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## TUBE CONNECTION STRUCTURE

### TECHNICAL FIELD

[0001]

The present invention relates to a tube connection structure which is used for dissipating static electricity generated from friction against a fluid or powder passing through the inside thereof or an external and an object, in a tube body such as a hose or a tube, for example.

### BACKGROUND

[0002]

In the related art, as the type of the aforementioned tube connection structure, there is a structure in which a hose with a conductive wire exposed on the surface of the hose is fitted into a grounded metal pipe, a coil-shaped metallic ground member is fitted into a connection portion between the metal pipe and the hose, the ground member is brought into contact with the metal pipe and the conductive wire on the surface of the hose, and whereby the conductive wire of the hose is electrically connected to the metal pipe through the ground member. Therefore, the hose enters a grounded state (refer to, for example, Japanese Patent Publication 2002-5372).

### CITATION LIST

#### PATENT LITERATURE

[0003]

Patent literature 1: Japanese Patent Publication 2002-5372



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### SUMMARY OF THE INVENTION

#### TECHNICAL PROBLEM

[0004]

However, in such a tube connection structure of the related art, pulling-out of the hose with respect to the metal pipe is restricted by a clamping force of the ground member. However, the restricting force is weak, and thus if an external force acts on the hose in a direction to be extracted from the metal pipe in a hose connection state or the pressure (internal pressure) of a fluid or the like passing through the inside of the hose rises, there is a concern that the hose may be pulled out from the metal pipe. Therefore, there is a problem in that a fluid or the like leaks or a connection state cannot be maintained over a long period of time. Therefore, it is conceivable that a clamping band is mounted on a connection portion between the metal pipe and the hose from the outside and pulling-out of the hose fitted into the metal pipe is prevented by clamping using the clamping band. However, since clamping work of the hose by the ground member and clamping work of the hose using the clamping band are performed

separately, depending on a worker, there is a risk of forgetting any one of the work to clamp the hose by the ground member and the work to clamp the hose using the clamping band, and thus there is a problem of poor safety. Further, in the hose, a conductive wire is wound on the surface of a hose main body and a reinforcing member made of hard resin is spirally wound outside the conductive wire. However, since the conductive wire is disposed to be exposed on the outer circumference surface of the hose main body, if the tension of the conductive wire increases, for example, due to foreign matters being caught, then the conductive wire gets cut easily, and some of cut and separated conductive wires fall on the conductive wire or float in air. Therefore, since there is also a rare possibility that some of the separated conductive wires may be mixed in with other things such as a product being manufactured, in the industry such as a food factory or a pharmaceutical factory, in particular, where the handling with mixing of foreign matters into a product is difficult, a hose in which a conductive wire is exposed on the outer circumference surface of a hose main body cannot be used and static electricity prevention measures are troublesome.

[0005]

The present invention has a task to handle with such a problem and has an object to perform ground connection of a tube body while reliably connecting the tube body by a tube joint, or the like.

#### SOLUTION TO PROBLEM

[0006]

In order to achieve such an object, according to an aspect of the present invention, there is provided a tube connection structure including: a tube body with a conductive part provided on an outer surface in an axial direction; a tube joint to which one end portion of the tube body is detachably connected; and a ground member which makes the conductive part and the tube joint electrically communicate with each other, in which the tube joint has a nipple which is provided so as to oppose an inner surface of the tube body, a clamp member which is provided to compress an inserting space of the tube body put therebetween in a radial direction with respect to an outer circumference surface of the nipple, and a connecting part which is made of a conductive material and mounted so as to electrically communicate with other equipment, and the ground member is disposed over the conductive part and the connecting part so as to electrically communicate with each of the conductive part and the connecting part.

#### ADVANTAGEOUS EFFECT

[0007]

According to the present invention having the above-described features, since the

ground member is disposed over the connecting part of the tube joint made of a conductive material and the conductive part of the tube body so as to electrically communicate with each of the connecting part and the conductive part, whereby static electricity generated in the tube body flows from the conductive part to the connecting part through the ground member and is grounded from the connecting part to other equipment, thus it is possible to perform ground connection of the tube body while reliably connecting the tube body using the tube joint.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figs. 1A and 1B are explanatory diagrams showing the overall configuration of a tube connection structure according to an embodiment of the present invention, wherein Fig. 1A is a longitudinal cross-sectional front view showing a state before connection of a tube body, and Fig. 1B is a longitudinal cross-sectional front view showing a state after connection of the tube body with a tube joint.

Fig. 2 is an exploded perspective view.

Fig. 3 is an explanatory diagram (a partially cut-away front view) showing the overall configuration of a tube connection structure according to another embodiment of the present invention and shows a state after connection of the tube body with the tube joint.

Fig. 4 is an explanatory diagram (a longitudinal cross-sectional front view) showing the overall configuration of a tube connection structure according to another embodiment of the present invention and shows a state after connection of the tube body with the tube joint.

