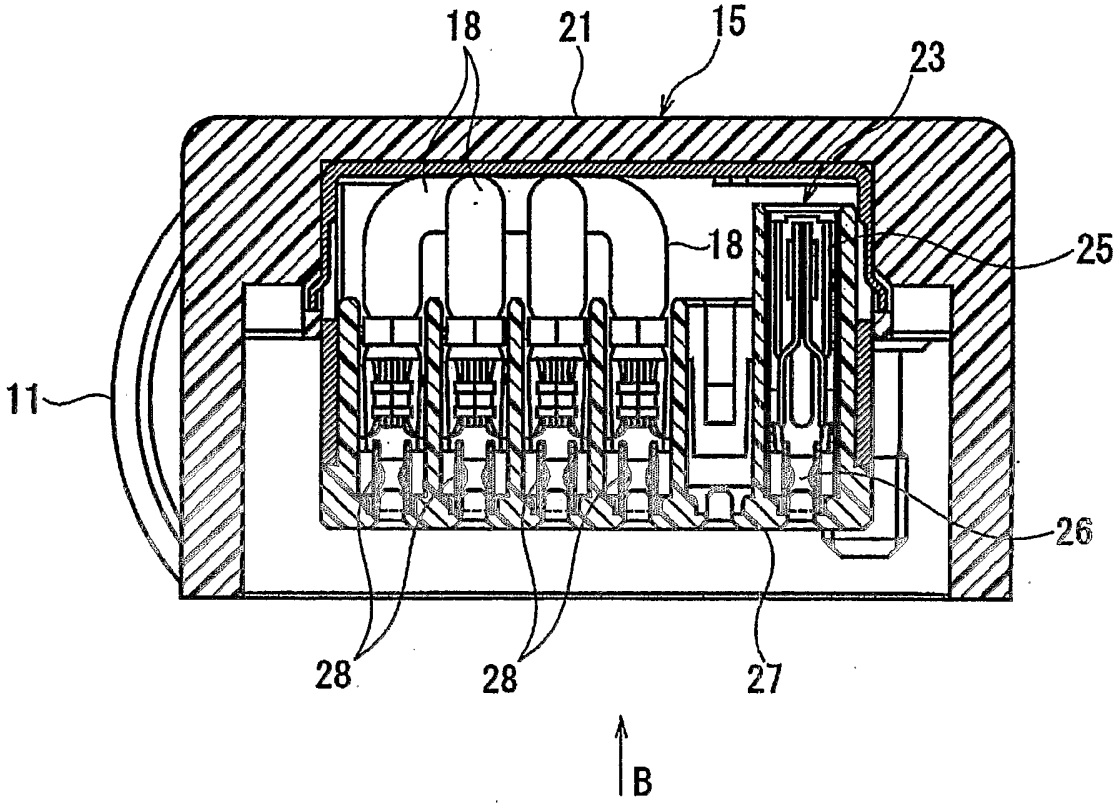


FIG. 4

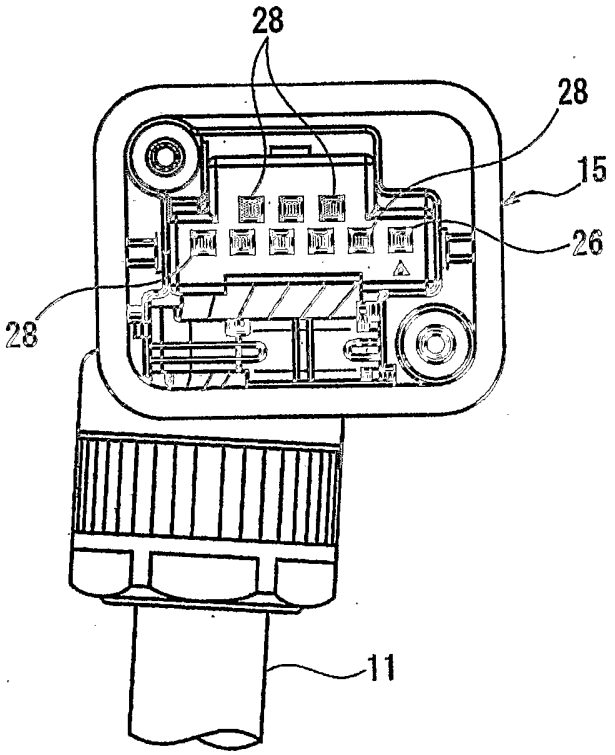


FIG. 5

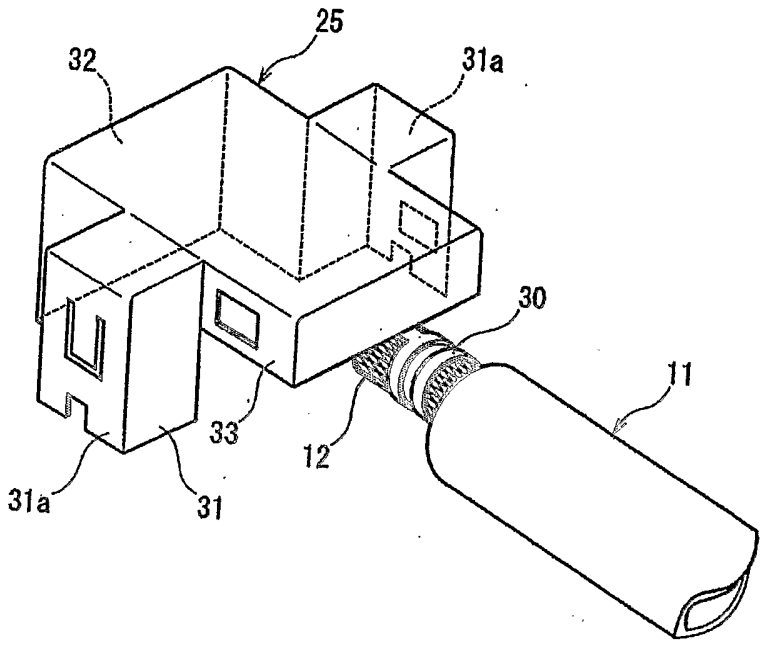
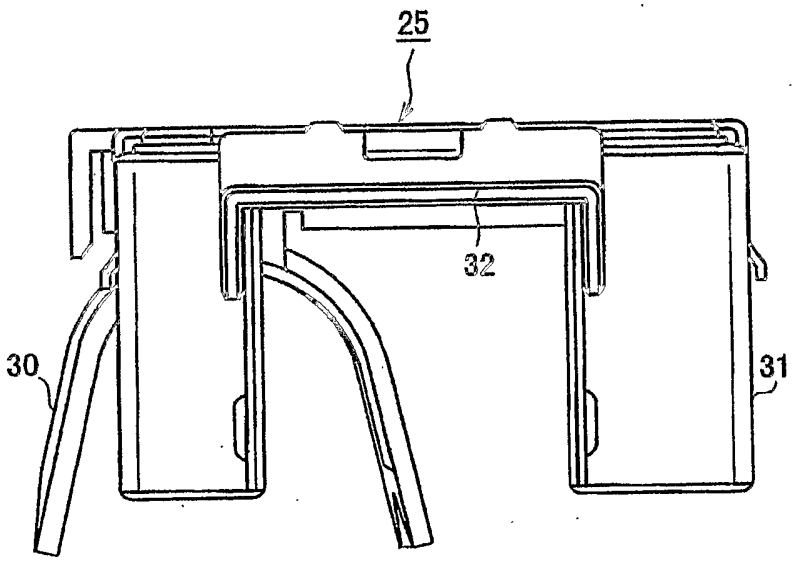


