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# (54) IMAGE DIAGNOSTIC PROBE

BILDDIAGNOSESONDE

SONDE DE DIAGNOSTIC D'IMAGE

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EP 3 199 109 B1

## Description

### Technical Field

**[0001]** The present invention relates to an imaging probe for diagnosis used for diagnosing a biological lumen such as blood vessels and the like.

### Background Art

**[0002]** The present invention relates to an imaging probe for diagnosis as it is, e.g., known from US 2009/0281430 or WO 2013/145689.
When a stenotic lesion or the like appearing inside a biological lumen such as blood vessels and vascular channels is percutaneously treated, in order to observe a nature of the lesion or to observe a post-treatment condition, a catheter for diagnosis is used which acquires a tomographic image inside the biological lumen by using an ultrasound wave, light, or the like.

**[0003]** In intravascular ultrasound (IVUS) diagnosis, a rotatable imaging core having an ultrasound transducer is disposed in a distal end of an insertion unit. Rotary scanning (radial scanning) is generally performed via a drive shaft or the like extending from the imaging core to a user's hand-side drive unit.

**[0004]** In addition, in optical coherence tomography (OCT) utilizing wavelength sweeping, an imaging core having an optical transceiver attached to a distal end of an optical fiber is present, and is rotated via a drive shaft or the like extending from the imaging core to a user's hand-side drive unit. While the imaging core is rotated, near-infrared light is emitted to a vascular lumen from the optical transceiver in the distal end, and reflected light is received from a biological tissue. In this manner, the radial scanning is performed inside the blood vessel. Then, based on interference light generated by interference between the received reflected light and reference light, a cross-sectional image of the blood vessel is generally visualized.

**[0005]** Although OCT can obtain a high resolution image, OCT can obtain only an image captured from a vascular lumen surface to a relatively shallow tissue. On the other hand, in a case of IVUS, whereas the obtainable image resolution is lower than that of OCT, IVUS can obtain an image of vascular tissue which is deeper than that in OCT. Therefore, there has been proposed an imaging apparatus for diagnosis (imaging apparatus for diagnosis which includes an ultrasound transceiver capable of transmitting and receiving an ultrasound wave and an optical transceiver capable of transmitting and receiving light) that has an imaging core in which an IVUS function and an OCT function are combined with each other (refer to PTL 1).

**[0006]** Similar imaging probes are described in US2009281430 A1, which discloses all features of the preamble of claim 1, WO2013145689 A1, and US2011098572 A1.

### Citation List

### Patent Literature

**[0007]** PTL 1: JP-A-11-56752

### Summary of Invention

### Technical Problem

**[0008]** However, according to a dual sensor disclosed in PTL 1, a lens for OCT is arranged at a position close to a drive shaft, and an ultrasound transducer for IVUS is arranged at a position far from the drive shaft. Here, when an imaging core is manufactured, an end portion of the ultrasound transducer and a conductive wire extending from the drive shaft side are joined (soldered) to each other. Therefore, solder (joining material) is scattered during soldering, thereby causing a possibility that the solder may adhere to the lens located close to the end portion of the ultrasound transducer. In addition, the lens is likely to receive thermal influences from the solder or iron during the soldering. Furthermore, considering the scattering solder, the thermal influence during the soldering, or a wiring space, a mountable lens size has a strictly fixed upper limit.

**[0009]** The present invention is made in view of the above-described problem, and an object thereof is to provide a technique for minimizing possibilities that lens performance may be adversely affected by a scattered joining material or heat generated during joining.

### Solution to Problem

**[0010]** In order to achieve the above-described object, an imaging probe for diagnosis according to the present invention includes the following configuration. That is, there is provided an imaging probe for diagnosis which includes an imaging core having a drive shaft internally provided with an optical fiber and a signal line. The imaging probe for diagnosis includes an optical transceiver that is disposed in one end of the optical fiber, and an ultrasound transceiver that is joined to the signal line. The optical transceiver is arranged on a distal side of the imaging core from the ultrasound transceiver. An emitting direction of an ultrasound wave emitted from the ultrasound transceiver and an emitting direction of light emitted from the optical transceiver are substantially parallel to each other, and are directions which further tilt to a proximal end of the drive shaft than a direction orthogonal to the drive shaft.

### Advantageous Effects of Invention

**[0011]** According to the present invention, it is possible to minimize possibilities that lens performance may be affected by a scattered joining material or heat generated during joining.

**[0012]** Other features and advantageous effects according to the present invention will become apparent from the following description made with reference to the accompanying drawings. Note that in the accompanying drawings, the same reference numerals will be given to the same or similar configurations.