Figs. 5A and 5B are explanatory diagrams showing the overall configuration of a tube connection structure according to another embodiment of the present invention, wherein Fig. 5A is a longitudinal cross-sectional front view showing a state after connection of the tube body with the tube joint, and Fig. 5B is a perspective view of a ground member (a clip).

#### DETAILED DESCRIPTION OF EMBODIMENTS

[0009]

Hereinafter, an embodiment of the present invention will be described in detail based on the drawings. A tube connection structure A according to the embodiment of the present invention includes, as main constituent elements, a tube body 10 with a conductive part 11 provided on an outer surface 10a in an axial direction, a tube joint 20 to which one end portion of the tube body 10 is detachably connected, and a ground member 30 which makes the conductive part 11 and the tube joint 20 electrically

communicate with each other, as shown in Figs. 1A to 5B.

[0010]

The tube body 10 is, for example, a hose, a tube, or the like, which is molded using soft synthetic resin such as vinyl chloride, for example, or a soft material such as silicone rubber or other rubbers, and it is preferable that the outer surface 10a and an inner surface 10b thereof be flat. As a specific example of the tube body 10, in cases of examples shown in Figs. 1A to 5B, a spiral reinforced hose is used in which a reinforcing wire 10c made of hard synthetic resin such as a monofilament or a multifilament, for example, or metal is spirally buried between an outer layer and an inner layer which are transparent, semi-transparent, or opaque. Further, although it is not shown in the drawings as another example, it is also possible to use a laminated hose (a braided hose) in which a plurality of or a single synthetic resin braid (reinforcing thread) is spirally buried between an outer layer and an inner layer which are transparent or opaque, a spiral reinforced hose (a Fohlen hose) in which a strip-shaped reinforcing material made of synthetic resin or metal and having a rectangular cross-sectional shape or the like and a linear reinforcing material having a circular cross-sectional shape or the like are spirally wound and integrated as intermediate layers, a hose having a single-layer structure, or the like.

[0011]

It is preferable that the conductive part 11 be made of a material having excellent electric conductivity, such as conductive carbon or metal, for example, and disposed so as to be integrated with the tube body 10 by being fixed in the axial direction of the tube body 10 along the outer surface 10a of the tube body 10. As a specific example of the conductive part 11, in the examples shown in Figs. 1A to 5B, a band shape body 12 in which a conductive material such as conductive carbon is mixed in synthetic resin such as polyurethane or vinyl chloride, for example, is integrally fixed to the outer surface 10a of the tube body 10 over the entire length in the axial direction of the tube body 10 by a common fixing method such as welding or adhesion. Further, as another example, it is also possible to mold the band shape body 12 made of synthetic resin with a conductive material such as conductive carbon mixed therein along the outer surface 10a of the tube body 10 by co-extrusion.

[0012]

The tube joint 20, a portion or the entirety of a constituent member of which is formed of a conductive material, has a nipple 21 which is provided so as to oppose the inner surface 10b of the tube body 10, a clamp member 22 which is provided so as to perform compression with respect to the outer circumference surface of the nipple 21

with an inserting space 20s for the tube body 10 put therebetween in a radial direction, and a connecting part 23 which is made of a conductive material and mounted so as to electrically communicate with other equipment (not shown). The inserting space 20s for the tube body 10 is formed in a cylindrical shape between the outer circumference surface of the nipple 21 and the clamp member 22, and one end portion of the tube body 10 is detachably connected to be tucked between the clamp member 22 and the nipple 21 by compressing one end portion of the tube body 10 in a thickness direction thereof by diameter contraction means 22b (described later) according to an operation of the clamp member 22 after one end portion of the tube body 10 is inserted into the inserting space 20s. In addition, it is preferable that a sleeve 24 which is elastically deformable in the radial direction be provided between the nipple 21 and the clamp member 22, which means specifically, between the inserting space 20s and the clamp member 22, and one end portion of the tube body 10 is detachably connected to be tucked between the sleeve 24 and the nipple 21 by deforming the sleeve 24 so as to be contracted in diameter by the diameter contraction means 22b (described later) according to an operation of the clamp member 22.

[0013]

The nipple 21 is molded integrally with the tube joint 20 by using a conductive material such as metal, for example, or molded separately from the tube joint 20 by using a non-conductive material such as hard synthetic resin. For details, the nipple 21 is formed into a cylindrical shape having an outer diameter which is approximately the same as or is slightly larger than or slightly smaller than the inner diameter of the tube body 10, or formed into the form of a cylinder having a thin wall thickness and an outer diameter which is approximately the same as or is slightly larger than or slightly smaller than the inner diameter of the tube body 10 by performing press work or other molding processing on a plate material made of a deformable conductive material such as stainless steel, for example. In addition, it is preferable that a concave-convex portion for pulling-out prevention 21a which is opposed to an inner surface 10b in one end portion of the tube body 10 be formed on the outer circumference surface of the nipple 21. In the examples shown in Figs. 1A to 5B, it is preferable to form an annular concave portion at an intermediate position in the axial direction of the outer circumference surface of the nipple 21, as the concave-convex portion for pulling-out prevention 21a. Further, although it is not shown in the drawings as another example, it is also possible to form the concave-convex portion for pulling-out prevention 21a into the form of a bamboo shoot in which an annular concave portion and an annular convex portion are alternately continuous, at an intermediate position in the

axial direction of the outer circumference of the nipple 21, or form the outer circumference surface of the nipple 21 into a smooth surface.

