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(54) **PROBE ASSEMBLY AND END COVER**

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

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(57) **ABSTRACT**

A probe assembly includes: a measurement probe having a plurality of optical fibers configured to propagate light, emit the light to a measurement target, and receive scattered light returned from the measurement target; and an end cover having: an endoscope holding portion configured to hold an insertion portion of an endoscope, the insertion portion being configured to be inserted into a body cavity of a subject; and a probe position defining portion configured to define a position of a distal end surface of the plurality of optical fibers of the measurement probe.

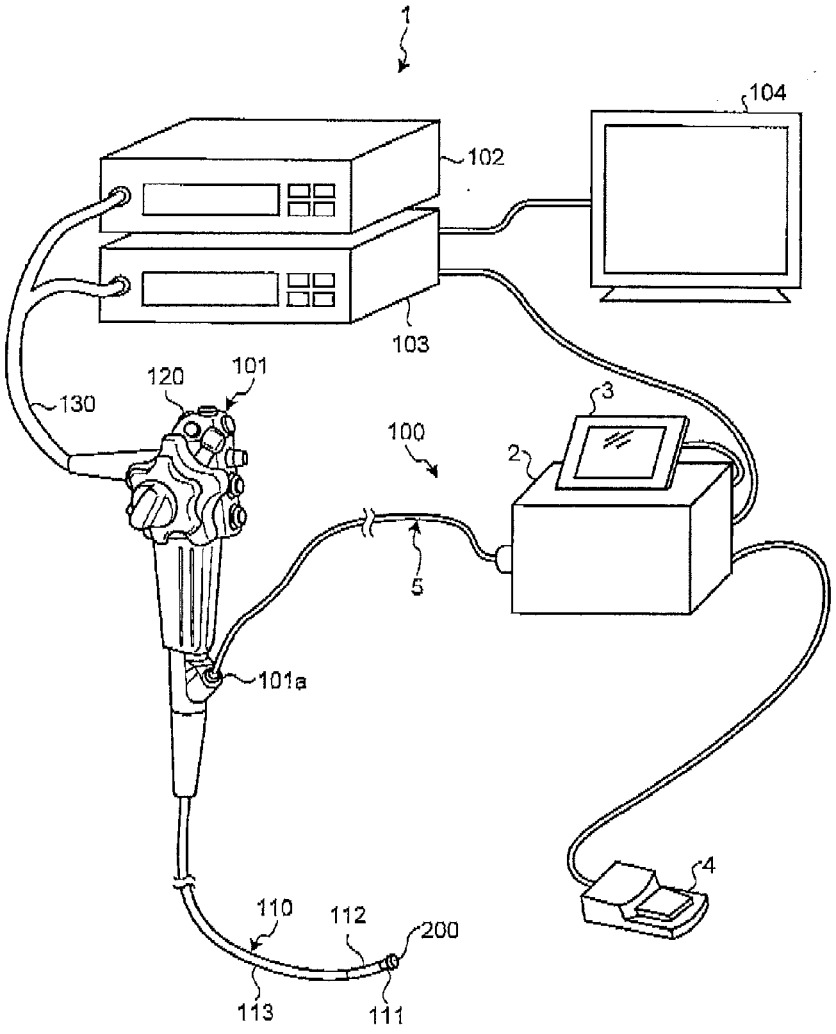


FIG.1

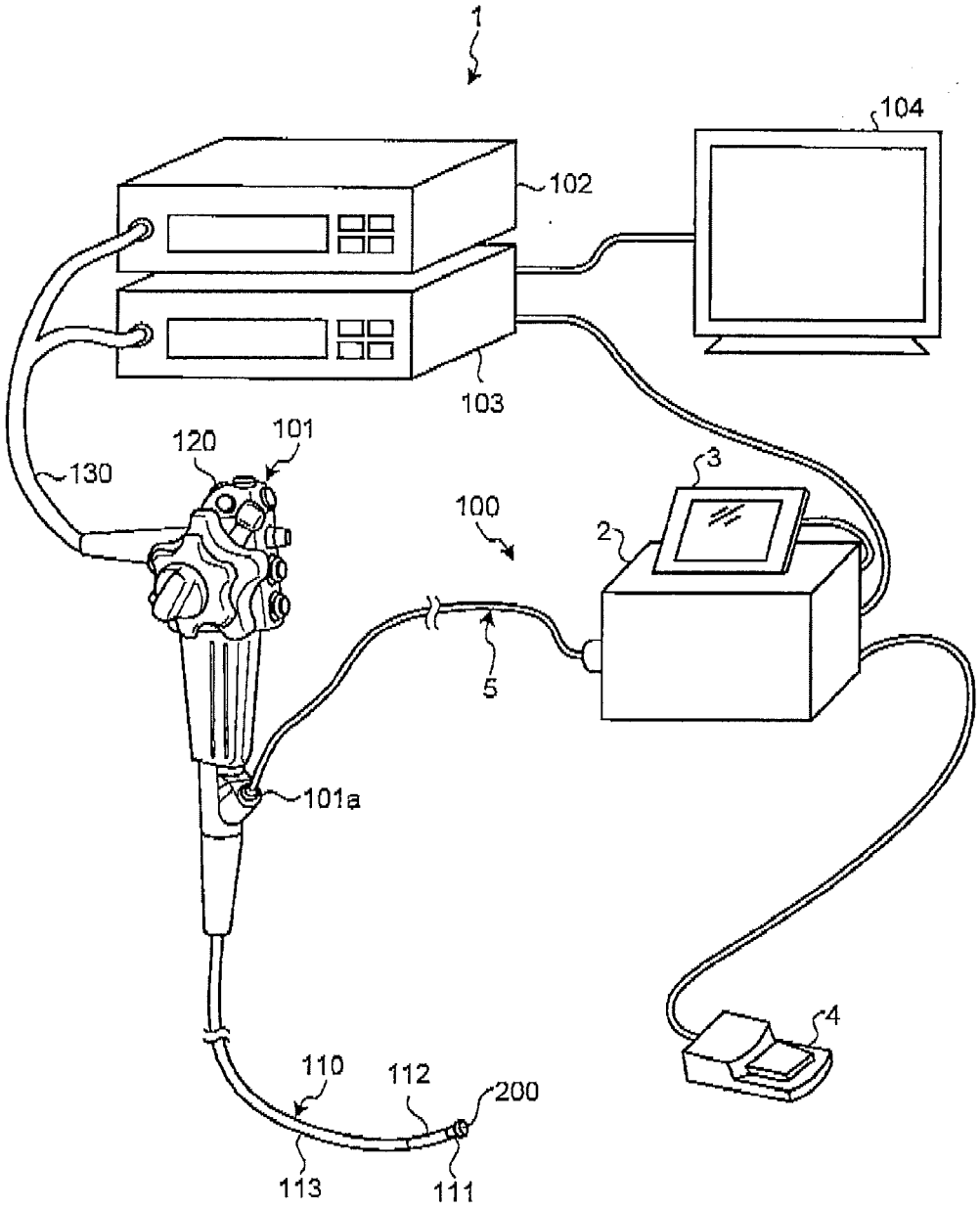
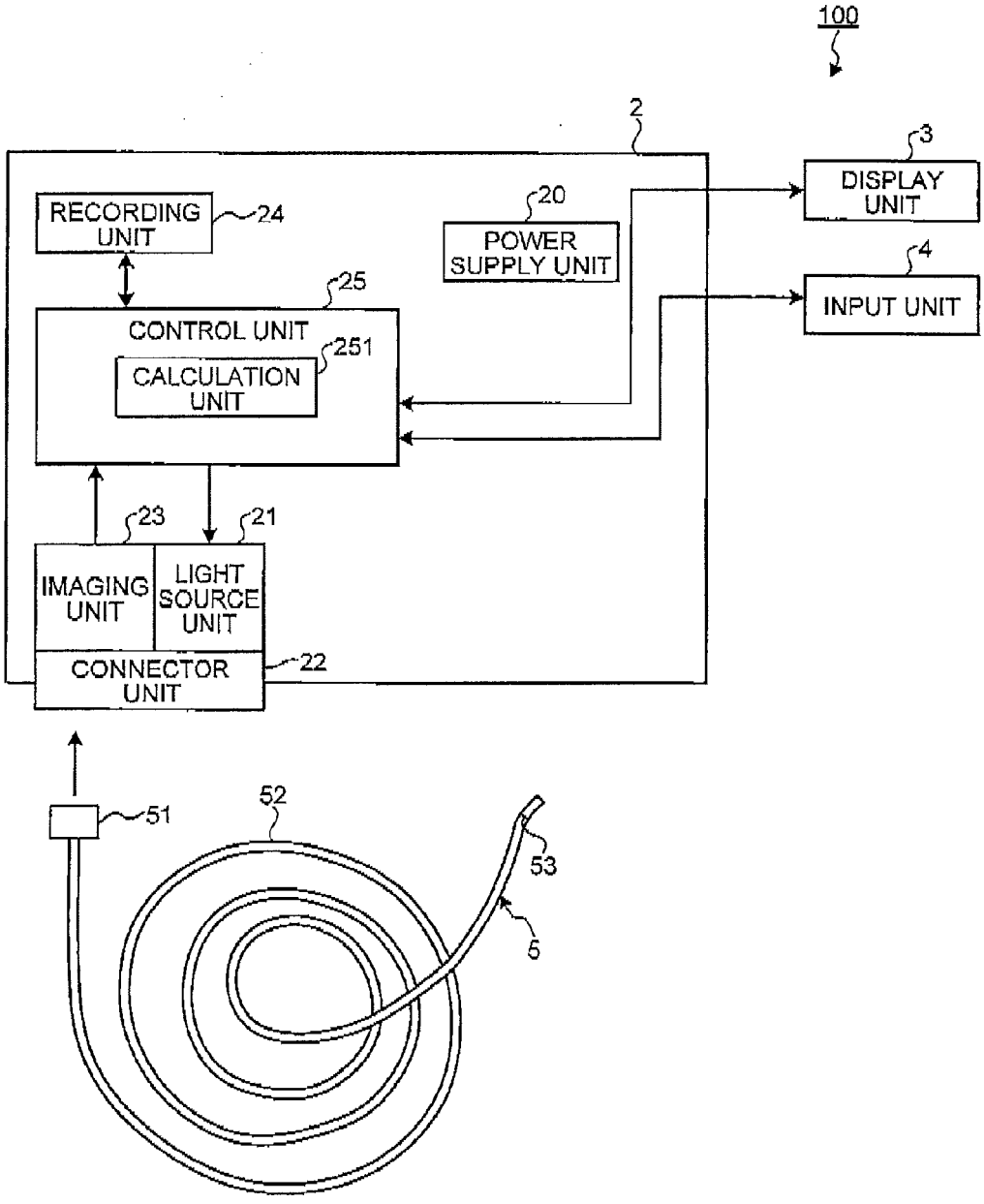