FIG. 7



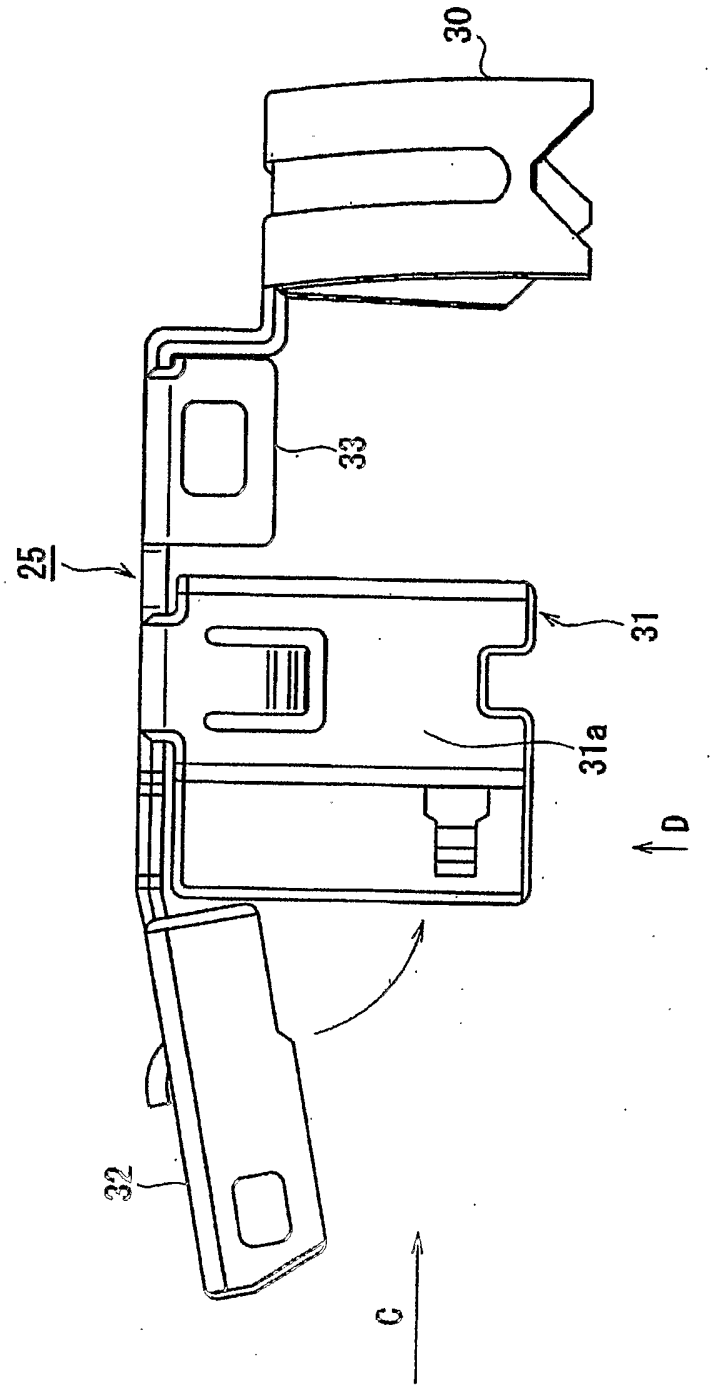


FIG. 6

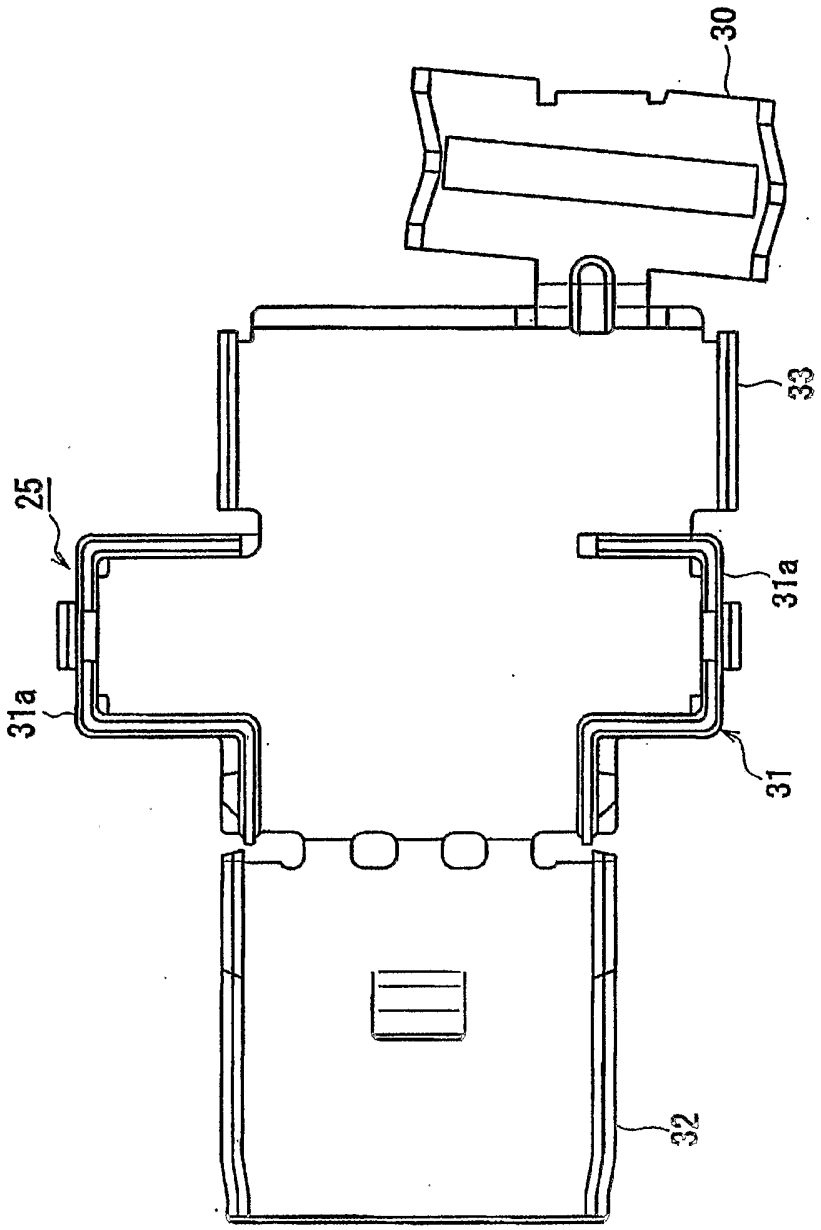


FIG. 8

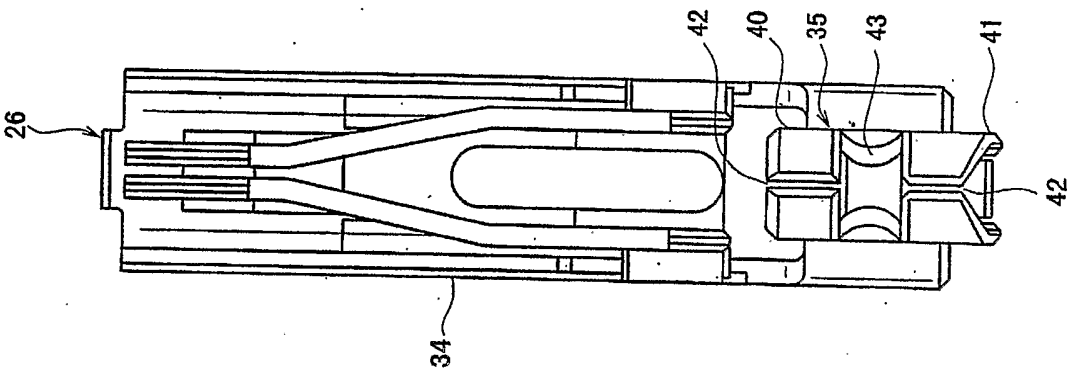


FIG. 10

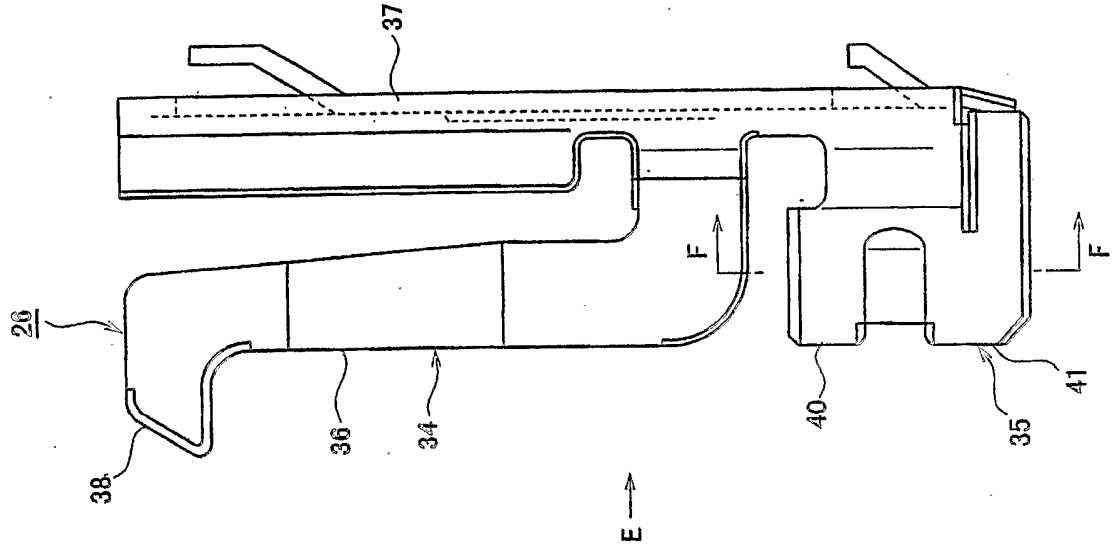


FIG. 9

FIG. 12

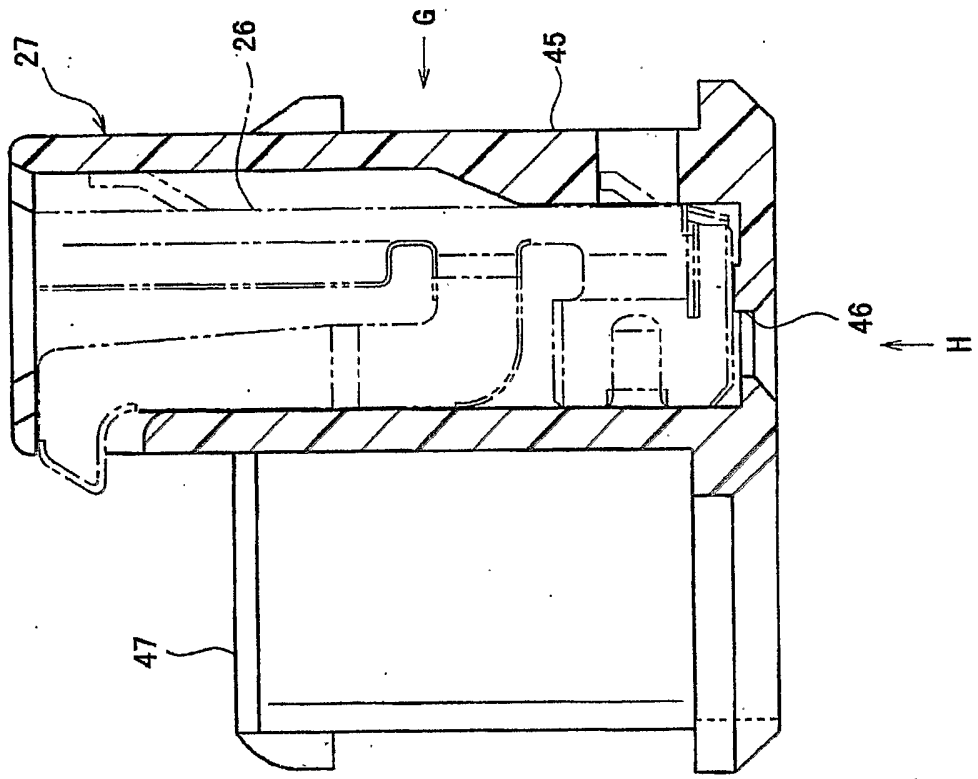