[0014]

The clamp member 22 is formed into a substantially cylindrical shape having an inner diameter larger than the outer diameter of the tube body 10 by using a conductive material such as metal, for example, or a non-conductive material such as a hard synthetic resin and is supported so as to be able to reciprocate in the axial direction of the nipple 21 with respect to the nipple 21 side through slide means 22a. The clamp member 22 has the diameter contraction means 22b on the surface which is opposed to the outer circumference surface of the nipple 21, and the diameter contraction means 22b performs pressing in the radial direction toward the inserting space 20s for the tube body 10 by mutual movement in the axial direction with respect to the nipple 21. As a specific example of the diameter contraction means 22b, a tapered surface is formed which is gradually reduced in diameter toward a direction opposite an insertion direction of the tube body 10 (hereinafter referred to as a "tube insertion direction N"). By moving the clamp member 22 with respect to the nipple 21 in the tube insertion direction N by the slide means 22a in a state where one end portion of the tube body 10 is inserted into the inserting space 20s which is formed between the outer circumference surface of the nipple 21 and the clamp member 22, the outer circumference surface of one end portion of the tube body 10 is compressed in the wall thickness direction thereof by the tapered surface serving as the diameter contraction means 22b, and thus one end portion of the tube body 10 is pinched between the nipple 21 and the clamp member 22.

[0015]

The connecting part 23 is a member which is formed of a conductive material such as metal, for example, and detachably connected to other equipment electrically grounded, and the connecting part 23 is connected to the other equipment, whereby only the connecting part 23 or a portion or the entirety of the tube joint 20 is grounded. As a specific example of the connecting part 23, a threaded cylinder or the like for connecting the tube joint 20 to a tube connection port (not shown) of other equipment can be given. In the examples shown in Figs. 1A to 5B, an external thread is engraved as the connecting part 23 and is made so as to be screwed into an internal thread (not shown) engraved in the inner circumference surface of the tube connection port. Further, although it is not shown in the drawings as another example, in a case where an external thread is engraved in the outer circumference surface of the tube connection port, an internal thread corresponding thereto is engraved, or a change into a structure different from the threaded cylinder, or the like is possible.

[0016]

The sleeve 24 is formed into a substantially cylindrical shape having an outer diameter which is approximately the same as or smaller than the inner diameter of the clamp member 22 by using a conductive material in which, for example, conductive carbon or the like is mixed in, for example, polyacetal resin or other elastically deformable soft synthetic resin having excellent surface slip properties and heat resistance, or a non-conductive material of only soft synthetic resin, and is configured so as to be elastically deformed in a radial direction according to the movement of the clamp member 22 with respect to the nipple 21, and thus at the time of diameter contraction deformation thereof, an inner circumference surface 24a of the sleeve 24 is brought into contact with and electrically communicates with the conductive part 11 of the tube body 10.

[0017]

Describing in detail, the sleeve 24 has an elastic deformation portion 24b which is elastically deformed in the radial direction thereof so as to be expanded and contracted in diameter, and the inner diameter thereof is set to be approximately the same as or larger than the outer diameter of the tube body 10 at the time of diameter expansion and set to become smaller than the outer diameter of the tube body 10 at the time of diameter contraction. As a specific example of the elastic deformation portion 24b, a configuration is made such that diameter expansion or diameter contraction is smoothly performed by elastic deformation to expand and contract in the radial direction by forming a cutout portion such as a slot, a slit, or a dent at a portion in the axial direction of the sleeve 24, and a configuration is made such that the entirety of the sleeve 24 is deformed so as to be contracted in diameter by the tapered surface serving as the diameter contraction means 22b by the relative approach movement of the clamp member 22 with respect to the nipple 21. In the example shown in Fig. 2, the entire length in the axial direction of the sleeve 24 can be smoothly deformed so as to be expanded and contracted in diameter by cutting out and forming a plurality of slots (slits) extending linearly in the axial direction from both end portions in the axial direction of the sleeve 24, in a zigzag pattern in a circumferential direction, as the elastic deformation portion 24b. Further, although it is not shown in the drawings as another example, it is also possible to cut out and form a plurality of slots extending in the axial direction from one end portion in the axial direction of the sleeve 24, in the circumferential direction, to cut out and form a single slot over the entire length in the axial direction of the sleeve 24, or to form a slot extending in a non-linear shape such as a curved line.