FIG.2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2
3
DISPLAY UNIT
RECORDING UNIT
24
20
POWER SUPPLY UNIT
4
INPUT UNIT
25
CONTROL UNIT
251
CALCULATION UNIT
23
21
IMAGING UNIT
LIGHT SOURCE UNIT
CONNECTOR UNIT
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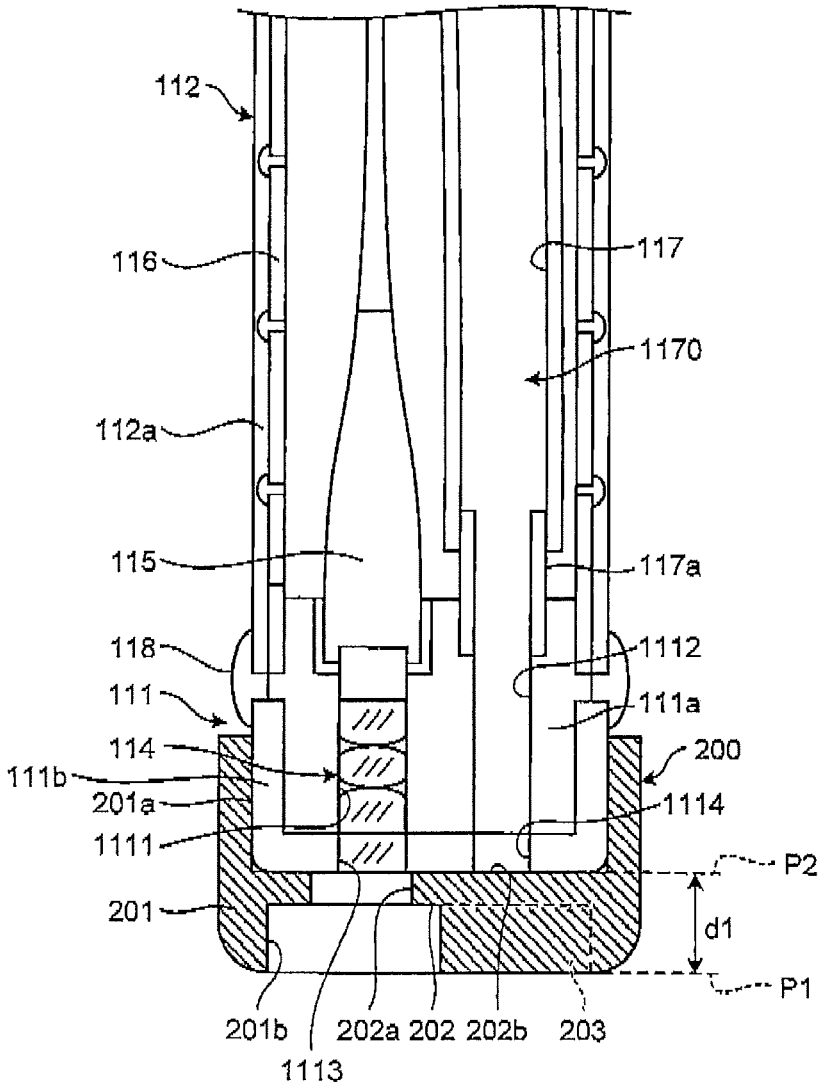
51
52
53
5

FIG.3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112a
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114
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202
202b
203

FIG.4

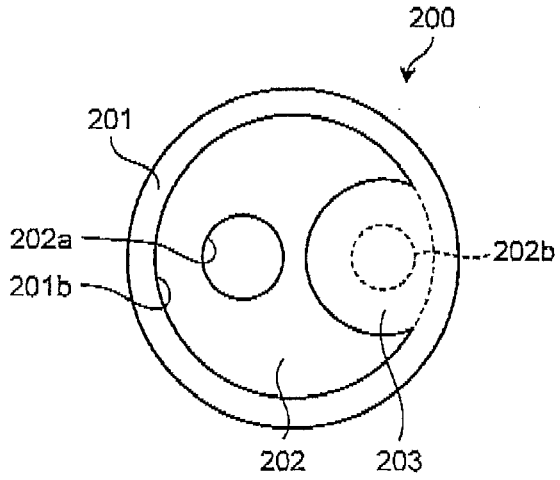
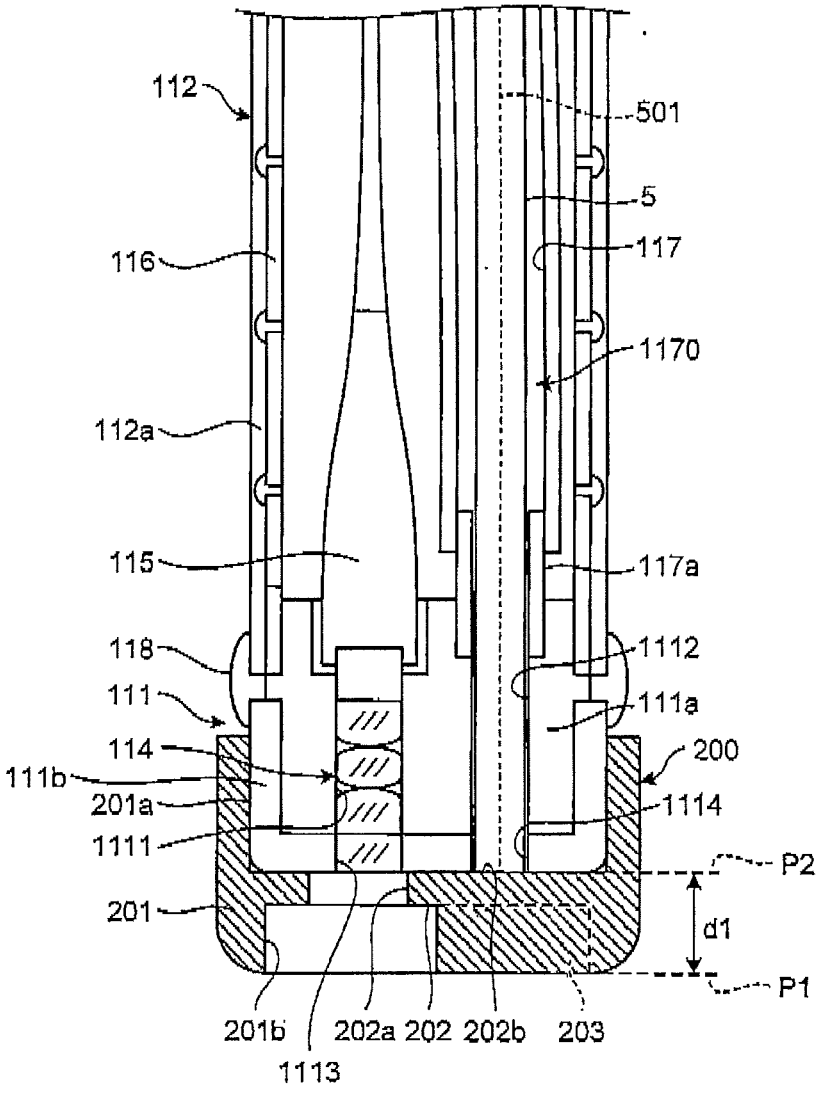