Brief Description of Drawings

**[0013]** The accompanying drawings are incorporated in the description, configure a part of the description, illustrate embodiments of the present invention and are used to explain principles of the present invention as well as describes the embodiments.

[Fig. 1] Fig. 1 is a view illustrating an external configuration of an imaging apparatus for diagnosis according to an embodiment of the present invention.
[Fig. 2] Fig. 2 is a view illustrating a structure example of an imaging core and a catheter accommodating the imaging core according to an embodiment of the present invention.
[Fig. 3] Fig. 3 is a view illustrating a modification example of the structure of the imaging core according to the embodiment of the present invention.
[Fig. 4] Fig. 4 is a view for describing a problem in a case where an ultrasound transceiver is arranged on a distal portion side of a catheter and an optical transceiver is arranged on a drive shaft side in the related art, compared to the present invention.
[Figs. 5A and 5B] Figs. 5A and 5B are views for describing an emitting direction (crossing or parallel) according to an embodiment of the present invention.
[Figs. 6A and 6B] Figs. 6A and 6B are views for describing an emitting direction (forward or rearward) according to an embodiment of the present invention.

Description of Embodiments

**[0014]** Hereinafter, each embodiment according to the present invention will be described in detail with reference to the accompanying drawings. Note that since embodiments described below are preferred embodiments of the present invention, there are various limitations which are technically preferable. However, in the following description, unless otherwise described to limit the present invention, the scope of the present invention is not limited to these embodiments. In addition, throughout the description, the same reference numerals represent the same configuration elements.

**[0015]** Fig. 1 is a view illustrating an external configuration of an imaging apparatus for diagnosis 100 according to an embodiment of the present invention. The imaging apparatus for diagnosis 100 according to the present embodiment has an IVUS function and an OCT function.

**[0016]** As illustrated in Fig. 1, the imaging apparatus for diagnosis 100 includes an imaging probe for diagnosis 101, a scanner and pull-back unit 102, and an operation control device 103. The scanner and pull-back unit 102 and the operation control device 103 are connected to each other via a connector 105 by a cable 104 which accommodates a signal line and an optical fiber.

**[0017]** The imaging probe for diagnosis 101 is directly inserted into a blood vessel. A catheter which accommodates an imaging core is inserted into the imaging probe for diagnosis 101. The imaging core includes an ultrasound transceiver which transmits an ultrasound wave based on a pulse signal and which receives a reflected wave from the inside of the blood vessel, and an optical transceiver which continuously transmits transmitted light (measurement light) to the inside of the blood vessel and which continuously receives reflected light from the inside of the blood vessel. The imaging apparatus for diagnosis 100 measures a state inside the blood vessel by using the imaging core.

**[0018]** The imaging probe for diagnosis 101 is detachably attached to the scanner and pull-back unit 102, and the scanner and pull-back unit 102 drives an embedded motor, thereby regulating motion, in an axial direction of the blood vessel, and rotation motion of the imaging core in the imaging probe for diagnosis 101 inserted into a catheter sheath. In addition, the scanner and pull-back unit 102 acquires a signal of the reflected wave received by the ultrasound transceiver inside the imaging core and the reflected light received by the optical transceiver, and transmits both of these to the operation control device 103.

**[0019]** In order to perform measurement, the operation control device 103 is provided with a function for inputting various setting values and a function for displaying various blood vessel images after processing ultrasound wave data or optical interference data obtained by measurement.

**[0020]** In the operation control device 103, the reference numeral 111 represents a main body control unit. The main body control unit 111 generates line data from the signal of the reflected ultrasound wave obtained by the measurement, and generates an ultrasound wave tomographic image through interpolation processing. Furthermore, the main body control unit 111 generates interference light data by causing the reflected light from the imaging core to interfere with reference light obtained by separating light from a light source. Based on the interference light data, the main body control unit 111 generates the line data, and generates a blood vessel tomographic image based on light interference through the interpolation processing.

**[0021]** The reference numeral 111-1 represents a printer & DVD recorder, which prints a processing result in the main body control unit 111 or stores the processing result as data. The reference numeral 112 represents an operation panel. A user inputs various setting values and instructions via the operation panel 112. The reference

numeral 113 represents an LCD monitor serving as a display apparatus. The LCD monitor 113 displays various tomographic images generated by the main body control unit 111. The reference numeral 114 represents a mouse serving as a pointing device (coordinate input device) .