[0018]

It is preferable that on the inner circumference surface 24a of the sleeve 24, an elastically deformable annular seal member 24c such as an O-ring, for example, be provided to protrude toward the inserting space 20s for the tube body 10. The seal member 24c is formed into an annular shape by using a compressively deformable material such as rubber, for example, as shown in Fig. 2, and an outer peripheral portion thereof is immovably disposed in a fitted manner or the like with respect to a mounting concave portion 24d which is formed in the inner circumference surface 24a of the sleeve 24, whereby an inner peripheral end of the seal member 24c is positioned so as to protrude toward the outer surface 10a of the tube body 10. In addition, it is preferable that the inner circumference surface of the seal member 24c be formed to be curved in a substantially arcuate cross-sectional shape and a concave groove portion 24e into which a swelled and deformed portion of the seal member 24c goes when the seal member 24c is compressively deformed be formed in the surface thereof. Further, although it is not shown in the drawings as another example, it is also possible to have the inner circumference surface 24a of the sleeve 24 to come into contact with the outer surface 10a of the tube body 10 and the conductive part 11 by smoothly forming a portion or the entirety in the axial direction in the inner circumference surface 24a of the sleeve 24 without providing the seal member 24c on the inner circumference surface 24a of the sleeve 24.

[0019]

The ground member 30 is a component made of a conductive material, which is provided as a portion of a constituent member of the tube joint 20, or a component made of a conductive material, which is provided separately from the tube body 10 or the tube joint 20, and the conductive part 11 electrically communicates with other equipment through the ground member 30 and the connecting part 23 by disposing the ground member 30 over the conductive part 11 provided on the outer surface 10a of the tube body 10 and the connecting part 23 of the tube joint 20 so as to electrically communicate with each of the conductive part 11 and the connecting part 23. In a case where, as a specific example of the ground member 30, the ground member 30 is a conductive component which is provided as a portion of the constituent member of the tube joint 20, the sleeve 24, a tubular ring 27 (described later), a press sleeve 26 (described later), or the like can be given which is provided between the nipple 21 and the clamp member 22 so as to oppose and come into contact with the conductive part 11 of the tube body 10. Further, in a case where, the ground member 30 is a conductive component which is provided separately from the tube joint 20 as a specific example of the ground member

30, a clip 31 (described later) or the like can be given which is provided so as to oppose and come into contact with the clamp member 22 and the conductive part 11 of the tube body 10.

[0020]

Therefore, according to the tube connection structure A related to the embodiment of the present invention, since the ground member 30 is disposed over the connecting part 23 of the tube joint 20 made of a conductive material and the conductive part 11 of the tube body 10 so as to electrically communicate with each of the connecting part 23 and the conductive part 11, even if static electricity is generated from friction against a fluid or powder passing through the inside of the tube body 10 or an external and an object, the static electricity flows from the conductive part 11 to the connecting part 23 through the ground member 30 and is grounded from the connecting part 23 to other equipment, and therefore, it is possible to perform ground connection of the tube body 10 while reliably connecting the tube body 10 using the tube joint 20. Therefore, static electricity generated from friction against a fluid or powder passing through the inside of the tube body 10 or an external and an object flows to other equipment, and thus occurrence of explosion or fire in which the static electricity becomes an ignition source can be prevented.

[0021]

Further, in a case where, as the conductive part 11, the band shape body 12 made of a conductive material is fixed to and integrated with the outer surface 10a of the tube body 10 in the axial direction of the tube body 10, the band shape body 12 made of a conductive material is not easily cut unlike a wire, and thus even if a worker or the like touches the band shape body 12, there is no concern that a portion thereof may be damaged and separated. Therefore, it is possible to reliably prevent the conductive part 11 from being separated. As a result, in comparison with the related art in which a conductive wire is disposed to be exposed on the outer circumference surface of a hose main body, there is no concern that some of cut and separated conductive wires may be mixed in a product such as foodstuff or medicine, and thus a use is possible particularly even in the industry such as food industry or pharmaceutical industry, in which handling with the mixing of foreign matter into a product is difficult, and sufficient static electricity prevention measures are attained. Next, each example of the present invention will be described based on the drawings.

## EMBODIMENT 1

[0022]

Embodiment 1 shows a case where the ground member 30 is the sleeve 24 made of a

conductive material, which is provided as a portion of the constituent member of the tube joint 20, the inner circumference surface 24a of the sleeve 24 is disposed to oppose the outer surface 10a of the tube body 10, and thus at the time of the connection of the tube body 10 with the tube joint 20 by an operation of the clamp member 22, the inner circumference surface 24a of the sleeve 24 is brought into contact with the conductive part 11 of the tube body 10 and the sleeve 24 is disposed so as to electrically communicate with the connecting part 23, as shown in Figs. 1A, 1B, and 2. In addition, in a case of Embodiment 1, as a material of forming the clamp member 22, it is not limited to a conductive material such as metal and it is possible to form the clamp member 22 by using a non-conductive material such as hard synthetic resin.