FIG. 11

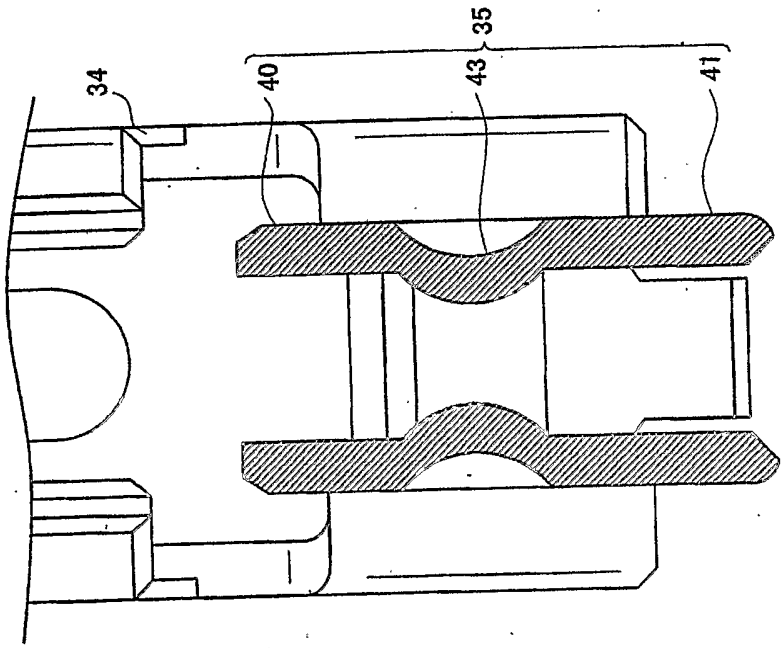


FIG. 13

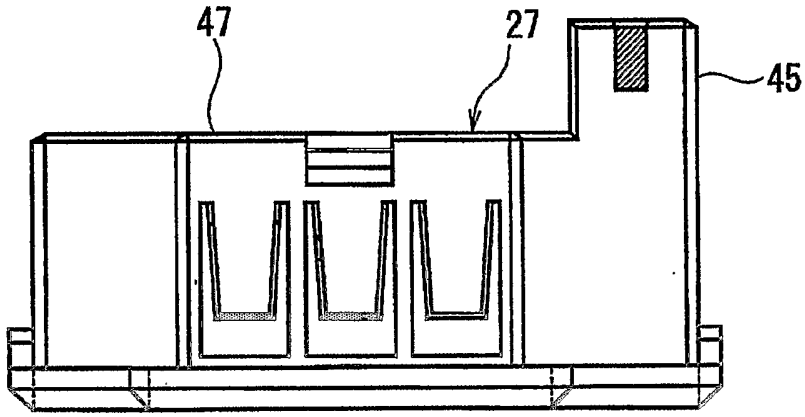


FIG. 14

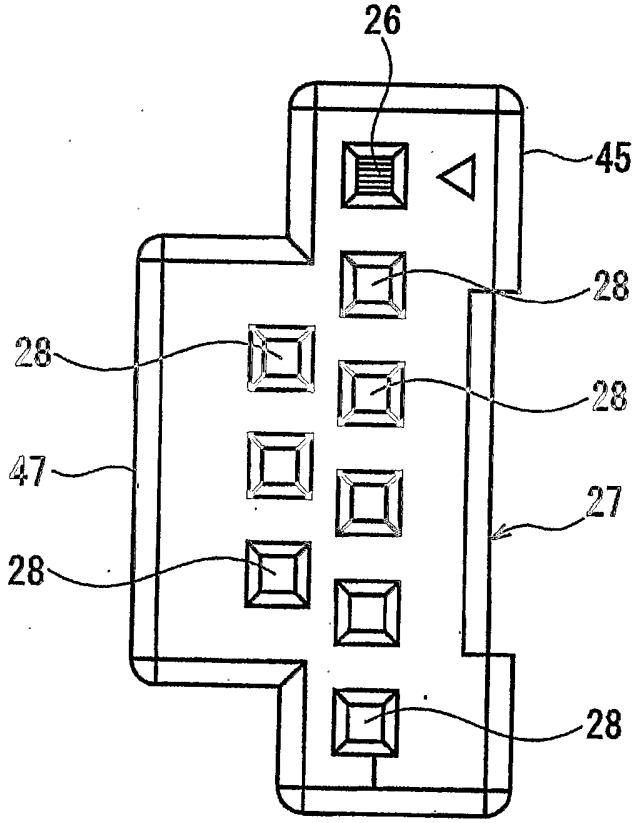


FIG. 15A

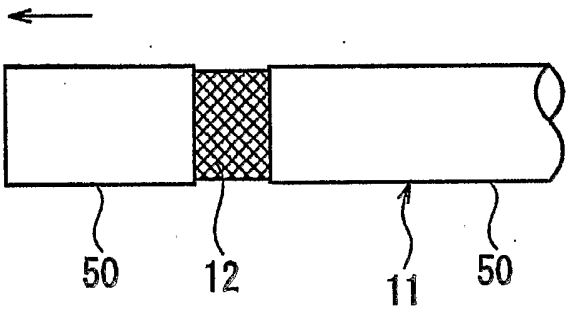


FIG. 15B

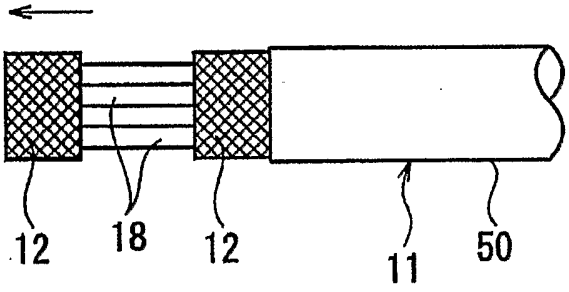