FIG.5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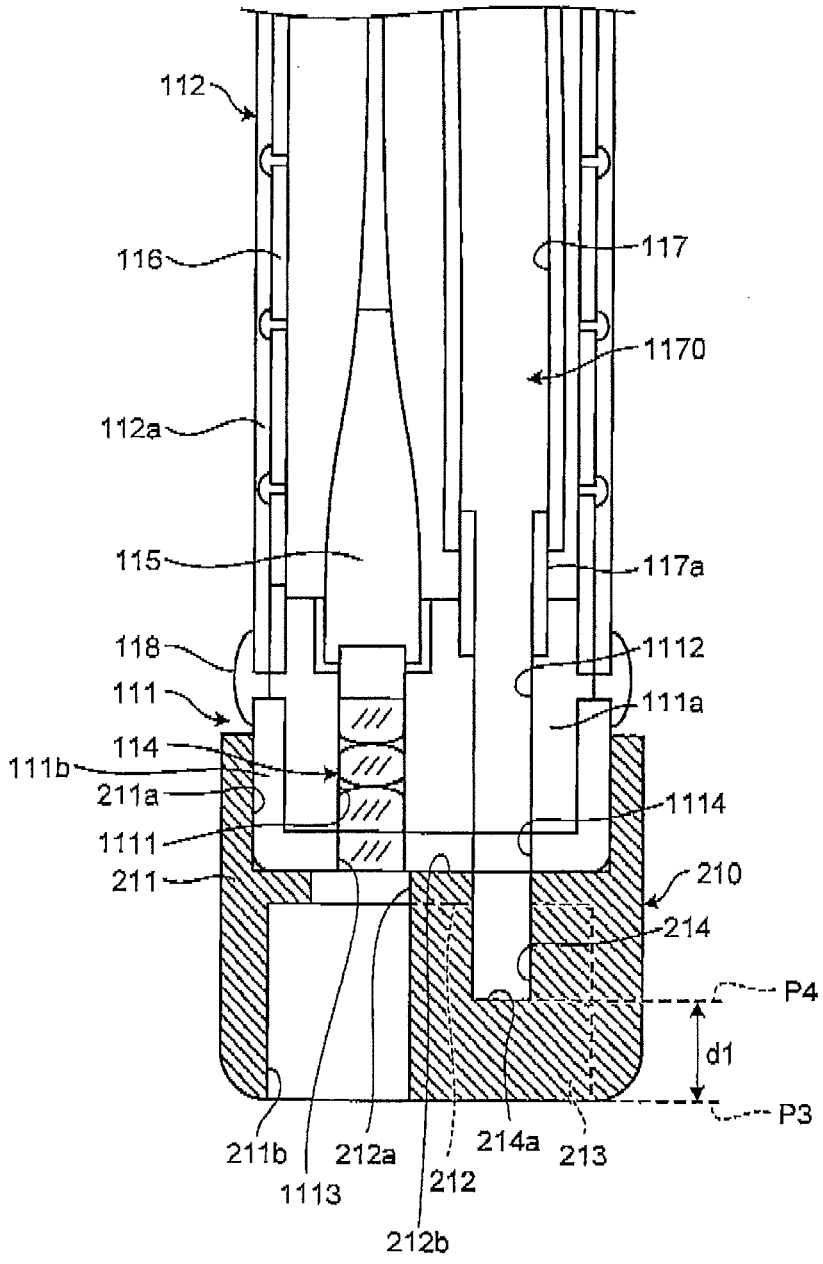
203

FIG.6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P4
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211b
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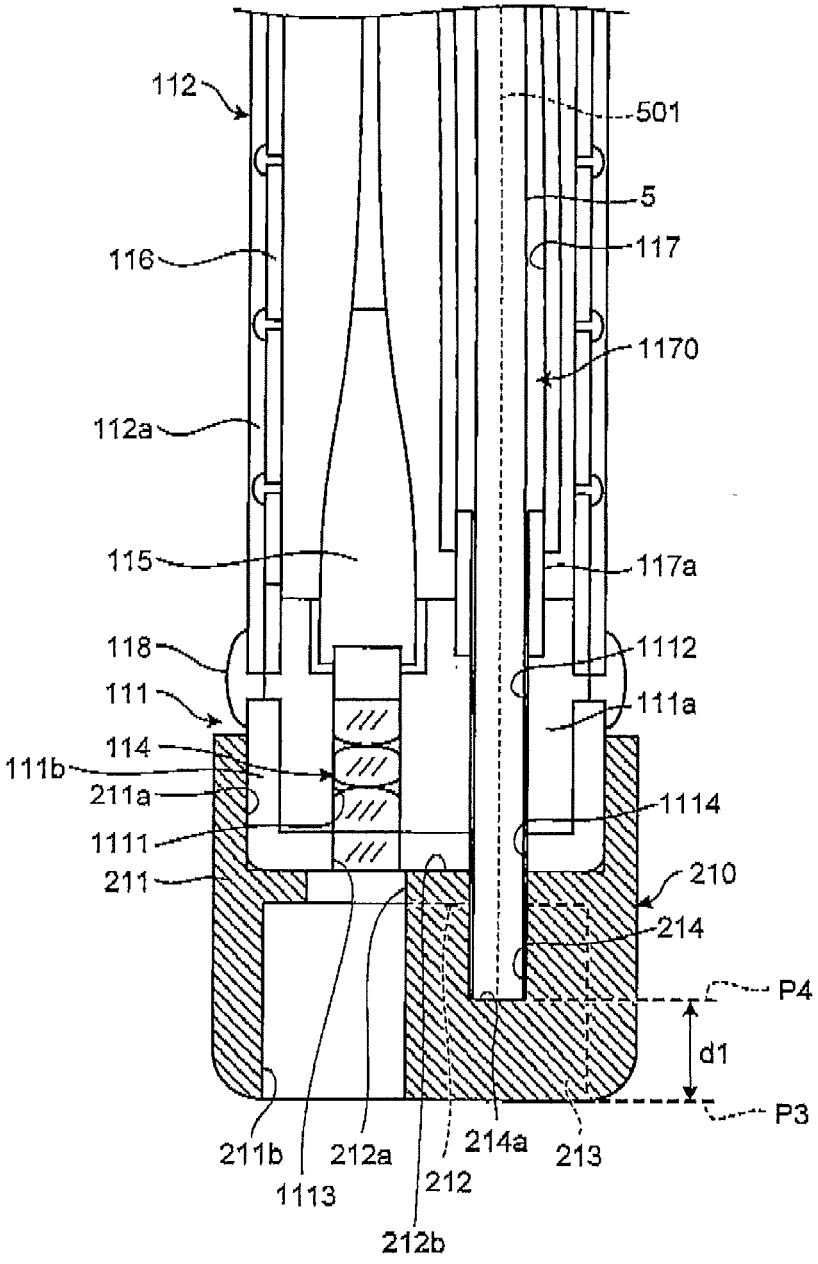
212b

FIG.7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P4
d1
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214a
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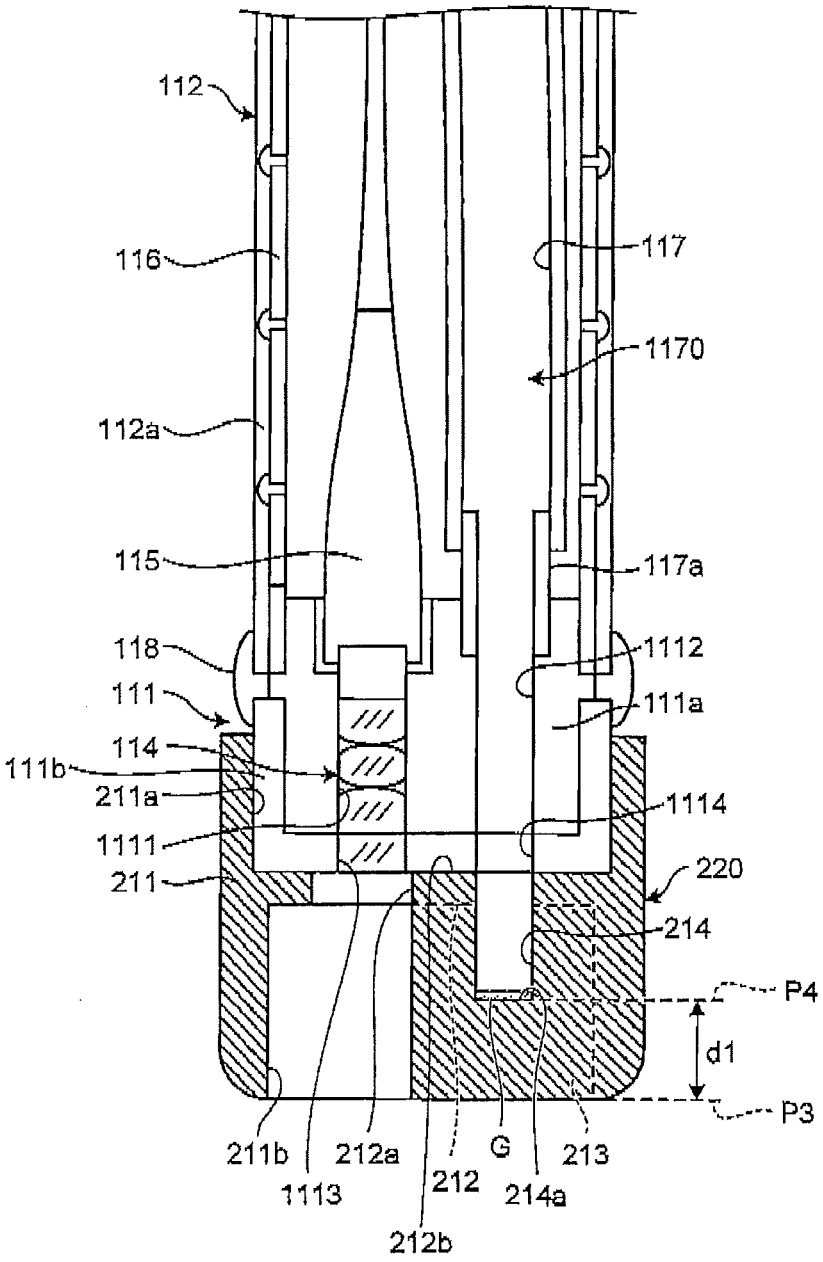
1113
212
212b