[0023]

The sleeve 24 has a terminal portion 24f which electrically communicates with the connecting part 23. In a case of the example shown in Figs. 1A and 1B, the terminal portion 24f is bent and formed at an end portion on the back side in the tube insertion direction N in the sleeve 24 and is tucked between a leading end surface 10d of the tube body 10 inserted along the outer circumference surface of the nipple 21 and an abutment portion 25b of a joint main body 25 (described later), whereby the terminal portion 24f is reliably electrically connected to the connecting part 23 through the joint main body 25. Further, although it is not shown in the drawings as another example, even if the terminal portion 24f is not bent and formed at the end portion on the back side in the tube insertion direction N in the sleeve 24, if the terminal portion 24f electrically communicates with the connecting part 23 through the joint main body 25 or the like, it is also possible to change the terminal portion 24f into other structures.

[0024]

The joint main body 25 is integrally formed into a tubular shape having a larger diameter than the nipple 21 and the connecting part 23 between the back side in the tube insertion direction N in the nipple 21 and the connecting part 23 by using a conductive material such as metal, for example, or is formed separately from any one or both of the nipple 21 and the connecting part 23 and is integrally mounted on the nipple 21 or the connecting part 23, thereby being made so as to electrically communicate with the connecting part 23.

[0025]

In the example shown in Figs. 1A, 1B, and 2, a tool engagement portion 25a with which a tool (not shown) such as a spanner or a wrench, for example, is engaged, the abutment portion 25b which is opposed to the leading end surface 10d of the tube body 10, and a male thread portion 25c configuring a portion of the slide means 22a of the

clamp member 22 are integrally formed at the joint main body 25. The clamp member 22 is a nut with a female thread portion engraved therein as the slide means 22a, and the female thread portion is screwed into the male thread portion 25c of the joint main body 25, whereby the clamp member 22 is supported so as to be able to reciprocate in the axial direction thereof with respect to the nipple 21 by a rotating operation of the clamp member 22.

[0026]

Then, in the example shown in Figs. 1A, 1B, and 2, the press sleeve 26 is rotatably provided between the inner circumference surface of the clamp member 22 and the outer circumference surface of the sleeve 24. The press sleeve 26 in the illustrated example is formed into a substantially cylindrical shape having an outer diameter which is approximately the same as the inner diameter of the clamp member 22 by using a non-conductive material such as hard synthetic resin, and on the inner circumference surface thereof, the tapered surface serving as the diameter contraction means 22b is formed, and at the outer circumference on the leading end side in a direction opposite the tube insertion direction N in the outer circumference surface, a locking portion 26a is formed, and the press sleeve 26 is supported so as to be able to reciprocate in the tube insertion direction N. In the clamp member 22, at a leading end inner circumference in a direction opposite the tube insertion direction N, which is opposed to the locking portion 26a of the press sleeve 26, a flange portion 22c protruding toward the inserting space 20s for the tube body 10 is formed. The locking portion 26a of the press sleeve 26 rotatably comes into sliding contact with the flange portion 22c of the clamp member 22, whereby according to the movement in the tube insertion direction N of the clamp member 22, the tapered surface serving as the diameter contraction means 22b of the press sleeve 26 interlocks in the same direction, thereby deforming the sleeve 24 so as to be contracted in diameter, and thus one end portion of the tube body 10 is tucked between the sleeve 24 and the nipple 21.

[0027]

In addition, as the tube body 10, a spiral reinforced hose made of synthetic resin in which the reinforcing wire 10c such as a monofilament spirally buried is used. Describing a specific example of a method of manufacturing the tube body 10 with the conductive part 11 provided therein in the axial direction, first, a tube body in which as the band shape body 12, a single or a plurality of conductive lines 12a with a conductive material such as conductive carbon, for example, mixed therein is formed on the entire surface in a width direction thereof or at a portion in the width direction is prepared in advance. Next, the rear surface of the band shape body 12 is stuck to the outer

surface 10a of the tube body 10 by heating and melting the outer surface 10a of the tube body 10 into a band shape by heating and melting by heating means (not shown) and bringing the band shape body 12 into contact with the outer surface 10a of the tube body 10 along the heated and melted portion by pressing means (not shown) such as a roller and at the same time, pressing the band shape body 12 with appropriate pressure.