FIG. 15C

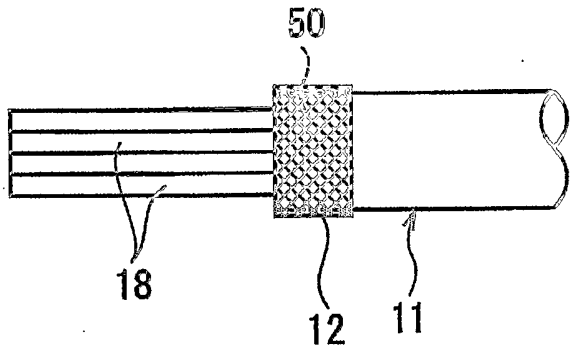


FIG. 16A

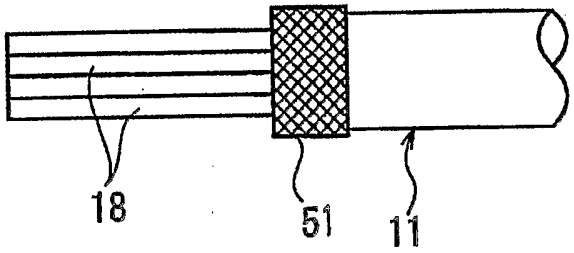


FIG. 16B

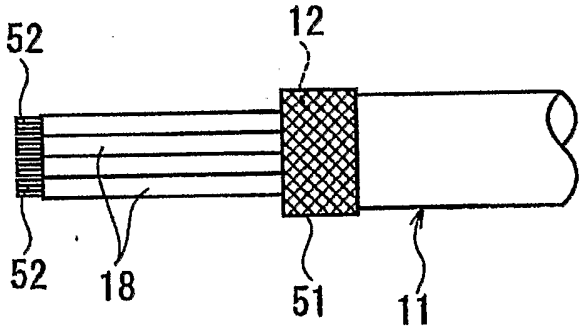


FIG. 16C

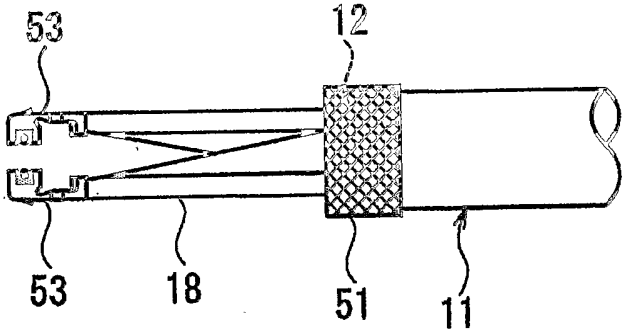


FIG. 17

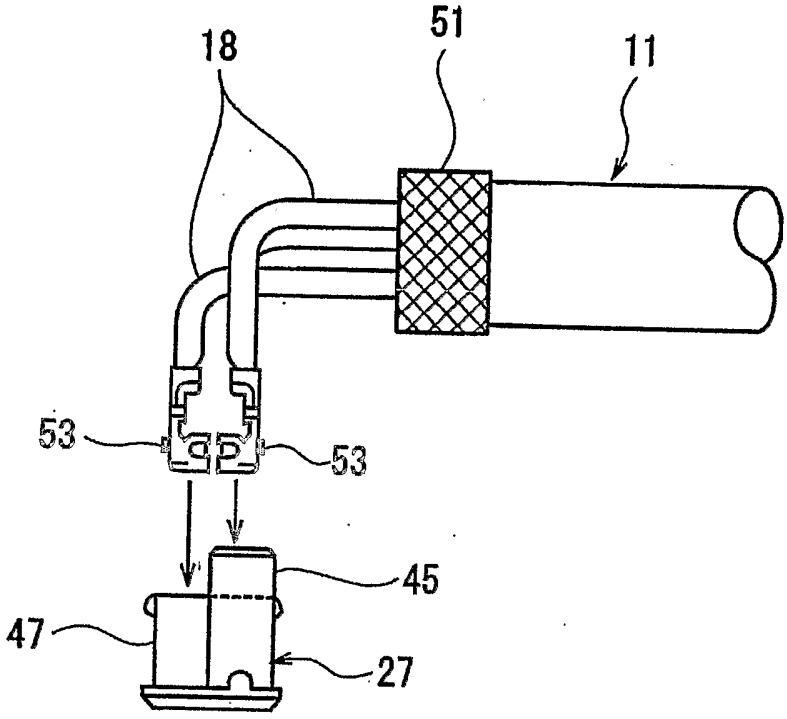