FIG.8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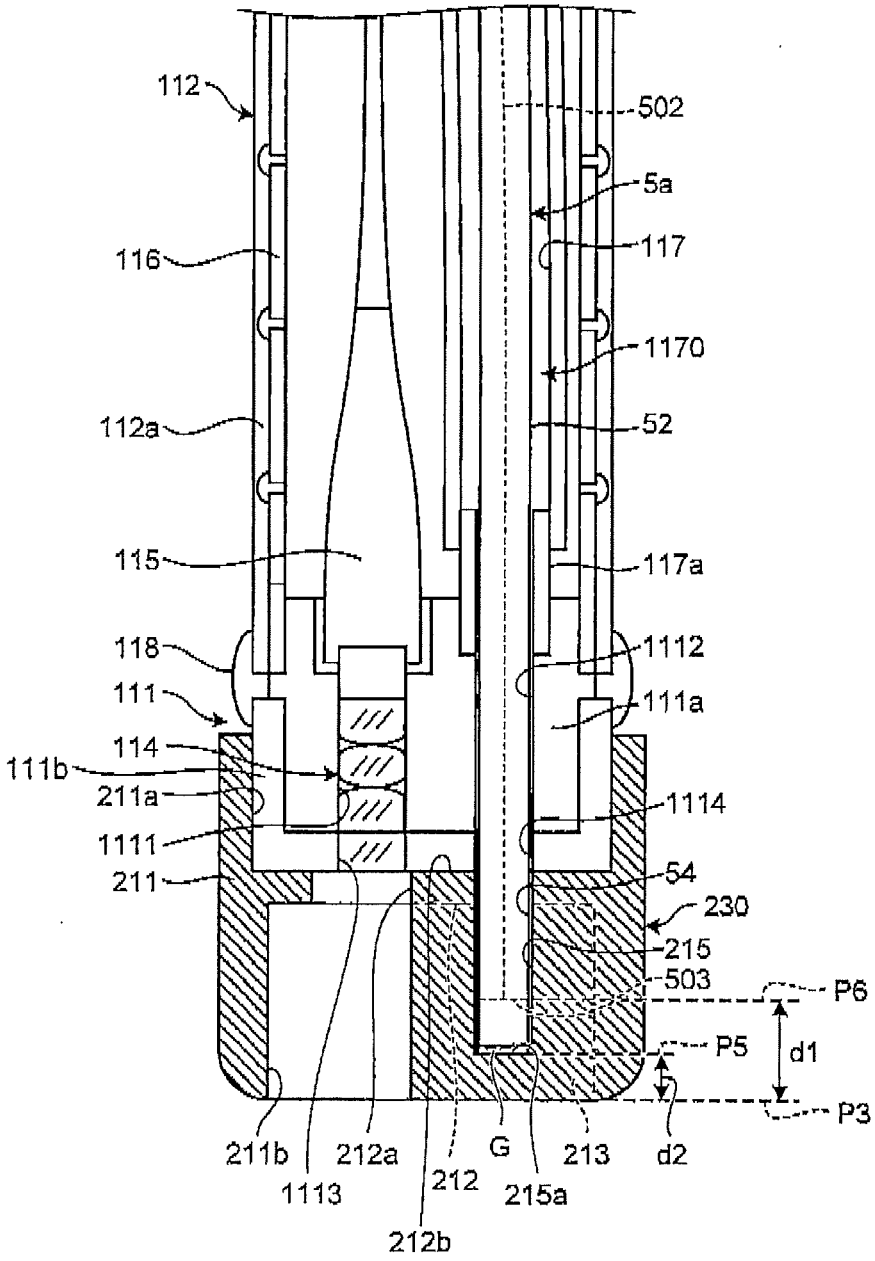
212b

FIG.9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117a
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1112
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111b
211a
1114
1111
211
54
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P3
211b
212a
G
213
d2
1113
212
215a
212b