[0028]

According to the tube connection structure A related to Embodiment 1 of the present invention, the sleeve 24 serving as the ground member 30 is deformed so as to be contracted in diameter due to the movement of the clamp member 22 with respect to the nipple 21 and thus the inner circumference surface 24a thereof is brought into contact with the conductive part 11 of the tube body 10, whereby static electricity generated in the tube body 10 flows to the connecting part 23 through the conductive part 11 and the sleeve 24 serving as the ground member 30 and is grounded. Therefore, there is an advantage that it is possible to simultaneously perform the connection of the tube body 10 to the tube joint 20 and the ground of the tube body 10. As a result, in comparison with the related art in which clamping work of a hose by a ground member and clamping work of a hose using a clamping band are separately performed, in the present invention, high pressure resistance performance and ground performance can be expected regardless of a person's connection work experience, and improvement in safety is attained.

[0029]

In particular, in a case where the clamp member 22 is supported so as to be able to reciprocate in the axial direction with respect to the nipple 21, the press sleeve 26 is rotatably provided on the inner circumference of the clamp member 22, and the tapered surface serving as the diameter contraction means 22b is formed on the inner circumference surface of the press sleeve 26. The press sleeve 26 is maintained in non-rotation by frictional resistance with the outer surface 10a of the tube body 10 regardless of the rotating operation of the clamp member 22. At the same time, the tapered surface serving as the diameter contraction means 22b in the inner circumference surface of the press sleeve 26 is circumferentially provided along the outer circumference surface of the sleeve 24 and deforms the sleeve 24 so as to be contracted in diameter. Accordingly, it is possible to smoothly perform diameter contraction without twisting the sleeve 24 by the rotating operation of the clamp member 22. Therefore, there is an advantage that there is no feeling of resistance to the rotating operation of the clamp member 22 and connection work of the tube body 10 can be easily performed.

## EMBODIMENT 2

[0030]

In Embodiment 2, as shown in Fig. 3, a configuration in which the ground member 30 is the tubular ring 27 made of a conductive material, which is provided, as a portion of the constituent member of the tube joint 20, between the clamp member 22 made of a conductive material and the sleeve 24 made of a non-conductive material, a portion of the tubular ring 27 is bent and disposed so as to oppose the outer surface 10a of the tube body 10, and at the time of the connection of the tube body 10 with the tube joint 20 by an operation of the clamp member 22, a portion of the tubular ring 27 is brought into contact with the conductive part 11 of the tube body 10 and the other portion of the tubular ring 27 is disposed so as to electrically communicate with the connecting part 23 through the clamp member 22 made of a conductive material and the joint main body 25 is different from that in Embodiment 1 shown in Figs. 1A, 1B, and 2. Other configurations are the same as those in Embodiment 1 shown in Figs. 1A, 1B, and 2. That is, Embodiment 2 uses the sleeve 24 made of a non-conductive material, rather than the sleeve 24 made of a conductive material used in Embodiment 1, and uses the clamp member 22 made of a conductive material.

[0031]

The tubular ring 27 is formed into a substantially cylindrical shape in which a leading end portion 27a thereof has an inner diameter which is approximately the same as or slightly smaller than the outer diameter of the tube body 10 and a base end portion 27b has an outer diameter which is approximately the same as the inner diameter of the clamp member 22, by using a conductive material elastically deformable in the radial direction, such as metal, for example, and the base end portion 27b is supported so as to be immovable in the axial direction of the nipple 21 with respect to the inner circumference surface of the clamp member 22, whereby the inner circumference surface of the leading end portion 27a is disposed so as to oppose and comes into contact with the conductive part 11 of the tube body 10.

[0032]

In the example shown in Fig. 3, the leading end portion 27a of the tubular ring 27 is formed so as to have an inner diameter slightly smaller than the outer diameter of the tube body 10, and a plurality of slots (slits) linearly extending in the axial direction from a leading end edge of the tubular ring 27 is cut out and formed in the circumferential direction, whereby the leading end portion 27a of the tubular ring 27 can be smoothly deformed so as to be expanded and contracted in diameter. In addition, a guide portion 27c which is gradually expanded in the radial direction toward a direction

opposite the tube insertion direction N is formed at the leading end portion 27a of the tubular ring 27, whereby according to the insertion of the tube body 10 into the inserting space 20s, the leading end surface 10d smoothly passes through without being caught, and the guide portion 27c is deformed so as to be expanded in diameter according to the insertion of the tube body 10, and thus the inner circumference surface of the leading end portion 27a is reliably brought into contact with the conductive part 11 of the tube body 10. The base end portion 27b of the tubular ring 27 is pinched between the inner circumference surface of the clamp member 22 and the outer circumference surface of the press sleeve 26 so as to be immovable in the tube insertion direction N, and the leading end portion 27a and the guide portion 27c are formed to be bent in an arcuate cross-sectional shape along the flange portion 22c of the clamp member 22 from a leading end of the base end portion 27b. Further, although it is not shown in the drawing as another example, a shape other than that in the illustrated example is also possible such as supporting the base end portion 27b of the tubular ring 27 without the press sleeve 26 by fixing the base end portion 27b of the tubular ring 27 to the inner circumference surface of the clamp member 22, or bending and forming the leading end portion 27a and the guide portion 27c into a substantially linear cross-sectional shape.

