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ENDOSCOPE AND METHOD FOR CONFIRMING GROUNDING OF ENDOSCOPE

Abstract

An endoscope can include an internal member provided at a distal end of an insertion portion a conductive external member fitted over the internal member and electrically connected to a ground. The endoscope can also include an image pickup instrument fixed to the internal member, and the image pickup instrument can include a lens. The endoscope can include an electrical connection part having a first end portion connected to the conductive member and a second end portion connected to the external member, the electrical connection part being configured to electrically connect the conductive member and the external member, a conductor wire including a third end portion electrically connected to the first end portion, and a fourth end portion that passes through an opening formed in the external member.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION [0001] This application is a continuation of U.S. application Ser. No. 17/519,281 filed on Nov. 4, 2021 which in turn is a continuation application of PCT/J P2019/018297 filed on May 7, 2019, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION
1. Field of the Invention
[0002] The present invention relates to an endoscope with an image pickup instrument mounted on a non-conductive frame component provided at a distal end portion of an insertion portion, and more specifically, to an endoscope configured to confirm electrical continuity of grounding of an image pickup instrument and a method for confirming grounding of an endoscope.
2. Description of the Related Art
[0003] As is well known, endoscopes are widely used for observation, treatment or the like of a living body (inside of a body cavity) or inspection, repair or the like of an inside of industrial plant equipment. Such endoscopes are provided with insertion portions for inserting into bent conduits.
[0004] As such an endoscope, a configuration with an image pickup instrument provided at a distal end portion of the insertion portion is known. In order to prevent static electricity, high frequency current or the like applied to the distal end portion from flowing to the image pickup instrument and causing a defect, the endoscope needs to allow the static electricity, high frequency current or the like to escape to the ground (GND) of the apparatus.
[0005] Leakage of static electricity or high frequency when a distal end rigid member is formed of an insulator is realized together with a diameter reduction of the distal end portion.
[0006] For example, International Publication No. 2012-124526 discloses an endoscope including a frame member of an observation optical system included in an insulating distal end rigid portion provided at an insertion portion and a connector member connected to a ground, in which a grounding metal member forming a structure of the insertion portion and a conductive connection part are connected in order from the connector member side.
[0007] As described in International Publication No. 2012-124526, when the distal end portion of the insertion portion is formed of an insulating member, as a method for grounding the image pickup instrument, it is necessary to electrically connect an exterior metal of the image pickup instrument and the ground (GND) of the endoscope via a conductor.
SUMMARY
[0008] An endoscope can include an internal member provided at a distal end of an insertion portion a conductive external member fitted over the internal member and electrically connected to a ground. The endoscope can also include an image pickup instrument fixed to the internal member, and the image pickup instrument can include a lens. The endoscope can include an electrical connection part having a first end portion connected to the conductive member and a second end portion connected to the external member, the electrical connection part being configured to electrically connect the conductive member and the external member, a conductor wire including a third end portion electrically connected to the first end portion, and a fourth end