FIG.10

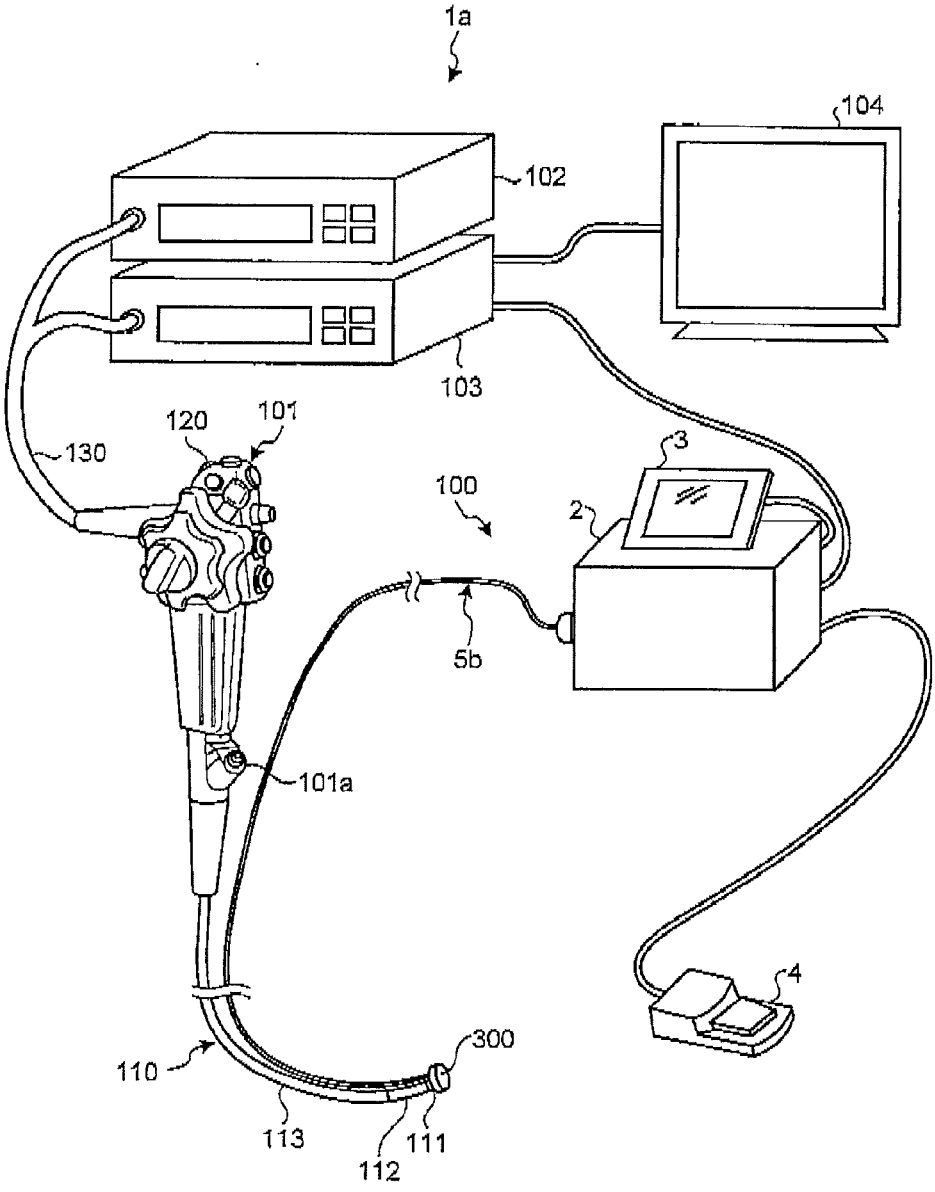


FIG.11

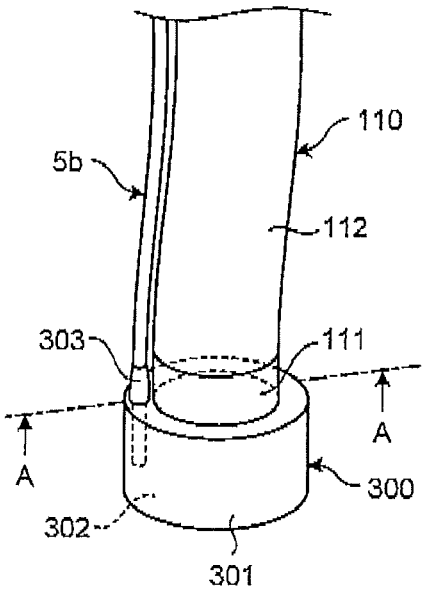
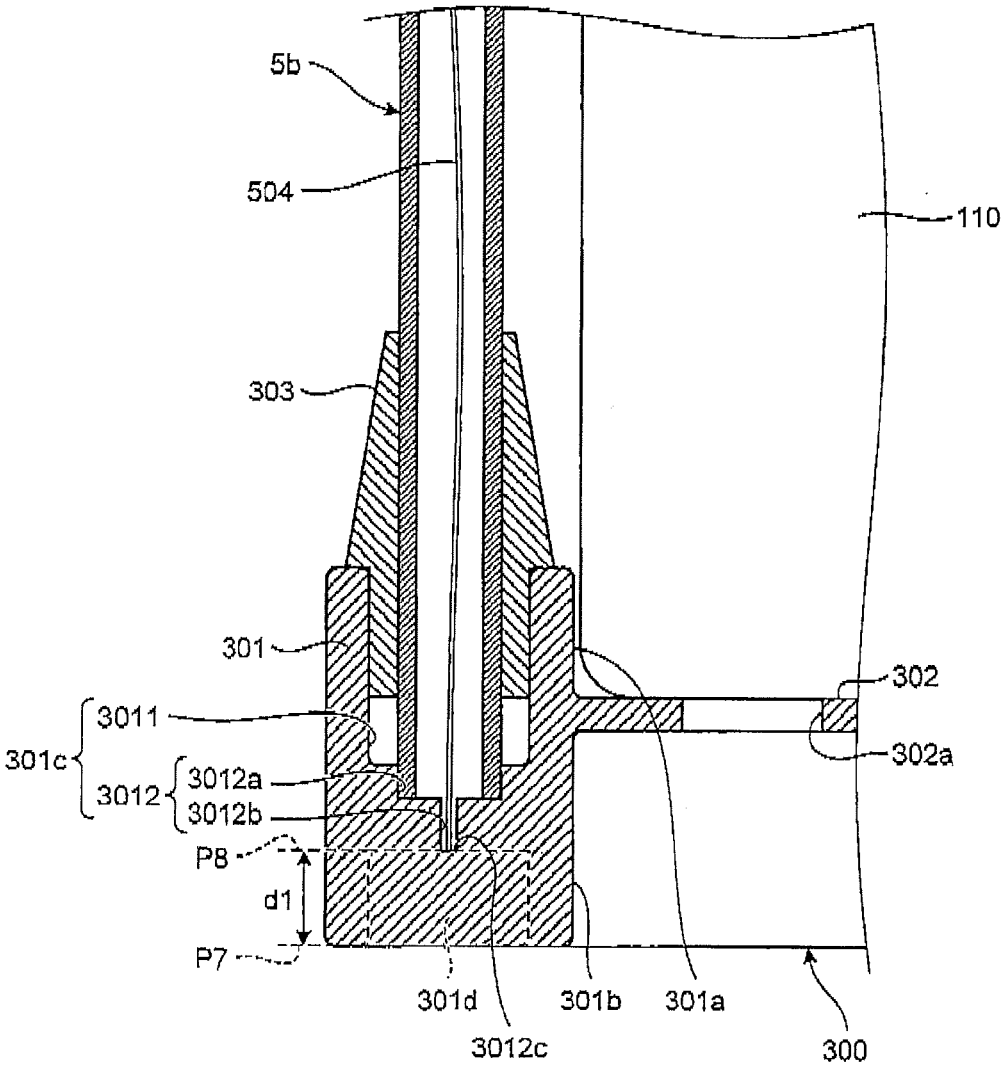


FIG.12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302
3011
301c
3012
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3012b
302a
P8
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P7
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301b
301a
3012c
300

PROBE ASSEMBLY AND END COVER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from U.S. Provisional Patent Application No. 62/057,665, filed on Sep. 30, 2014, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] 1. Technical Field

[0003] The disclosure relates to a probe assembly including a measurement probe that measures optical characteristics of a body tissue and an end cover that defines a position of the measurement probe, and relates to an end cover that defines a distal end position of the measurement probe.

[0004] 2. Related Art

[0005] In recent years, an optical measurement device is known which emits illumination light to a body tissue and estimates characteristics of the body tissue based on measured values of detected light reflected or scattered from the body tissue. The optical measurement device is used by being combined with an endoscope that observes an organ such as a digestive organ. As such an optical measurement device, an optical measurement device using Low-Coherence Enhanced Backscattering (LEBS) is proposed, which detects characteristics of a body tissue by emitting low-coherent white light with a short spatial coherence length to the body tissue from an illumination fiber of a measurement probe, detecting scattered light entering at angles different from each other by using a plurality of light-receiving fibers, and measuring intensity distribution of the scattered light by using spectroscopes, each of which is provided for each of the light-receiving fibers (for example, see Japanese Patent No. 5049415).

SUMMARY

[0006] In some embodiments, a probe assembly includes: a measurement probe having a plurality of optical fibers configured to propagate light, emit the light to a measurement target, and receive scattered light returned from the measurement target; and an and cover having: an endoscope holding portion configured to hold an insertion portion of an endoscope, the insertion portion being configured to be inserted into a body cavity of a subject; and a probe position defining portion configured to define a position of a distal end surface of the plurality of optical fibers of the measurement probe.

[0007] In some embodiments, an end cover includes: an endoscope holding portion configured to hold an insertion portion of an endoscope, the insertion portion being configured to be inserted into a body cavity of a subject; and a probe position defining portion configured to define a position of a distal end surface of a plurality of optical fibers of a measurement probe, the plurality of optical fibers being configured to propagate light, emit the light to a measurement target, and receive scattered light returned from the measurement target.

[0008] The above and other features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a schematic diagram illustrating a schematic configuration of an endoscope system according to a first embodiment of the present invention;

[0010] FIG. **2** is a block diagram schematically illustrating a functional configuration of an optical measurement system according to the first embodiment of the present invention;

[0011] FIG. **3** is a diagram schematically illustrating a configuration of an insertion portion and an end cover of an endoscope according to the first embodiment of the present invention;

[0012] FIG. **4** is a plan view schematically illustrating a configuration of the end cover according to the first embodiment of the present invention;

[0013] FIG. **5** is a diagram schematically illustrating a configuration of a distal end portion and the end cover of the endoscope according to the first embodiment of the present invention when a measurement probe is inserted;

[0014] FIG. **6** is a diagram schematically illustrating a configuration of an insertion portion and an end cover of an endoscope according to a second embodiment of the present invention;

[0015] FIG. **7** is a diagram schematically illustrating a configuration of a distal end portion and the end cover of the endoscope according to the second embodiment of the present invention when a measurement probe is inserted;

[0016] FIG. **8** is a diagram schematically illustrating a configuration of an insertion portion of an endoscope, a distal end portion of a measurement probe, and an end cover according to a first modified example of the second embodiment of the present invention;

[0017] FIG. **9** is a diagram schematically illustrating a configuration of an insertion portion of an endoscope, a distal end portion of a measurement probe, and an end cover according to a second modified example of the second embodiment of the present invention;

[0018] FIG. **10** is a schematic diagram illustrating a schematic configuration of an endoscope system according to a third embodiment of the present invention;

[0019] FIG. **11** is a perspective view schematically illustrating a configuration of an insertion portion of an endoscope, a distal end portion of a measurement probe, and an end cover according to the third embodiment of the present invention; and

[0020] FIG. **12** is a partial cross-sectional view taken along line A-A in FIG. **11**.

DETAILED DESCRIPTION

[0021] Modes for carrying out the invention (hereinafter referred to as "embodiments") will be described below with reference to the drawings. The same reference signs are used to designate the same elements throughout the drawings. The drawings are schematic, and the relation between the thickness and the width of each member, and the ratio of the size of each member should be noted that this is different from the reality. Also in between the drawings, portions in which dimensional relationships and ratios are different from each other are included. The present invention is not limited by the embodiments.

First Embodiment

[0022] FIG. **1** is a schematic diagram illustrating a schematic configuration of an endoscope system according to a

first embodiment of the present invention. The endoscope system **1** includes an optical measurement system **100** that performs an optical measurement on a measurement target such as a body tissue that is a scatterer and detects characteristics (characteristic features) of the measurement target, an endoscope **101** that captures an in-vivo image of a subject by inserting its distal end portion into a body cavity of the subject, a light source device **102** that generates illumination light emitted from the distal end portion of the endoscope **101**, a processing device **103** that performs predetermined image processing on the in-vivo image captured by the endoscope **101** and generally controls an operation of the entire endoscope system **1**, and a display device **104** that displays the in-vivo image on which the processing device **103** performs image processing.

[0023] FIG. **2** is a block diagram schematically illustrating a functional configuration of the optical measurement system according to the embodiment of the present invention. The optical measurement system **100** illustrated in FIGS. **1** and **2** includes an optical measurement device **2**, a display unit **3** that displays a measurement result of the optical measurement device **2**, an input unit **4** that receives an input of an instruction signal that instructs the optical measurement device **2** to perform measurement, and a measurement probe **5** which is attachable to and detachable from the optical measurement device **2** and which is inserted into the subject.

[0024] First, a configuration of the optical measurement device **2** will be described. The optical measurement device **2** includes a power supply unit **20**, a light source unit **21**, a connector unit **22**, an imaging unit **23**, a recording unit **24**, and a control unit **25**. The power supply unit **20** supplies power to each unit of the optical measurement device **2**.

[0025] The light source unit **21** emits illumination light to the measurement probe **5** through the connector unit **22**. The light source unit **21** is realized by using, for example, a light-emitting element that is an incoherent light source such as a white LED (Light Emitting Diode), a condenser lens that condenses light emitted by the light-emitting element, and a filter that transmits light of a predetermined wavelength band. Examples of the condenser lens include a condenser lens and a collimator lens. The light source unit **21** emits incoherent light having at least one spectral component to the measurement probe **5** through the connector unit **22** as illumination light. The light-emitting element may be realized by using an incoherent light source such as a xenon lamp, a tungsten lamp, and a halogen lamp.