[0033]

According to the tube connection structure A related to Embodiment 2 of the present invention, the tubular ring 27 serving as the ground member 30 comes into contact with the conductive part 11 of the tube body 10 due to the movement of the clamp member 22 with respect to the nipple 21, and thus static electricity generated in the tube body 10 flows to the connecting part 23 through the conductive part 11, the tubular ring 27 serving as the ground member 30, the clamp member 22, and the joint main body 25 and is grounded. Therefore, there is an advantage that it is possible to simultaneously perform the connection of the tube body 10 to the tube joint 20 and the ground of the tube body 10, similar to Embodiment 1.

### EMBODIMENT 3

[0034]

In Embodiment 3, as shown in Fig. 4, a configuration in which the ground member 30 is the press sleeve 26 made of a conductive material, which is provided, as a portion of the constituent member of the tube joint 20, between the clamp member 22 made of a conductive material and the sleeve 24 made of a non-conductive material, the inner circumference surface of a portion of the press sleeve 26 is disposed so as to oppose the outer surface 10a of the tube body 10, and at the time of the connection of the tube body

10 with the tube joint 20 by an operation of the clamp member 22, the inner circumference surface of a portion of the press sleeve 26 is brought into contact with the conductive part 11 of the tube body 10 and the outer circumference surface of the press sleeve 26 is disposed so as to electrically communicate with the connecting part 23 through the clamp member 22 made of a conductive material and the joint main body 25 is different from that in Embodiment 1 shown in Figs. 1A, 1B, and 2. Other configurations are the same as those in Embodiment 1 shown in Figs. 1A, 1B, and 2. That is, Embodiment 3 uses the sleeve 24 made of a non-conductive material, rather than the sleeve 24 made of a conductive material used in Embodiment 1, and uses the clamp member 22 made of a conductive material.

[0035]

The press sleeve 26 in Embodiment 3 is formed into a substantially cylindrical shape in which an inner circumference surface 26b further on the leading end side than the tapered surface serving as the diameter contraction means 22b has an inner diameter which is approximately the same as or slightly smaller than the outer diameter of the tube body 10, by using a conductive material in which, for example, conductive carbon or the like is mixed in synthetic resin, or a conductive material such as metal, and is supported to be rotatable with respect to the clamp member 22, whereby the inner circumference surface 26b on the leading end side is disposed so as to oppose and come into contact with the conductive part 11 of the tube body 10.

[0036]

In the example shown in Fig. 4, the inner circumference surface 26b on the leading end side of the press sleeve 26 is formed to be approximately the same as the outer diameter of the tube body 10, and a guide portion 26c which is gradually expanded in the radial direction toward a direction opposite the tube insertion direction N is formed on the inner circumference surface of a leading end edge thereof, whereby according to the insertion of the tube body 10 into the inserting space 20s, the leading end surface 10d smoothly passes through without being caught, and thus the inner circumference surface 26b on the leading end side reliably comes into contact with the conductive part 11 of the tube body 10. Further, although it is not shown in the drawing as another example, a shape other than that in the illustrated example is also possible such as forming the inner circumference surface 26b on the leading end side of the press sleeve 26 so as to be slightly smaller than the outer diameter of the tube body 10, to come into contact with the conductive part 11 of the tube body 10 reliably, or forming a locking portion which rotatably comes into sliding contact with the flange portion 22c of the clamp member 22, at the press sleeve 26, similar to Embodiment 1 or Embodiment 2.

[0037]

According to the tube connection structure A related to Embodiment 3 of the present invention, the press sleeve 26 made of a conductive material, which serves as the ground member 30, comes into contact with the conductive part 11 of the tube body 10 due to the movement of the clamp member 22 with respect to the nipple 21, and thus static electricity generated in the tube body 10 flows to the connecting part 23 through the conductive part 11, the press sleeve 26 made of a conductive material, which serves as the ground member 30, the clamp member 22, and the joint main body 25 and is grounded. Therefore, there is an advantage that it is possible to simultaneously perform the connection of the tube body 10 to the tube joint 20 and the ground of the tube body 10, similar to Embodiment 1.

#### EMBODIMENT 4

[0038]

In Embodiment 4, as shown in Figs. 5A and 5B, a configuration in which the ground member 30 is the clip 31 made of a conductive material, which is provided separately from the tube joint 20, the clip 31 is wound along the outer surface 10a of the tube body 10, and a portion of the clip 31 is disposed so as to come into contact with the clamp member 22 made of a conductive material, and at the time of the connection of the tube body 10 with the tube joint 20 by an operation of the clamp member 22, the inner circumference surface of the clip 31 comes into contact with the conductive part 11 of the tube body 10 and a portion of the clip 31 is disposed so as to electrically communicate with the connecting part 23 through the clamp member 22 made of a conductive material and the joint main body 25 is different from that in Embodiment 1 shown in Figs. 1A, 1B, and 2. Other configurations are the same as those in Embodiment 1 shown in Figs. 1A, 1B, and 2.