portion that passes through an opening formed in the external member.
[0009] An endoscope can also include an internal member provided at a distal end of an insertion portion, a conductive external member including an opening, fitted over the internal member and electrically connected to a ground that serves as an electrical reference, an image pickup instrument held to the internal member, a conductive member provided at the image pickup instrument, an electrical connection part configured to electrically connect the conductive member and the external member, and a conductor wire electrically connected to the conductive member, in which the opening is formed and a part of the conductor wire can pas through the opening.
[0010] A method for confirming grounding of an endoscope can employ an endoscope including an internal member provided at a distal end of an insertion portion, a conductive external member fitted over the internal member and electrically connected to a ground that serves as an electrical reference, an image pickup instrument fixed to the internal member, a conductive member provided at the image pickup instrument, an electrical connection part having a first end portion connected to the conductive member and a second end portion connected to the external member, the second end portion being on an opposite side of the first end portion, the electrical connection part being configured to electrically connect the conductive member and the external member, a conductor wire having one end electrically connected to the first end portion, and an opening formed in the external member with the internal member fitted in the external member and configured to lead in/out another end portion of the conductor wire. The method for confirming grounding of the endoscope can include sandwiching the second end portion of the electrical connection part between an outer surface of the internal member and an inner surface of the external member and fitting the internal member into the external member so that the other end of the conductor wire is led out from the opening, applying a tester to the other end of the conductor wire and the external member, and conducting a continuity test between the image pickup instrument and the external member with the electrical connection part and a step of accommodating the conductor wire through the opening in the external member after the continuity test.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0011] FIG. **1** is a diagram illustrating an appearance of an endoscope according to an exemplary embodiments;
[0012] FIG. **2** is a perspective view illustrating a configuration of a distal end portion of an insertion portion of the endoscope according to the aspect of the present invention;
[0013] FIG. **3** is a cross-sectional view illustrating a configuration of the distal end portion of the insertion portion of the endoscope according to exemplary embodiments;
[0014] FIG. **4** is an exploded perspective view illustrating a distal end rigid portion fitted in a most distal end bending piece of the endoscope according to exemplary embodiments;
[0015] FIG. **5** is a perspective view illustrating the distal end rigid portion fitted in the most distal end bending piece of the endoscope according exemplary embodiments; and
[0016] FIG. **6** is a diagram illustrating the distal end rigid portion fitted in the most distal end bending piece, continuity of which is tested using a tester, of the endoscope according to exemplary embodiments.
DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS
[0017] Note that in the following description, drawings based on each embodiment are schematic ones and a thickness-width relationship among components and thickness ratios among the components are different from the actual relationships and ratios, and there are cases where dimensional relationships and ratios differ among drawings.
[0018] The endoscope according to exemplary embodiments is an endoscope, an insertion portion

of which has a small diameter, such as a bronchoscope or a uroscope. However, without being limited to this, the invention is also applicable to a so-called flexible scope, an insertion portion of which is flexible so as to be inserted into an upper or lower digestive organ or a so-called rigid endoscope, an insertion portion of which is rigid, so as to be used for surgery.

[0019] Hereinafter, an endoscope according to an aspect of the present invention will be described based on the accompanying drawings.

[0020] As illustrated in FIG. **1**, an endoscope **1**, which is an electronic endoscope of the present embodiment, is mainly constructed of an insertion portion **2** formed in an elongated tubular shape, an operation portion **3** connected to a proximal end of the insertion portion **2**, a universal cord **4**, which is an endoscope cable that extends from the operation portion **3** and an endoscope connector **5** or the like disposed at a distal end of the universal cord **4**.

[0021] The insertion portion **2** is a flexible tubular member formed by connecting a distal end portion **6**, a bending portion **7** and a flexible tube portion **8** in order from a distal end side. Of the components, the distal end portion **6** accommodates and disposes an image pickup instrument, which is an image pickup apparatus incorporating image pickup means and which will be described later, and illumination means or the like.

[0022] The bending portion **7** is a mechanical part configured to allow the insertion portion **2** to be actively bent in two directions, up and down (UP-DOWN) by rotating operation of a bending lever **13** among operation members of the operation portion **3**.

[0023] Note that the bending portion **7** is not limited to a type of bending portion that is actively bent in two directions, up and down, but may also be a type of bending portion that can be bent in four directions including left and right directions in addition to the up and down directions (in all directions around the axis, UP-DOWN/LEFT-RIGHT through up-down, left-right operations) or may be a type of bending portion that can be bent only in one (UP) direction or may be a type of bending portion that is simply passively bent without having any mechanism to actively bend the bending portion by the bending lever **13**.

[0024] The flexible tube portion **8** is a tubular member formed with flexibility so as to be passively made flexible. In addition to a treatment instrument insertion channel, which will be described later, a signal cable bundle, which will be described later, and extends from the image pickup apparatus incorporated in the distal end portion **6** and further extends from the operation portion **3** to the inside of the universal cord **4**, and a light guide bundle, which will be described later, and guides illumination light from a light source apparatus to be emitted from the distal end portion **6**, and the like are inserted through the flexible tube portion **8** (none of the above-described components is shown here).