[0026] The connector unit **22** attachably and detachably connects the measurement probe **5** to the optical measurement device **2**.

[0027] The imaging unit **23** generates an electrical signal by receiving return light of the illumination light which is emitted from a distal end of the measurement probe **5** and reflected and/or scattered from a measurement target and performing photoelectric conversion and outputs the electrical signal to the control unit **25**. The imaging unit **23** is realized by using an imaging element such as a Charge Coupled Device (CCD) image sensor and a Complementary Metal Oxide Semiconductor (CMOS) image sensor. The imaging unit **23** can also be realized by a simple photoelectric conversion element such as a photodiode in addition to the imaging element.

[0028] The recording unit **24** records various programs to operate the optical measurement device **2** and various data and various parameters used by the optical measurement device **2**. The recording unit **24** is realized by using a volatile memory, a non-volatile memory, and the like. The recording unit **24** temporarily records information and data that are being processed by the optical measurement device **2**. Further, the recording unit **24** records a measurement result of the optical measurement device **2** and information related to an arrangement of a light receiving fiber. The recording unit **24** may be configured by using a memory card or the like attached from the outside of the optical measurement device **2**.

[0029] The control unit **25** controls processing operation of each unit of the optical measurement device **2**. The control unit **25** is configured by using a Central Processing Unit (CPU) and the like and generally controls the optical measurement device **2** by transmitting instruction information and data to each component of the optical measurement device **2**. The control unit **25** includes a calculation unit **251**. The calculation unit **251** performs a plurality of calculation processes based on the electrical signal inputted from the imaging unit **23** and calculates characteristic values related to the characteristics of the measurement target.

[0030] The display unit **3** outputs various information of the optical measurement device **2**. Specifically, the display unit **3** outputs information inputted from of the optical measurement device **2**. The display unit **3** is realized by using a display panel such as a liquid crystal display panel and an organic Electro Luminescence (EL) display panel, a speaker, and the like. A touch panel that receives an input of a position signal corresponding to a position contacted from the outside may be provided on a display screen of the display unit **3**.

[0031] The input unit **4** receives an input of an instruction signal that instructs the optical measurement device **2** to perform measurement. The input unit **4** is realized by using, for example, a foot switch. In addition, the input unit **4** may be realized by an input interface such as a keyboard and a mouse or may be realized by combining these components.

[0032] The measurement probe **5** is configured by using at least a plurality of optical fibers. Specifically, the measurement probe **5** is realized by using an illumination fiber (an illumination channel) that emits illumination light to a measurement target and a plurality of light receiving fibers (light receiving channels) which the return light (scattered light) of the illumination light reflected and/or scattered from the measurement target enters at different angles. The measurement probe **5** includes a proximal end portion **51** that is attachably and detachably connected to the connector unit **22** of the optical measurement device **2**, a flexible portion **52** having flexibility, and a distal end portion **53** in which a distal end surface of a fiber group including the illumination fiber and the light receiving fibers is exposed from its distal end surface and which emits the illumination light supplied from the light source unit **21** through the connector unit **22** and receives the return light of the illumination light from the measurement target.

[0033] In the optical measurement system **100** configured as described above, the measurement probe **5** is inserted through a treatment tool channel **101***a* of the endoscope **101** (scope of endoscope) of the endoscope system **1**, the illumination fiber emits the illumination light to the measurement target, and each of the plurality of light receiving fibers receives the return light of the illumination light reflected and/or scattered from the measurement target at the distal end portion **53** and emits the return light to each light receiving surface of the imaging unit **23**. Thereafter, the calculation unit

251 calculates the characteristic values of the characteristics of the measurement target based on a measurement result of each light receiving surface of the imaging unit **23**.

[0034] The endoscope **101** includes an insertion portion **110** having an elongated shape with flexibility, an operating unit **120** which is connected to the proximal end of the insertion portion **110** and receives inputs of various operation signals, and a universal cord **130** which extends in a direction different from a direction in which the insertion portion **110** extends from the operating unit **120** and includes various cables connected to the light source device **102** and the processing device **103**.

[0035] The insertion portion **110** includes a distal end portion **111** including an imaging element in which pixels that generate signals by receiving light and performing photoelectric conversion are two-dimensionally arranged, a bendable bending portion **112** configured by a plurality of bending pieces, and a flexible tube portion **113** which has flexibility and is connected to the proximal end of the bending portion **112**.

[0036] In the first embodiment, an end cover **200** is attached to the distal end portion **111** of the insertion portion **110**. The end cover **200** is fitted to the distal end portion **111**, so that the end cover **200** is attached to the distal end portion **111**.

[0037] Here, a configuration of the insertion portion **110** and the end cover **200** of the endoscope **101** will be described with reference to the drawings. FIG. **3** is a diagram schematically illustrating a configuration of the distal end portion and the end cover of the endoscope according to the first embodiment. FIG. **4** is a plan view schematically illustrating a configuration of the end cover according to the first embodiment.

[0038] The distal end portion **111** includes a distal end main body **111***a* and a main body cover **111***b*. Two through holes (through holes **1111** and **1112**) are formed in the distal end main body **111***a*. In the through hole **1111**, a lens group **114** including a plurality of lenses and one end (an end of a light receiving surface) of an imaging element **115** are held. The imaging element **115** is realized by using an imaging element such as a CCD image sensor and a CMOS image sensor.

[0039] The main body cover **111***b* has a bottomed tubular shape and is attached by being fitted to the outer circumference of the distal end main body **111***a*. Two through holes (through holes **1113** and **1114**) are formed in the main body cover **111***b*. The through hole **1113** communicates with the through hole **1111** and holds a cover glass. The through hole **1114** communicates with the through hole **1112**.

[0040] The bending portion **112** has a bending cover **112***a* having a flexible tubular shape. In the bending cover **112***a*, a plurality of bending pieces **116** having a substantially tubular shape and a tube **117** in which its one end communicates with the through hole **1112** and the other end forms the treatment tool channel **101***a* are provided. The tube **117** connects to the through hole **1112** through a relay member **117***a*. A treatment tool insertion hole **1170** is formed by a hollow space formed by the tube **117** and the through holes **1112** and **1114**.

[0041] The main body cover **111***b* and the bending cover **112***a* are connected by an adhesive portion **118** that fills a step generated between both covers and connects both covers in a watertight manner.

[0042] The end Cover **200** is formed by using a light transmissive material and has a bottomed tubular shape having an opening at both ends. The end cover **200** includes a side portion **201**, a bottom portion **202**, and a rod portion **203**. Examples of the light transmissive material include a glass and a resin that satisfies optical performance. At least the rod portion **203** may have optical transparency.

[0043] The side portion **201** has a substantially tubular shape. The bottom portion **202** is provided inside the side portion **201** and forms a bottom of the side portion **201**. The bottom portion **202** has a flat plate shape perpendicular to a central axis of the side portion **201** (a central axis of the tube). The rod portion **203** extends from one main surface of the bottom portion **202** to a plane P**1** that passes through a distal end of the side portion **201**. It is assumed that the plane P**1** is a plane perpendicular to the central axis of the side portion **201**.

[0044] The end cover **200** includes a housing portion **201***a* (an endoscope holding portion) and an opening portion **201***b*. The housing portion **201***a* is provided on one end side of the end cover **200** on which the rod portion **203** is not formed, has a substantially concave shape formed by an inner circumferential surface of the side portion **201** and a main surface of the bottom portion **202**, and can house the distal end portion **111**. The opening portion **201***b* is provided on the other end side of the end cover **200** on which the rod portion **203** is formed, includes the through hole **1113** at least in a plan view when the end cover **200** is attached to the distal end portion **111**, and forms a hollow space formed by an inner circumferential surface of the side portion **201**, a main surface of the bottom portion **202**, and an outer circumference of the rod portion **203**. Here, "in plan view" is a case in which the end cover **200** is seen in a plane perpendicular to the central axis of the side portion **201** (tube), that is, a case in which the end cover **200** is seen in the central axis direction.

[0045] In the bottom portion **202**, a through hole **202***a* that communicates with the through hole **1113** when the end cover **200** is attached to the distal end portion **111** is formed. On a main surface of the bottom portion **202** facing the housing portion **201***a*, a contact surface **202***b* (a probe position defining portion) is provided that is configured to come into contact with a distal end surface of the measurement probe **5** (the distal end portion **53**) exposed from the distal and portion **111** through the treatment tool channel **101***a*.

[0046] The rod portion **203** includes at least the through hole **1114** in the bottom portion **202** in a plan view when the end cover **200** is attached to the distal end portion **111**. Here, a distance between the plane P**1** that passes through a distal end surface of the rod portion **203** (the side portion **201**) and a plane P**2** that passes through a surface of the bottom portion **202** facing the housing portion **201***a* (the contact surface **202***b*) is designed to be a distance d**1** in order to maintain a constant distance between the measurement target and the distal and portion **53**. The plane P**2** is a plane in parallel with the plane P**1**.