FIG. 18A

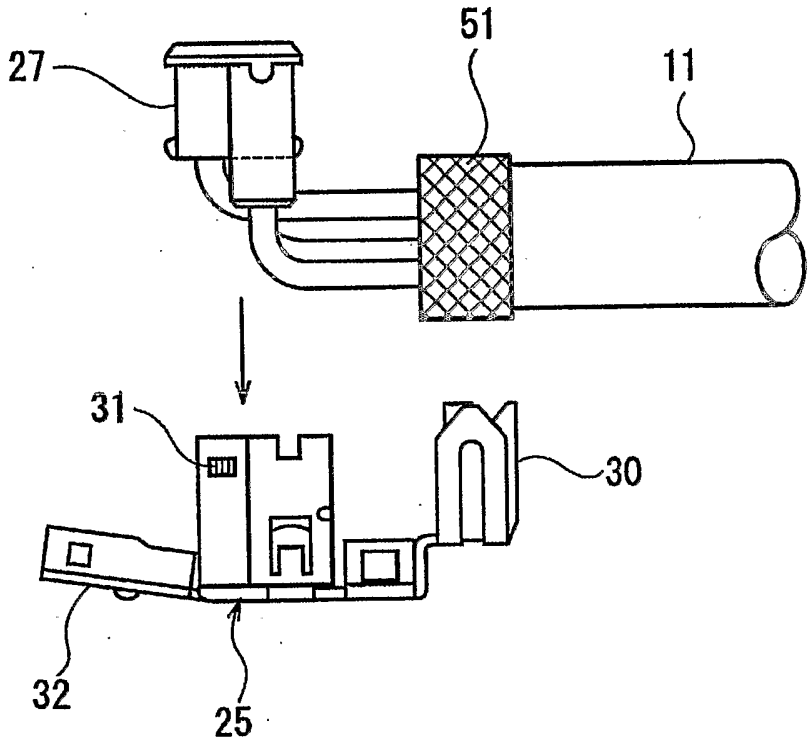


FIG. 18B

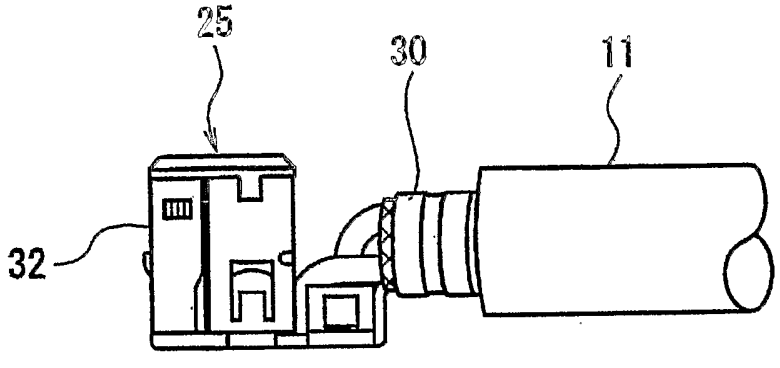


FIG. 19A

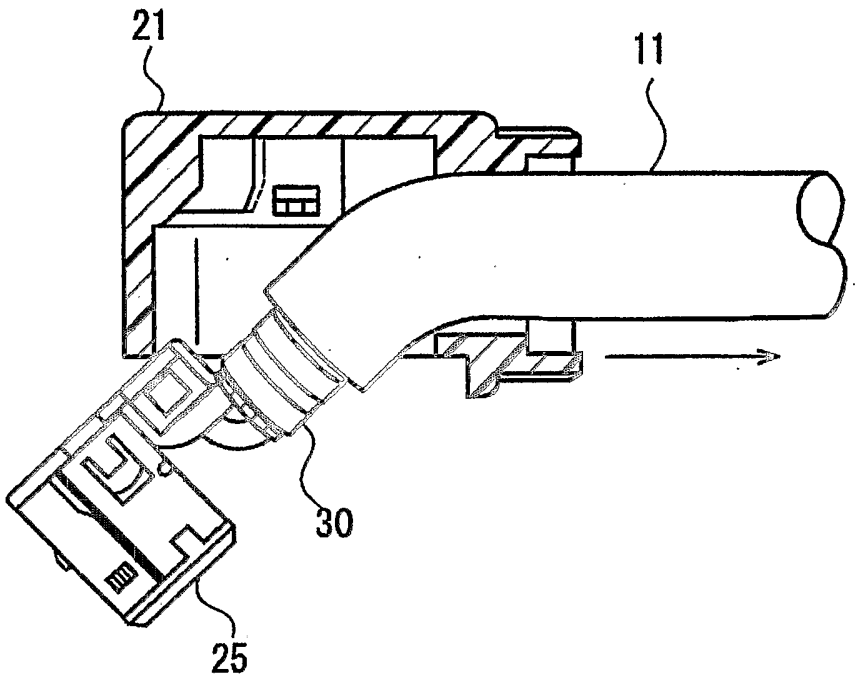


FIG. 19B

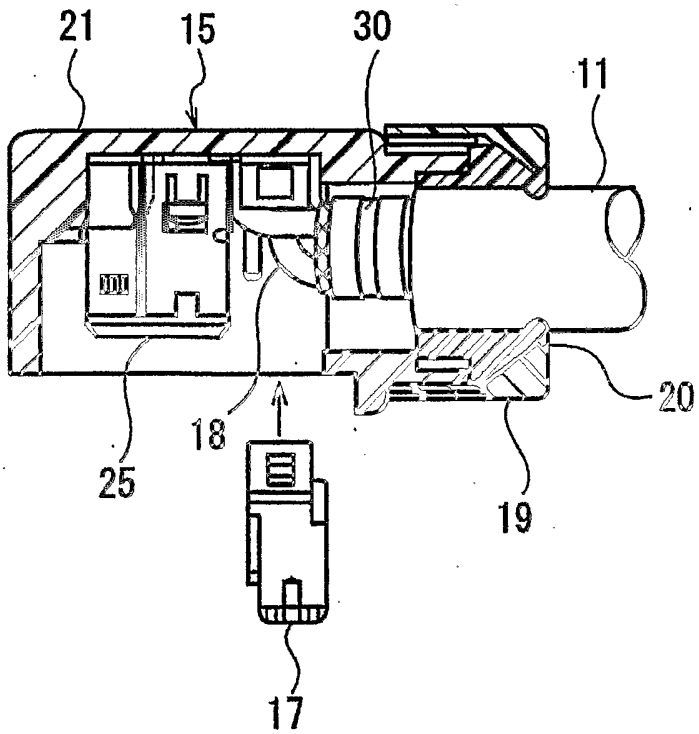
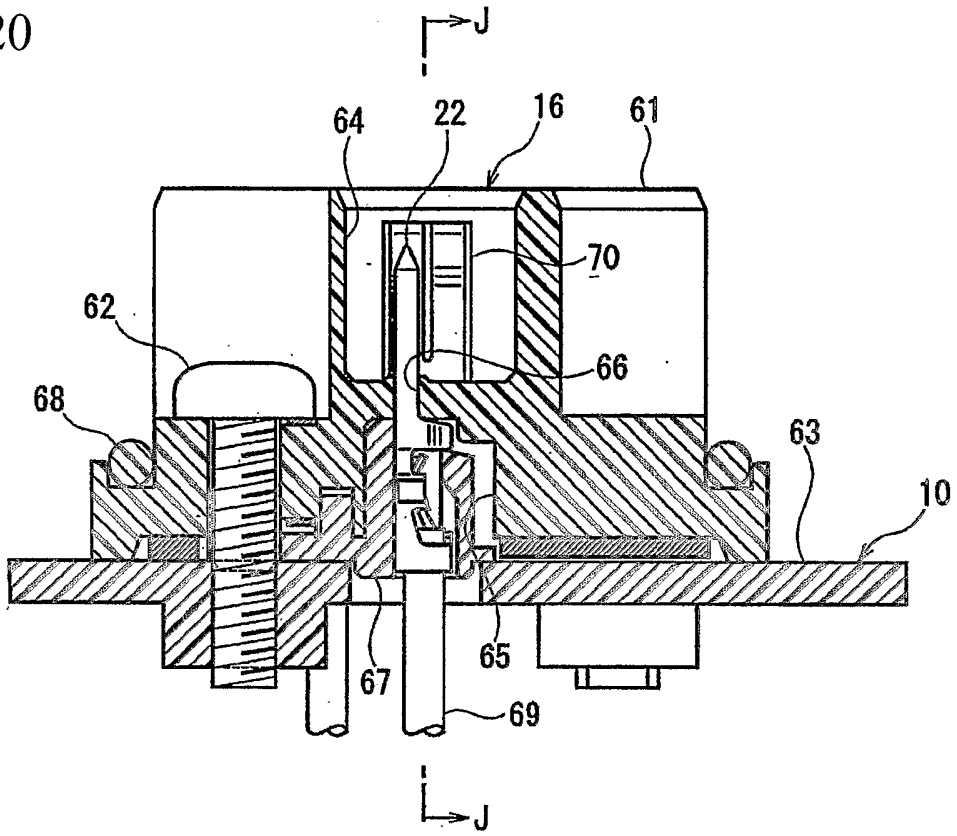