[0025] The operation portion **3** is constructed of a bend preventing portion **9** provided on a distal end side and connected to the flexible tube portion **8** by covering a proximal end of the flexible tube portion **8**, a grasping portion **10** connected to the bend preventing portion **9** and grasped by the user's hand when using the endoscope **1**, operation means for operating various endoscope functions provided on an outer surface of the grasping portion **10**, a treatment instrument insertion portion **11** and a suction valve **15** and the like.

[0026] Examples of the operation means provided in the operation portion **3** include the bending lever **13** that performs bending operation of the bending portion **7** and a plurality of operation members **14** for performing operations corresponding to air/water feeding operation or suction operation, image pickup means, illumination means and the like.

[0027] The treatment instrument insertion portion **11** is a component provided with a treatment instrument insertion port through which various treatment instruments (not shown) are inserted and configured to communicate with the treatment instrument insertion channel (not shown) inside the operation portion **3** via a branching member.

[0028] The treatment instrument insertion portion **11** is provided with a forceps plug **12**, which is a lid member to open/close the treatment instrument insertion port and configured to be

attachable/detachable (replaceable) to/from the treatment instrument insertion portion **11**. Note that the treatment instrument insertion channel is configured to also communicate with the suction valve **15** by the branching member inside the operation portion **3**.

[0029] The universal cord **4** is a composite cable through which a signal cable bundle, a light guide bundle configured to transmit illumination light from a light source apparatus (not shown), and the like are inserted. The signal cable bundle, the light guide bundle, and the like are passed from the distal end portion **6** of the insertion portion **2** to the endoscope connector **5** via the operation portion **3** and the universal cord **4**.

[0030] The endoscope connector **5** includes an electric connector portion **16** to which a signal cable for connection with a video processor (not shown) as an external device is connected on a side surface, a light source connector portion **17** to which a light guide bundle, which will be described later, for connection with the light source apparatus as an external device and an electric cable (not shown) are connected and an air/water feeding plug **18** to connect an air/water feeding tube (not shown) from an air/water feeding apparatus (not shown) as an external device or the like.

[0031] Here, a configuration of a distal end portion of the insertion portion **2** of the endoscope **1** of the present embodiment will be described based on FIG. **2** and FIG. **3**. Note that description of a well-known configuration of the insertion portion **2** is omitted.

[0032] As illustrated in FIG. **2**, the distal end portion **6** of the insertion portion **2** is provided with a distal end rigid portion **20** as an internal member, which is a frame component of an insulating non-conductive substantially columnar block body provided with an observation window **21**, illumination windows **22** and a channel opening portion **23**. The distal end rigid portion **20** is covered with curved rubber **25** from the middle to the proximal end side and the distal end of the curved rubber **25** is fixed by a thread winding adhesive part **24**.

[0033] At the distal end portion **6**, as illustrated in FIG. **3**, an image pickup instrument **30** is fitted in a fitting hole **28** formed in the distal end rigid portion **20**. The image pickup instrument **30** is fixed to the distal end rigid portion **20** with a filler **36** such as an adhesive.

[0034] The image pickup instrument **30** includes two lens frames **31** and **32**, which are conductive parts made of conductive metals or the like configured to hold an objective lens group **33** including the observation window **21**. The image pickup instrument **30** also includes a thermal contraction tube **34** configured to cover an element frame (not shown) provided with a solid image pickup device such as a CCD or CM OS and a drive circuit board together with a proximal end outer peripheral portion of the lens frame **32** on the proximal end side.

[0035] An image pickup cable **35** extends from the thermal contraction tube **34** on the proximal end side. Note that the inside of the thermal contraction tube **34** is filled with an adhesive or the like for watertightness.

[0036] A distal end of a jumper wire **50** as an electrical connection part and a core wire on a distal end side of an insulating cable **54** of a coated conductor wire with an insulating outer shell such as an enameled wire or vinyl-coated wire as a tester cable are electrically connected to the lens frames **31** and **32** of the image pickup instrument **30** by means of an electric connection part **55** such as solder.

[0037] The proximal end portion of the jumper wire **50** is electrically connected to a most distal end bending piece **41** as an external member, which is a conductive and annular exterior member, fitted over an outer peripheral portion **26** on the proximal end side of the distal end rigid portion **20**.