[0047] The end cover **200** having the configuration as described above is attached to the distal end portion **111** such that the bottom portion **202** comes into contact with the main body cover **111***b*. In this case, the through hole **1113** and the through hole **202***a* communicate with each other. The through hole **1114** is located within a region in which the rod portion **203** is formed in the bottom portion **202** in plan view. A means (for example, a concave portion and a convex portion) to restrict a position where the end cover **200** is attached to the distal end portion **111** may be provided and a relative position of the end cover **200** with respect to the distal end portion **111** may be determined when the end cover **200** is attached to the distal end portion **111**. Alternatively, a user may rotate the end cover **200** with respect to the distal and portion **111** and adjust

the position of the through hole **1114**. A probe assembly is configured by the measurement probe **5** and the end cover **200**.

[0048] FIG. **5** is a diagram schematically illustrating a configuration of the distal and portion and the end cover of the endoscope according to the first embodiment when the measurement probe is inserted. When the measurement probe **5** is inserted from the treatment tool channel **101***a* in a state in which the end cover **200** is attached to the distal end portion **111**, the distal and surface of the distal end portion **53** is exposed from the through hole **1114** through the treatment tool insertion hole **1170**. In this case, the distal end surface of the distal end portion **53** (fiber group **501**) comes into contact with the contact surface **202***b* of the bottom portion **202**. Hence, when a measurement is performed with the measurement probe **5** by causing the end cover **200** (the distal end surface of the rod portion **203**) to be in contact with the measurement target, the distance from the distal end surface of the distal and portion **53** to the measurement target becomes the distance d**1** described above.

[0049] According to the first embodiment of the present invention described above, the position of the distal end portion **53** of the measurement probe **5** inserted into the treatment tool channel **101***a* is defined such that the distance from the position of the distal end portion **53** to the measurement target is a predetermined distance d**1** by the end cover **200** attached to the distal end portion **111**, so that it is possible to stabilize the relative positional relationship between the endoscope and the measurement probe.

[0050] Further, according to the first embodiment, the distal end surface of the end cover **200** (the opening surface of the opening portion **201***b* and the distal end surface of the rod portion **203**) is in contact with the measurement target, so that it is possible to increase the contact area (contact region) in contact with the measurement target as compared with a case in which a measurement is performed by causing the distal end surface of the measurement probe **5** to be in contact with the measurement target. Therefore, it is possible to maintain a stable contact state with the measurement target.

[0051] Further, according to the first embodiment, it is possible to maintain a relative positional relationship between the imaging element **115** of the endoscope **101** and the measurement probe **5** not only in the longitudinal direction of the insertion portion **110**, but also in a direction perpendicular to the longitudinal direction by aligning planes in the direction perpendicular to the longitudinal direction by the positions of distal end opening surfaces of the through holes **1113** and **1114**, so that it is possible to maintain more stable measurement processing.

Second Embodiment

[0052] FIG. **6** is a diagram schematically illustrating a configuration of an insertion portion and an end cover of an endoscope according to a second embodiment of the present invention. The same reference signs are used to designate the same elements as those in the above-described embodiment. In the aforementioned first embodiment, the distance d**1** is maintained by causing the distal end portion **111** to come into contact with the bottom portion **202** and causing the distal and portion **53** to come into contact with the bottom portion **202**. However, in the second embodiment, a hole portion **214** is formed from a bottom portion **212** to a rod portion **213** and the measurement probe **5** (the distal end portion **53**) is inserted into the hole portion and held.

[0053] The end cover **210** according to the second embodiment is formed by using a light transmissive material and has a bottomed tubular shape having an opening at both ends. The end cover **210** includes a side portion **211**, a bottom portion **212**, and a rod portion **213**. In the same manner as the end cover **200** described above, the end cover **210** is formed by using a light transmissive material.

[0054] The side portion **211** has a substantially tubular shape.

[0055] The bottom portion **212** is provided inside the side portion **211** and forms a bottom of the side portion **211**. The bottom portion **212** has a flat plate shape perpendicular to a central axis of the side portion **211** (a central axis of the tube). The rod portion **213** extends from one main surface of the bottom portion **212** to a plane P**3** that passes through a distal end of the side portion **211**.

[0056] The end cover **210** includes a housing portion **211***a* (an endoscope holding portion), an opening portion **211***b*, and the hole portion **214** (a probe position defining portion). The housing portion **211***a* is provided on one end side of the end cover **210** on which the rod portion **213** is not formed, has a substantially concave shape formed by an inner circumferential surface of the side portion **211** and a main surface of the bottom portion **212**, and is configured to house the distal end portion **111**. The opening portion **211***b* is provided on the other end side of the end cover **210** on which the rod portion **213** is formed, includes the through hole **1113** at least in a plan view when the end cover **210** is attached to the distal end portion **111**, and forms a hollow space formed by an inner circumferential surface of the side portion **211**, a main surface of the bottom portion **212**, and an outer circumference of the rod portion **213**.

[0057] The hole portion **214** extends from a main surface of the bottom portion **212** facing the housing portion **211***a* to substantially the center of the rod portion **213** in a central axis direction of the side portion **211** and forms a hollow space with a diameter in which the measurement probe **5** can be inserted. The hole portion **214** houses the measurement probe **5** (the distal end portion **53**) protruded from the distal end portion **111** through the treatment tool channel **101***a* and includes a bottom surface portion **214***a* which is a contact surface that comes into contact with the distal end surface of the measurement probe **5**. The bottom surface portion **214***a* forms a bottom surface of the hole portion **214**. When the end cover **210** is attached to the distal end portion **111**, the hole portion **214** communicates with the through hole **1114**.

[0058] In the bottom portion **212**, a through hole **212***a* is formed to communicate with the through hole **1113** when the end cover **210** is attached to the distal end portion **111**. On the bottom portion **212** facing the housing portion **211***a*, a contact surface **212***b* is provided that is configured to come into contact with a distal end surface of the insertion portion **110**.

[0059] The rod portion **213** includes at least the through hole **1114** in the bottom portion **212** in a plan view when the end cover **210** is attached to the distal end portion **111**. Here, a distance between the plane P**3** that passes through a distal end surface of the rod portion **213** (the side portion **211**) and a plane P**4** that passes through the bottom surface portion **214***a* is designed to be a distance d**1** in order to maintain a constant distance between the measurement target and the distal and portion **53**.

[0060] The end cover **210** having the configuration as described above is attached to the distal and portion **111** such that the bottom portion **212** facing the housing portion **211***a*

comes into contact with the main body cover **111***b*. In this case, the through hole **1113** and the through hole **212***a* communicate with each other and the through hole **1114** and the hole portion **214** communicate with each other.

[0061] FIG. **7** is a diagram schematically illustrating a configuration of the distal end portion and the end cover of the endoscope according to the second embodiment when the measurement probe is inserted. When the measurement probe **5** is inserted from the treatment tool channel **101***a* in a state in which the end cover **210** is attached to the distal end portion **111**, the distal end surface of the distal end portion **53** is exposed from the through hole **1114** through the treatment tool insertion hole **1170**. In this case, the distal end surface of the distal end portion **53** is inserted into the hole portion **214** and comes into contact with the bottom surface portion **214***a*. Hence, when a measurement is performed with the measurement probe **5** by causing the end cover **210** (the distal end surface of the rod portion **213**) to be in contact with the measurement target, the distance from the distal end surface of the distal and portion **53** (the fiber group **501**) to the measurement target becomes the distance d**1** described above.

[0062] According to the second embodiment of the present invention described above, the distal end portion **53** of the measurement probe **5** inserted into the treatment tool channel **101***a* is held by the end cover **210** (the hole portion **214**) attached to the distal end portion **111** and the position of the distal end portion **53** is defined such that the distance from the position of the distal end portion **53** to the measurement target is a predetermined distance d**1**, so that it is possible to stabilize the relative positional relationship between the endoscope and the measurement probe.

[0063] Further, according to the second embodiment, the distal end surface of the end cover **210** (the opening surface of the opening portion **211***b* and the distal end surface of the rod portion **213**) is in contact with the measurement target, so that it is possible to increase the contact area in contact with the measurement target as compared with a case in which a measurement is performed by causing the distal end surface of the measurement probe **5** to be in contact with the measurement target. Therefore, it is possible to maintain a stable contact state with the measurement target.

First Modified Example of Second Embodiment

[0064] FIG. **8** is a diagram schematically illustrating a configuration of an insertion portion of an endoscope, a distal end portion of a measurement probe, and an end cover according to a first modified example of the second embodiment of the present invention. In the second embodiment described above, the distal end surface of the distal end portion **53** is configured to directly come into contact with the bottom surface portion **214***a* of the hole portion **214**. However, in the first modified example, a gel G is arranged on the bottom surface portion **214***a*.

[0065] The end cover **220** illustrated in FIG. **8** is provided with the gel G on the bottom surface portion **214***a* of the hole portion **214** in addition to the configuration of the end cover **210** described above. The gel G is formed of a gel-like substance having optical transparency. Besides the gel-like substance, a resin or the like having optical transparency and elasticity may be used.