[0039]

The clip 31 is formed by bending a conductive material such as a metal wire, for example, and has a ring portion 31a which is formed into a ring shape which is approximately the same as or slightly smaller than the outer diameter of the tube body 10, along the outer surface 10a of the tube body 10, and a linear terminal portion 31b extending in the axial direction of the clamp member 22 along the inner circumference surface of the clamp member 22, and the ring portion 31a is mounted along the outer surface 10a of the tube body 10 such that the inner circumference surface thereof is opposed to and comes into contact with the conductive part 11, whereby the linear terminal portion 31b is disposed so as to come into contact with the outer circumference surface of the clamp member 22.

[0040]

In the example shown in Figs. 5A and 5B, the ring portion 31a is formed by winding a central site of a metal wire by two or more turns in the circumferential direction along the outer surface 10a of the tube body 10, a pair of knob operation portions 31c which deforms the ring portion 31a so as to be expanded and contracted in diameter is continuously formed by bending an intermediate site of each of two metal wires protruding from the ring portion 31a into a ring shape in the axial direction of the tube body 10, and a pair of linear terminal portions 31b is continuously formed by extending both end sites of the metal wires in the axial direction of the tube body 10 in a linear fashion approximately parallel to the outer surface 10a. Further, although it is not shown in the drawing as another example, a shape other than that in the illustrated example is also possible such as extending a leading end of the nipple 21 to a mounting position of the clip 31 such that the tube body 10 is disposed so as to be tucked between a leading end site of the nipple 21 and the ring portion 31a of the clip 31, or changing the shape of the terminal portion 31b or the knob operation portion 31c.

[0041]

According to the tube connection structure A related to Embodiment 4 of the present invention, even in a separate process from a process of connecting the tube body 10 to the tube joint 20, the clip 31 made of a conductive material, which serves as the ground member 30, is wound on the outer surface 10a of the tube body 10, and thus the inner circumference surface of the ring portion 31a is disposed so as to come into contact with the conductive part 11 and the linear terminal portions 31b are disposed so as to come into contact with the outer circumference surface of the clamp member 22, whereby static electricity generated in the tube body 10 flows to the connecting part 23 through the conductive part 11, the clip 31 made of a conductive material, which serves as the ground member 30, the clamp member 22, and the joint main body 25 and is grounded. Therefore, there is an advantage that it is possible to perform ground connection of the tube body 10 without improving the tube joint 20.

[0042]

In addition, in the illustrated examples, as the slide means 22a which moves the clamp member 22 with respect to the nipple 21 in the axial direction, the female thread portion and the male thread portion 25c which are screwed to each other are formed. However, the slide means 22a is not limited thereto. If it is possible to move the clamp member 22 with respect to the nipple 21 in the axial direction, then a structure other than a screw is also acceptable.

Explanation of References

[0043]

10 tube body

10a outer surface

10b inner surface

11 conductive part

12 band shape body

20 tube joint

20s inserting space for tube body

21 nipple

22 clamp member

23 connecting part

24 sleeve

24a inner circumference surface

30 ground member

N insertion direction of tube body (tube insertion direction)

## Claims

### [Claim 1]

A tube connection structure comprising:

a tube body with a conductive part provided on an outer surface in an axial direction;

a tube joint to which one end portion of the tube body is detachably connected; and

a ground member which makes the conductive part and the tube joint electrically communicate with each other,

wherein the tube joint has a nipple which is provided so as to oppose an inner surface of the tube body, a clamp member which is provided to compress an inserting space of the tube body put therebetween in a radial direction with respect to an outer circumference surface of the nipple, and a connecting part which is made of a conductive material and mounted so as to electrically communicate with other equipment, and

the ground member is disposed over the conductive part and the connecting part so as to electrically communicate with each of the conductive part and the connecting part.

### [Claim 2]

The tube connection structure according to Claim 1, wherein the clamp member is supported so as to be movable in an insertion direction of the tube body with respect to the nipple, a sleeve which is opposed to the outer surface of the tube body is provided, as the ground member, between the clamp member and the nipple so as to electrically communicate with the connecting part, and

the sleeve is formed of a conductive material so as to be elastically deformed in a radial direction according to movement of the clamp member with respect to the nipple, and at the time of diameter contraction deformation thereof, an inner circumference surface of the sleeve comes into contact with and electrically communicates with the conductive part.

### [Claim 3]

The tube connection structure according to Claim 1 or 2, wherein as the conductive part, a band shape body made of a conductive material is fixed to and integrated with the outer surface of the tube body in the axial direction of the tube body.