[0038] Thus, a configuration of conduction is provided such that a current (charge) applied to the lens frames **31** and **32** flows to the jumper wire **50** and the bending piece **41**.

[0039] The jumper wire **50** is held with the proximal end portion of the jumper wire **50** sandwiched between the outer peripheral portion **26**, which is an outer surface of the distal end rigid portion **20**, and an inner surface **42** of the most distal end bending piece **41**. Thus, the jumper wire **50** is electrically conducted to the bending piece **41** and the lens frames **31** and **32** of the image pickup instrument **30** are electrically connected via the jumper wire **50**.

[0040] Note that the proximal end of the insulating cable **54** is accommodated inside the insertion portion **2**.
[0041] The bending piece **41** is made up of a plurality of pieces connected together and axially supported by a pivotally supporting part **43** so as to be rotatable with each other. Bending operations of the plurality of bending pieces **41** are performed by pulling/relaxing the bending operation wires **44** and **45** through operation of the bending lever **13**.
[0042] Thus, the plurality of bending pieces **41** are caused to rotate around the pivotally supporting part **43**, and the bending portion **7** is thereby bent. Note that the bending operation wires **44** and **45** are fixed to or inserted into or held to wire guides **46** provided on the inner surface side of the plurality of bending pieces **41**.
[0043] The plurality of bending pieces **41** are electrically conducted to each other and connected so that the most proximal end bending piece **41** is electrically conducted to a metal braid (not shown) of the flexible tube portion **8**. Note that the metal braid of the flexible tube portion **8** is also electrically conducted to the endoscope connector **5** via a metallic frame of the operation portion **3** and the universal cord **4**.
[0044] The endoscope connector **5** is connected to an external device, and a patient ground (GND), which is used as an electrical reference for the endoscope, is electrically conducted to the image pickup instrument **30**.
[0045] In other words, the endoscope **1** is configured such that an electrically conductive path of a ground (GND) is formed from the bending pieces **41** through the metal braid of the flexible tube portion **8**, the frame of the operation portion **3**, the universal cord **4** to the endoscope connector **5**, and the endoscope connector **5** is connected to the external device and grounded.
[0046] Thus, the image pickup instrument **30** fitted in the non-conductive distal end rigid portion **20** is also inserted via the jumper wire **50** electrically connected to the most distal end bending piece **41**, thus providing a configuration in which the endoscope connector **5** is connected to the external device and grounded.
[0047] Note that an opening **51**, which is an electrical connection part cut hole partially cut out from an end portion on the distal end side on which the distal end opening **47** (see FIG. **4**) is provided toward a proximal end is formed in the most distal end bending piece **41** in which the distal end rigid portion **20** is fitted as illustrated in FIG. **4** and FIG. **5**. The opening **51** exposes part of an outer circumferential surface of the distal end rigid portion **20**.
[0048] As illustrated in FIG. **5**, the opening **51** includes a linear groove portion **52** cut out from the distal end opening **47** at an end portion of the bending piece **41** toward the proximal end and a triangular electrical connection part cut portion **53** that communicates with the groove portion **52**.
[0049] Furthermore, a notch **56** having a predetermined length cut out from the distal end opening **47** toward the proximal end is formed in the most distal end bending piece **41** in which the distal end rigid portion **20** is fitted. The notch **56** is intended to lead out the insulating cable **54** from the most distal end bending piece **41**.
[0050] While the distal end rigid portion **20** is fitted in the most distal end bending piece **41**, the notch **56** is set to a predetermined length larger than the length of the proximal end of the distal end rigid portion **20**.
[0051] In other words, the notch **56** is set to the predetermined length, which is longer than the length of the part of the distal end rigid portion **20** fitted in the most distal end bending piece **41** so that a cable outlet of an opening from which the insulating cable **54** is led out is formed.
[0052] Note that the configuration in which the insulating cable **54** is led out need not necessarily be cut out from the distal end opening **47** of the most distal end bending piece **41**, but a cable outlet having a hole shape to lead out the insulating cable **54** may be formed in the outer peripheral portion of the most distal end bending piece **41** that does not overlap the fitting part of the distal end rigid portion **20**.
[0053] Here, as illustrated in FIG. **4** and FIG. **5**, a configuration in which the distal end rigid

portion **20** is fitted in the most distal end bending piece **41** and the jumper wire **50** that extends out of the opening **51** is cut will be described.