[0066] In the same manner as in the second embodiment described above, the and cover **220** having the configuration as described above is attached to the distal end portion **111** such that the bottom portion **212** comes into contact with the main body cover **111***b*. When the measurement probe **5** is inserted from the treatment tool channel **101***a* in a state in which the end cover **220** is attached to the distal end portion **111**, the distal end surface of the distal and portion **53** is protruded from the through hole **1114** through the treatment tool insertion hole **1170** and inserted into the hole portion **214**. At this time, the distal end surface of the distal end portion **53** comes into contact with the bottom surface portion **214***a* of the hole portion **214** through the gel G. Hence, when a measurement is performed with the measurement probe **5** by causing the end cover **220** (the distal end surface of the rod portion **213**) to be in contact with the measurement target, the distance from the distal end surface of the distal end portion **53** to the measurement target can be substantially the same as the distance d**1** described above and the distal end portion **53** and the end cover **220** can be in close contact with each other in a contact portion thereof. Hence, it is possible to suppress decrease in connection efficiency of the contact portion between the distal end portion **53** and the end cover **220**.

Second Modified Example of Second Embodiment

[0067] FIG. **9** is a diagram schematically illustrating a configuration of an insertion portion of an endoscope, a distal and portion of a measurement probe, and an end cover according to a second modified example of the second embodiment of the present invention. In the second embodiment described above, the distal end surface of the distal end portion **53** from which the fibers are exposed is configured to come into contact with the bottom surface portion **214***a* of the hole portion **214**. However, in the second modified example, a measurement probe **5***a* includes a distal end portion **54** having a glass rod **503**.

[0068] The measurement probe **5***a* includes a proximal end portion **51** (not illustrated in FIG. **9**) that is attachably and detachably connected to the connector unit **22** of the optical measurement device **2**, a flexible portion **52** having flexibility, and a distal end portion **54** in which the glass rod **503** is exposed from its distal end surface and which emits the illumination light supplied from the light source unit **21** through the connector unit **22** and receives the return light of the illumination light from the measurement target. In the distal end portion **54**, a fiber group **502** including an illumination fiber and light receiving fibers is fixed in a state of being in contact with the glass rod **503**.

[0069] In the end Cover **230** illustrated in FIG. **9**, a hole portion **215** (a probe position defining portion) is formed instead of the hole portion **214** of the end cover **210** described above. Further, a gel G is provided on a bottom portion **215***a* of the hole portion **215**. In the hole portion **215**, a distance d**2** from a plane P**5** that passes through the bottom portion **215***a* to the plane P**3** is smaller than the distance d**1** from the plane P**3** to the plane P**4** described above by a length of the glass rod **503**. In the second modified example, it is designed so that a distance from the plane P**3** to a plane P**6** that passes through a contact surface of the glass rod **503** with which the illumination fiber and the light receiving fibers come into contact is d**1** described above.

[0070] In this way, even when the glass rod **503** is provided at the distal end portion of the measurement probe Sa, it is possible to stabilize the relative positional relationship between the endoscope and the measurement probe and it is also possible to set the distance to the measurement target to a predetermined distance.

Third Embodiment

[0071] FIG. **10** is a schematic diagram illustrating a schematic configuration of an endoscope system according to a third embodiment of the present invention. The same reference signs are used to designate the same elements as those in FIG. **1** and the like. In the aforementioned first embodiment, the measurement probe **5** is inserted into the treatment tool channel **101***a*. However, in an endoscope system **1***a* according to the third embodiment, a measurement probe **5***b* is held by an end cover **300** independently from the endoscope **101**. In other words, a probe assembly including the measurement probe **5***b* and the and cover **300** holds the endoscope **101**.

[0072] FIG. **11** is a perspective view schematically illustrating a configuration of an insertion portion of the endoscope, a distal end portion of the measurement probe, and the end cover according to the third embodiment. FIG. **12** is a partial cross-sectional view taken along line A-A in FIG. **11** and is a diagram illustrating a part of a configuration of the insertion portion of the endoscope, the distal end portion of the measurement probe, and the end cover. The end cover **300** is formed by using a light transmissive material and has a bottomed tubular shape having an opening at both ends. The end cover **300** includes a side portion **301**, a bottom portion **302**, and a fixation member **303**.

[0073] The side portion **301** has a substantially tubular shape. The bottom portion **302** is provided inside the side portion **301** and forms a bottom of the side portion **301**. The bottom portion **302** has a flat plate shape perpendicular to a central axis of the side portion **301** (a central axis of the tube).

[0074] The end cover **300** includes a housing portion **301***a* (an endoscope holding portion), an opening portion **301***b*, a probe holding portion **301***c* (a probe position defining portion), and a rod portion **301***d*. The housing portion **301***a* is provided on one end side of the end cover **300**, has a substantially concave shape formed by an inner circumferential surface of the side portion **301** and a main surface of the bottom portion **302**, and can house the distal end portion **11**. The opening portion **301***b* is provided on the other end side of the end cover **300** and has a substantially concave shape formed by an inner circumferential surface of the side portion **301** and a main surface of the bottom portion **302**.

[0075] In the bottom portion **302**, a through hole **302***a* that communicates with the through hole **1113** when the end cover **300** is attached to the distal end portion **111** and a through hole (not illustrated) which communicates with the through hole **1114** and into which a treatment tool that is exposed through the treatment tool channel **101***a* can be inserted are formed.

[0076] The probe holding portion **301***c* includes: a first hole portion **3011** that is a hole forming a cylindrical hollow space from a surface of the end cover **300** facing the housing portion **301***a*; and a second hole portion **3012** that is a bottom of the probe holding portion **301***c*. The second hole portion **3012** has a diameter similar to that of a distal end surface of the measurement probe **5***b* and includes a first holding portion **3012***a* that holds the measurement probe **5***b* and a second holding portion **3012***b* that extends with a diameter smaller than that of the first holding portion **3012***a* and holds a fiber group **504** including an illumination fiber and light receiving fibers. The second holding portion **3012***b* has a bottom surface portion **3012***c* which is a contact surface that comes in contact with a fiber distal end surface of the fiber group **504**. The first hole portion **3011** has a diameter greater than that of the first holding portion **3012***a* of the second hole portion **3012**.

[0077] The rod portion **301***d* extends from the bottom surface portion **3012***c* to a plane P**7** passing through a distal end of the side portion **301**. A distance between the plane P**7** and a plane P**8** passing through the bottom surface portion **3012***c* is designed to be a distance d**1** in order to maintain a constant distance between the measurement target and the distal end portion **53**.

[0078] The fixation member **303** has a substantially cylindrical shape. The diameter of the inner circumference of the fixation member **303** is similar to that of the distal and portion of the measurement probe **5***b*. The fixation member **303** is formed by using an elastically deformable material.

[0079] One end of the fiber group **504** is connected to the light source unit **21** and the imaging unit **23** through the connector unit **22** and the other end is fixed to the second hole portion **3012** in a state of being in contact with the bottom surface portion **3012***c*. The distal end of the measurement probe **5***b* is held by the fixation member **303**. The arrangement of the measurement probe **5***b* is fixed when the fixation member **303** is pressed into the first housing portion **301***a*. The measurement probe **5***b* is held through the fixation member **303**, so that it is possible to prevent the fibers from being folded at the distal end of the measurement probe **5***b*.

[0080] According to the third embodiment of the present invention described above, the end cover **300** to which the insertion portion **110** (the distal end portion **111**) can be attached holds a distal end portion of the measurement probe **5***b*, and the position of the fiber group **504** exposed from the distal end portion is defined such that the distance from the position of the fiber group **504** to the measurement target is a predetermined distance d**1**, so that it is possible to stabilize the relative positional relationship between the endoscope and the measurement probe.

[0081] According to some embodiments, it is possible to stabilize the relative positional relationship between the endoscope and the measurement probe.

[0082] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A probe assembly comprising:

a measurement probe having a plurality of optical fibers configured to propagate light, emit the light to a measurement target, and receive scattered light returned from the measurement target; and

an end cover having: an endoscope holding portion configured to hold an insertion portion of an endoscope, the insertion portion being configured to be inserted into a body cavity of a subject; and a probe position defining portion configured to define a position of a distal end surface of the plurality of optical fibers of the measurement probe.

2. The probe assembly according to claim **1**, wherein the probe position defining portion is a contact surface of the endoscope holding portion, which is configured to come into

contact with a distal end of the insertion portion and to come into contact with a distal end surface of the measurement probe.

3. The probe assembly according to claim **2**, wherein the contact surface is configured to come into contact with the distal end surface of the plurality of optical fibers.

4. The probe assembly according to claim **2**, further comprising a light transmissive member that is provided at a distal end of the measurement probe and has one end configured to come into contact with the distal and surface of the plurality of optical fibers, wherein

the contact surface is configured to come into contact with the other end of the light transmissive member.

5. The probe assembly according to claim **1**, wherein the probe position defining portion is a hole which is configured to house a distal end of the measurement probe and which has a bottom surface portion configured to come into contact with a distal end surface of the measurement probe.

6. The probe assembly according to claim **5**, wherein the hole is formed in a part of a contact surface of the endoscope holding portion, which is configured to come into contact with the insertion portion.

7. The probe assembly according to claim **5**, wherein the hole is formed separately from the endoscope holding portion.

8. An end cover comprising:

an endoscope holding portion configured to hold an insertion portion of an endoscope, the insertion portion being configured to be inserted into a body cavity of a subject; and

a probe position defining portion configured to define a position of a distal end surface of a plurality of optical fibers of a measurement probe, the plurality of optical fibers being configured to propagate light, emit the light to a measurement target, and receive scattered light returned from the measurement target.

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