FIG. 20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J

FIG. 21

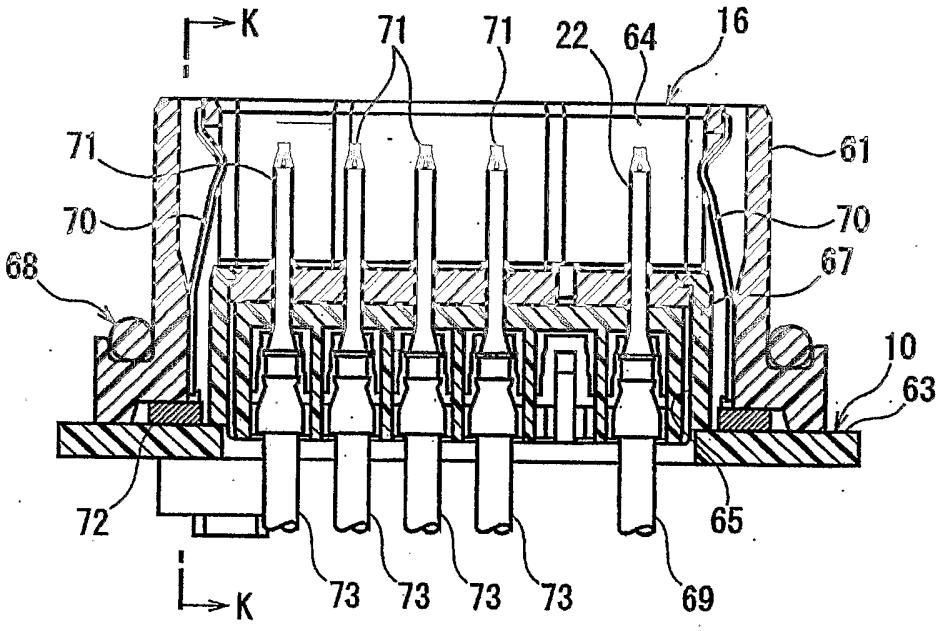
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FIG. 22

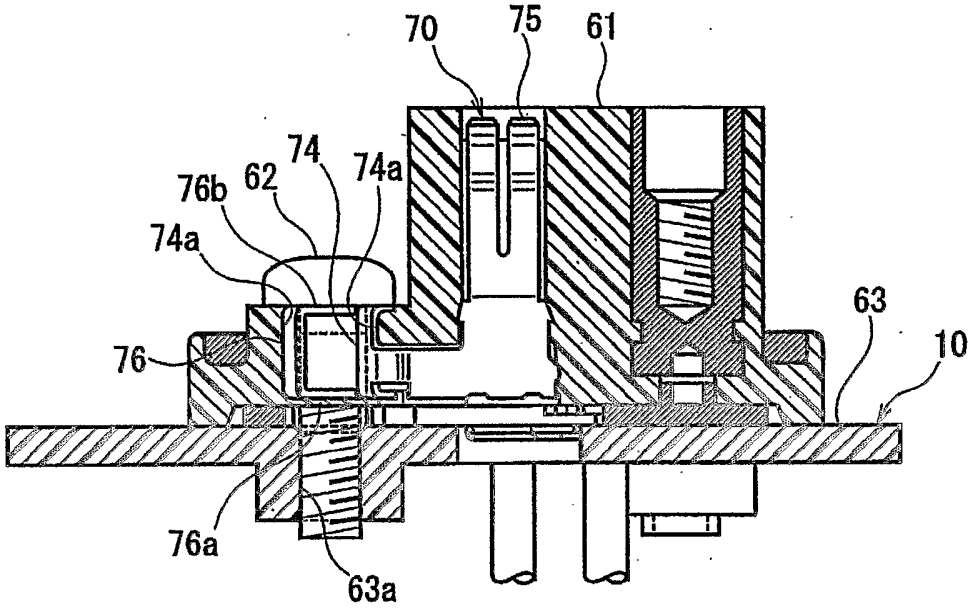


FIG. 23

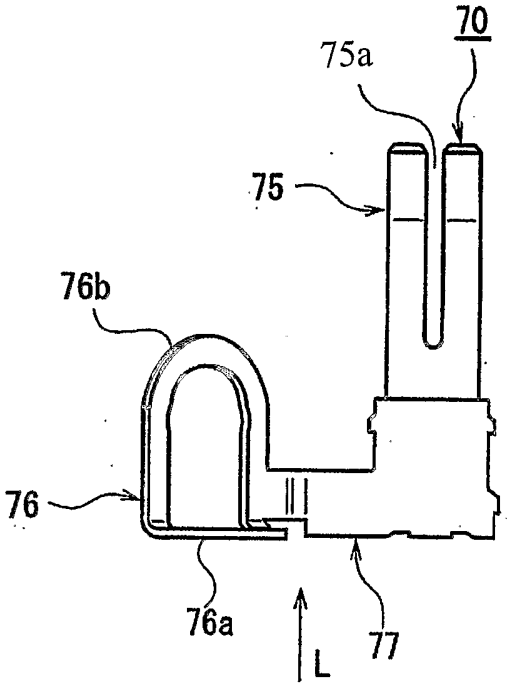
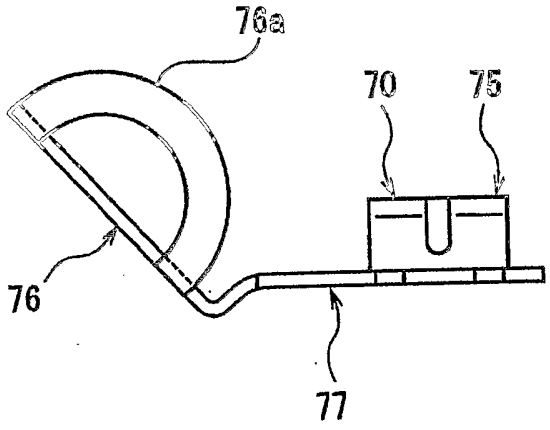