[0054] When the distal end rigid portion **20** is fitted into the most distal end bending piece **41**, as illustrated in FIG. **4**, the jumper wire **50** is passed from the groove portion **52** of the opening **51** of the bending piece **41** into the electrical connection part cut portion **53**.

[0055] Note that since the jumper wire **50** can be passed into the electrical connection part cut portion **53** of the opening **51** of the bending piece **41**, there may be no necessity for the groove portion **52** that communicates between the distal end opening **47** of the bending piece **41** and the opening **51**.

[0056] As illustrated in FIG. **5**, the distal end rigid portion **20** is fitted into the most distal end bending piece **41**. At this time, the jumper wire **50** is sandwiched and fixed between the outer peripheral portion **26**, which is the outer surface of the distal end rigid portion **20** and the inner surface **42** of the most distal end bending piece **41**, and led out from the electrical connection part cut portion **53** of the opening **51**.

[0057] An extra portion of the jumper wire **50** that extends out of the electrical connection part cut portion **53** is cut using a cutting tool (not shown) such as a design knife so that the jumper wire **50** fits in the electrical connection part cut portion **53** as illustrated in FIG. **6**.

[0058] In other words, when the distal end rigid portion **20** is fitted into the most distal end bending piece **41**, the jumper wire **50** connected to the lens frames **31** and **32**, which are conductive portions of the image pickup instrument **30**, is configured to be sandwiched between the distal end rigid portion **20** and the bending piece **41** so that the jumper wire **50** can be electrically connected to the conductive bending piece **41** easily and reliably.

[0059] Thus, in the endoscope **1**, even when static electricity, a high frequency current or the like generated from a treatment instrument or the like is applied to the distal end portion **6** of the insertion portion **2** where the non-conductive distal end rigid portion **20** is provided and flows to the lens frames **31** and **32** of the image pickup instrument **30**, the high frequency current or the like is dropped from the jumper wire **50** to the ground (GND) via the bending piece **41**.

[0060] In other words, a charge generated in the distal end portion **6** flows to the lens frames **31** and **32**, and is leaked from the jumper wire **50** to the ground (GND) via the bending piece **41**. Therefore, the image pickup instrument **30** of the endoscope **1** can prevent defects caused by static electricity, high frequency current or the like.

[0061] Therefore, the endoscope **1** is configured to have a simple structure in which in order to ground the image pickup instrument **30**, a neighboring portion at one end of the jumper wire **50**, which is a conductive wire, is sandwiched between the distal end rigid portion **20**, which is a distal end frame component that insulates the image pickup instrument **30** from outside, and the bending piece **41**, which is an exterior member connected to the ground (GND).

[0062] Note that the distal end rigid portion **20** is preferably non-conductive, but without being limited to this, the distal end rigid portion **20** may be conductive as well.

[0063] The distal end rigid portion **20** is fitted into the most distal end bending piece **41**, and one tester rod **101** of a tester **100** is applied to a conductor wire **54***a* such as a copper wire stripped of coating such as enamel, sheath from the lead out end portion of the insulating cable **54** led out of the notch **56** formed in the most distal end bending piece **41**. On the other hand, another tester rod **102** of the tester **100** is applied to the outer peripheral portion of the most distal end bending piece **41**, and a continuity test between the image pickup instrument **30** and the most distal end bending piece **41** is conducted.

[0064] In other words, the image pickup instrument **30** is electrically connected to the most distal end bending piece **41** via the jumper wire **50**, and one ends of the jumper wire **50** and the insulating cable **54** are connected to the lens frames **31** and **32** via the electric connection part **55**.

[0065] Thus, by applying the tester rods **101** and **102** of the tester **100** to the conductor wire **54***a* of the insulating cable **54** and the most distal end bending piece **41**, it is possible to conduct a

continuity test of the jumper wire **50** that electrically connects the lens frames **31** and **32** of the image pickup instrument **30** and the most distal end bending piece **41** to ensure that there is an electrical connection between the lens frames **31** and **32** and the distal end bending piece **41** and inspect for a defect such as a wire breakage in the jumper wire **50**.
[0066] Note that after the continuity test using the tester **100**, the insulating cable **54** is accommodated from the cable outlet formed of the notch **56** in the most distal end bending piece **41**. At this time, an uncoated conductor wire **54***a* of the insulating cable **54** may be cut off or an insulating sleeve may be provided at the end portion of the insulating cable **54**.
[0067] Even after fitting the distal end rigid portion **20** into the most distal end bending piece **41**, the endoscope **1** configured as described above can easily conduct a continuity test between the image pickup instrument **30** and the bending piece **41** conducted to the ground (GND), and confirm grounding of the image pickup instrument **30**.
[0068] Therefore, the endoscope **1** can easily and reliably electrically connect the image pickup instrument **30** incorporated in the distal end portion **6** of the insertion portion **2** to the bending piece **41**, which is the conductive portion conducted to the ground (GND) by the jumper wire **50** and can be configured to easily confirm grounding of the image pickup instrument **30** by conducting a continuity test with the tester **100** applied to the bending piece **41** and the insulating cable **54**.
[0069] The invention described in the above embodiment is not limited to the above embodiment, but various modifications can be implemented without departing from the gist of the invention in the implementation phase. Furthermore, the above embodiment includes inventions in various phases and various inventions can be extracted according to appropriate combinations in a plurality of disclosed configuration requirements.
[0070] For instance, even when some configuration requirements are deleted from all the configuration requirements illustrated in the embodiments and modifications, configurations from which the configuration requirements are deleted can be extracted as inventions as long as the described problems can be solved and the described effects can be achieved.

Claims

1. A bendable tube for use with an endoscope comprising: a first piece, the first piece including: a distal edge; a proximal edge; and a first opening extending from the distal edge toward the proximal edge.
2. The bendable tube according to claim 1, further comprising a second piece located proximally relative to the first piece.
3. The bendable tube according to claim 2, further comprising a pin pivotally connecting the first piece and the second piece, wherein the first piece and the second piece are configured to rotate about the pin.
4. The bendable tube according to claim 1, wherein the first opening penetrates the first piece.
5. The bendable tube according to claim 1, wherein the first piece has a cylindrical shape, the first opening includes a first portion and a second portion, the first portion is located distally relative to the second portion, a width of the first portion along a direction intersecting with a central axis of the first piece is shorter than a width of the second portion along the direction.
6. The bendable tube according to claim 5, wherein the first portion communicates with the second portion.
7. The bendable tube according to claim 1, wherein the first piece further includes a second opening.
8. The bendable tube according to claim 7, wherein the second opening extends from the distal edge toward the proximal edge.
9. The bendable tube according to claim 7, wherein a length of the second opening along a central axis of the first piece is longer than a length of the first opening along the central axis of the first

piece.
10. An insertion device comprising: a lens; a frame holding the lens; a first member holding the frame; a second member fitted over an outer surface of the first member, the second member includes a first opening; and a wire located between the frame and the first member, wherein a first end of the wire is exposed from the first opening.
11. The insertion device according to claim 10, wherein the first end of the wire is located between the first member and the second member.
12. The insertion device according to claim 10, wherein the first opening is located on a circumferential surface of the second member.
13. The insertion device according to claim 10, wherein the first opening penetrates the second member.
14. The insertion device according to claim 10, further comprising a cover, wherein the cover covers the first end of the wire.
15. The insertion device according to claim 10, wherein a second end of the wire is located in the second member.
16. A n insertion device comprising: a lens; a frame holding the lens; a first member holding the frame; and a wire, wherein at least two sections of the wire contact the first member.
17. The insertion device according to claim 16, wherein a first section of the wire is located between the frame and the first member.
18. The insertion device according to claim 17, further comprising a second member fitted over an outer surface of the first member, wherein a second section of the wire is located between the first member and the second member.
19. The insertion device according to claim 16, further comprising a second member fitted over an outer surface of the first member, wherein a first section of the wire is located between the first member and the second member.
20. The insertion device according to claim 16, wherein the wire is single.