FIG. 24



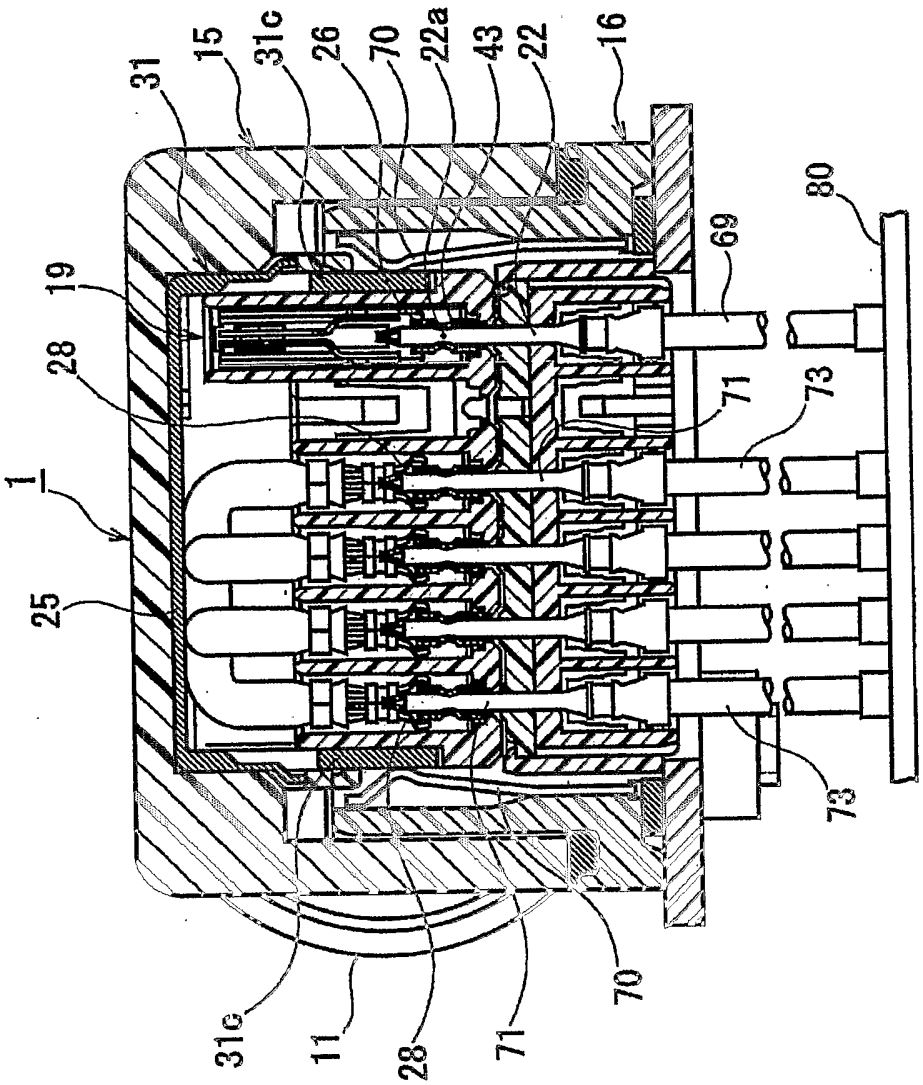


FIG. 25

FIG. 26

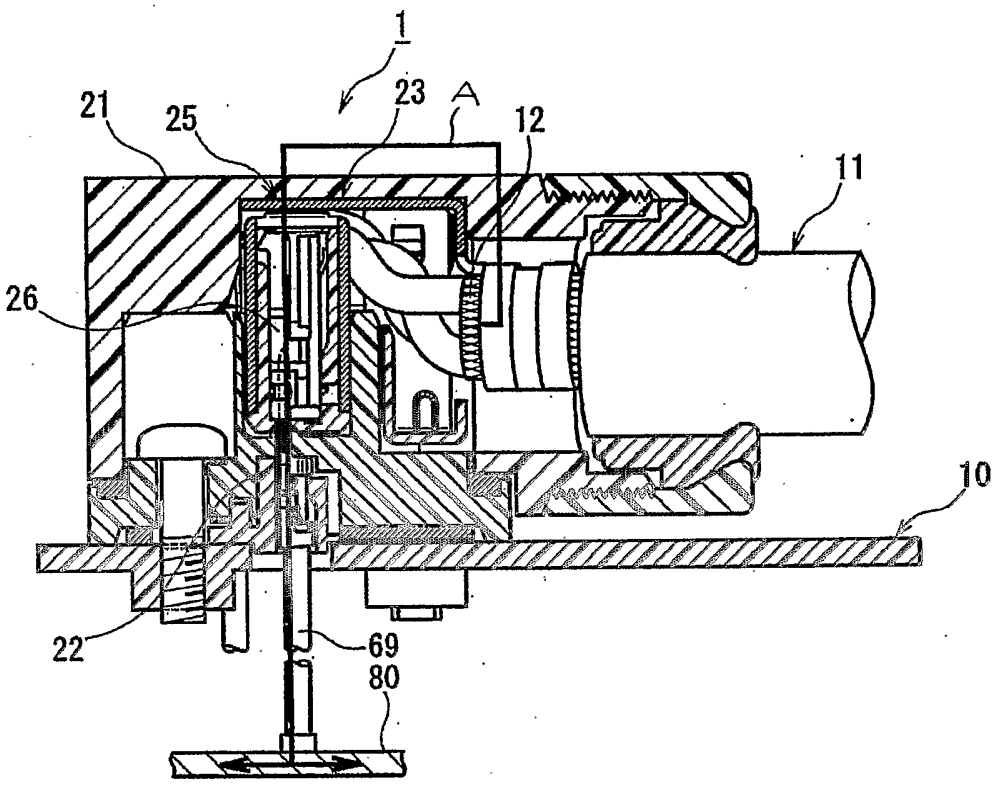


FIG. 27

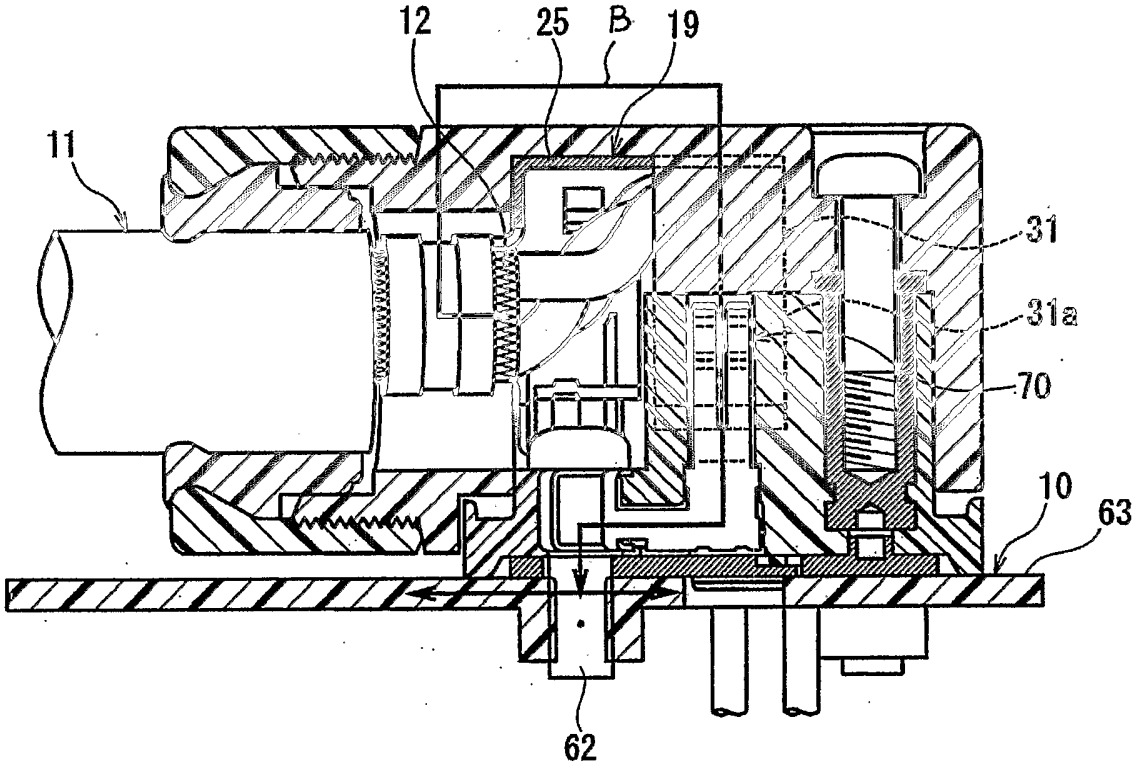


FIG. 28

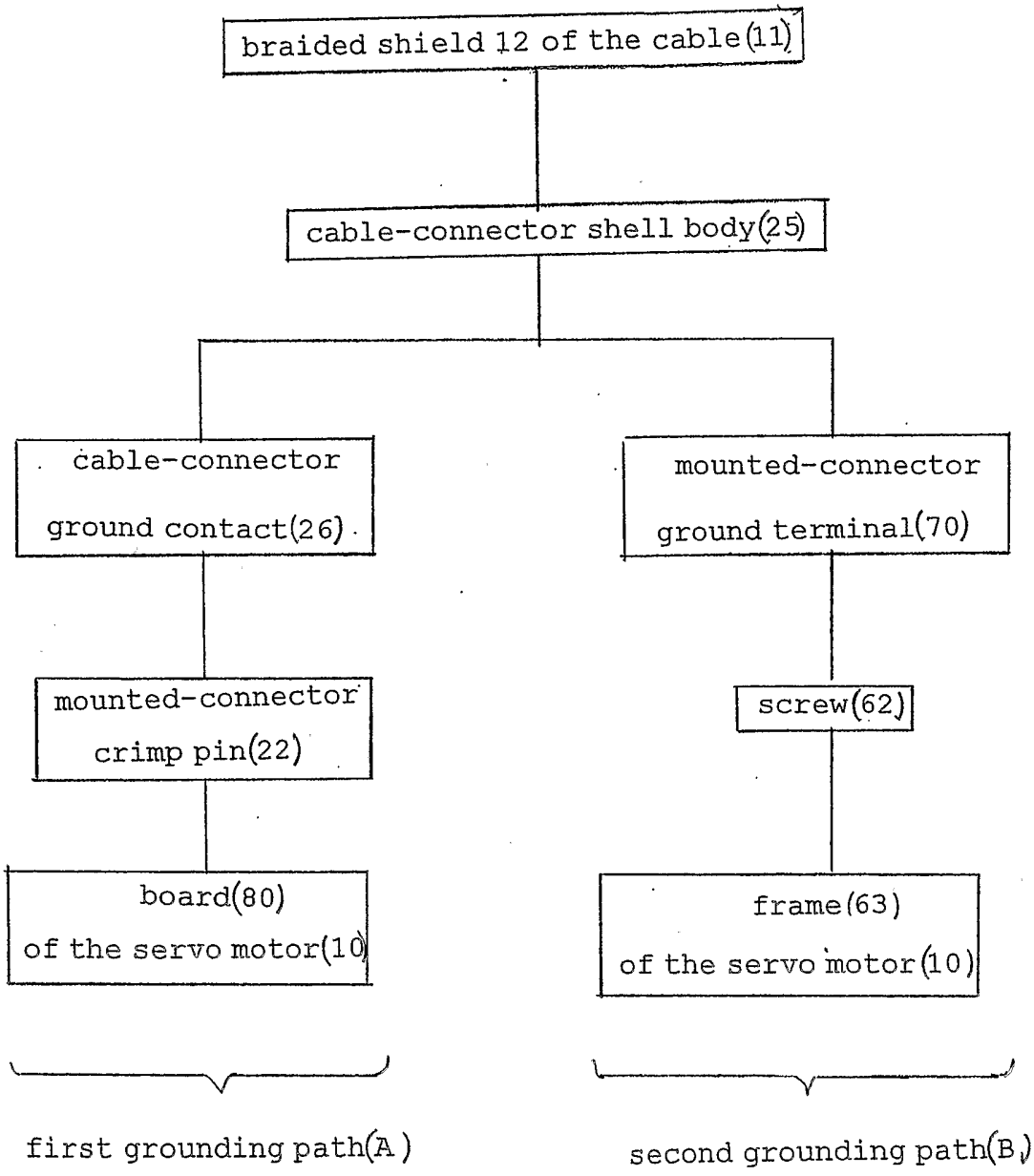
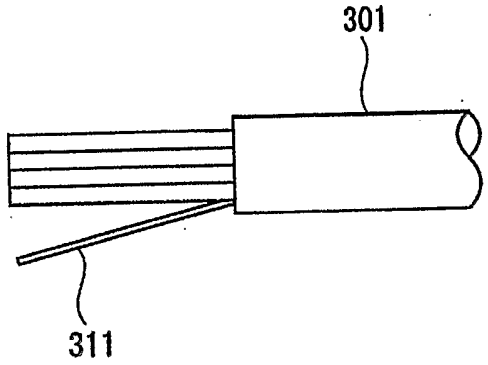
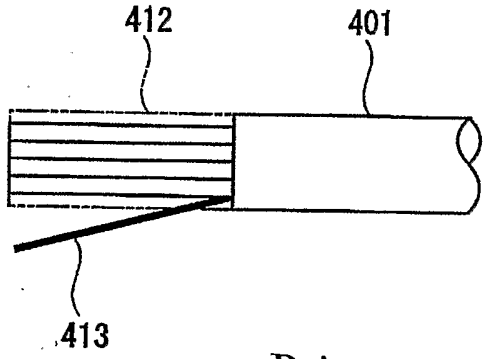

braided shield 12 of the cable(11)
cable-connector shell body(25)
cable-connector ground contact(26)
mounted-connector ground terminal(70)
mounted-connector crimp pin(22)
screw(62)
board(80) of the servo motor(10)
frame(63) of the servo motor(10)
first grounding path(A)
second grounding path(B)

FIG. 29



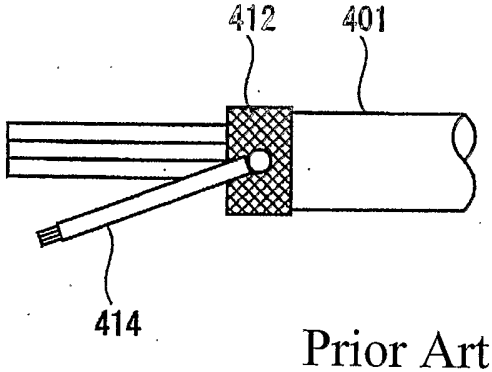
Prior Art

FIG. 30



Prior Art

FIG. 31



Prior Art