**[0022]** Next, referring to Fig. 2, a structure of an imaging core 210 and a structure of a catheter 200 accommodating the imaging core 210 will be described. The reference numeral 200 in Fig. 2 represents a catheter according to the present embodiment. In addition, the catheter 200 corresponds to the imaging probe for diagnosis 101 in Fig. 1. An injection port 220 for injecting a transparent liquid (physiological salt solution or the like) into a catheter sheath 230 is disposed in the vicinity of a rear end (end portion connected to the pullback unit 102) in the catheter 200.

**[0023]** In addition, the catheter sheath 230 of the catheter 200 is configured to include a transparent material, and internally accommodates the imaging core 210 which is rotatable and movable along the catheter 200. The imaging core 210 includes a drive shaft 2104, and a housing 2103 is disposed in one end of the drive shaft 2104. The housing 2103 accommodates an ultrasound transceiver 2101 and an optical transceiver 2102. The ultrasound transceiver 2101 is supported by a backing member 2107. In addition, the housing 2103 is supported by the drive shaft 2104.

**[0024]** The drive shaft 2104 is configured to include a flexible material which has a characteristic capable of excellently transmitting rotation, for example, a multiplex-multilayer contact coil made of a metal wire such as stainless steel. Then, the drive shaft 2104 internally accommodates a signal line 2105 and an optical fiber 2106. An end portion of the signal line 2105 is joined to an electrode 2112 of the ultrasound transceiver 2101 on the backing member 2107 by soldering (solder 2113) . Here, since the backing member 2107 is provided, reflection from a rear surface side of the ultrasound transceiver 2101 can be restrained, and reflection from a side other than a vascular lumen surface can be restrained.

**[0025]** The electrode 2112 is connected to an ultrasound transducer which configures the ultrasound transceiver 2101. The signal line 2105 and the electrode 2112 of the ultrasound transceiver 2101 are joined to each other in one end on a side far from the optical transceiver 2102, which is one end of the ultrasound transceiver 2101. The backing member 2107 has a groove portion 2107a for allowing the optical fiber 2106 to pass therethrough. In this manner, a diameter of the imaging core 210 can be formed small.

**[0026]** In addition, the housing 2103 is a cylindrical metal pipe, and partially has a cutout portion. The ultrasound transceiver 2101 and the optical transceiver 2102 transmit and receive an ultrasound wave and light via the cutout portion.

**[0027]** The ultrasound transceiver 2101 emits the ultrasound wave toward an illustrated arrow 2108a in accordance with a pulse signal applied from the signal line 2105, detects the reflected wave from a vascular tissue illustrated by an arrow 2108b, and transmits the reflected wave to the signal line 2105 after converting the reflected wave into an electric signal.

**[0028]** The optical transceiver 2102 is disposed in an end portion of the optical fiber 2106, and has a hemispherical shape in which a spherical body is cut at an angle of approximately 45 degrees from a vertical plane in the drawing. A mirror portion is formed on a slope of the optical transceiver 2102. In addition, the optical transceiver 2102 has the hemispherical shape. In this manner, a lens function is also provided therefor. The light supplied via the optical fiber 2106 is reflected on the mirror portion, and is emitted toward the vascular tissue along an illustrated arrow 2109a. Then, the optical transceiver 2102 receives the reflected light from the vascular tissue indicated by an illustrated arrow 2109b. The reflected light is reflected on the mirror portion, and returns to the optical fiber 2106.

**[0029]** When scanning is performed, in accordance with driving of a radial scanning motor of the pullback unit 102, the drive shaft 2104 is rotated along an arrow 2110, and is moved along an arrow 2111. As a result, while the ultrasound transceiver 2101 and the optical transceiver 2102 which are accommodated in the housing 2103 are rotated and moved in the axial direction, both of these respectively emit the ultrasound wave and detect the reflected wave, and emit the light and detect the reflected light.

**[0030]** Note that in the example illustrated in Fig. 2, the groove portion 2107a for allowing the optical fiber 2106 to pass therethrough is formed in the backing member 2107. However, as illustrated in Fig. 3, a central axis of the optical fiber 2106 may be eccentric from a central axis of the drive shaft 2104. In this manner, a configuration may be adopted in which the optical fiber 2106 is arranged along the backing member 2107 without coming into contact with the backing member 2107.

**[0031]** As illustrated in Figs. 2 and 3, according to the present embodiment, the ultrasound transceiver 2101 is arranged on the drive shaft 2104 side, and the optical transceiver 2102 is arranged on the distal portion side. In this manner, compared to a case where both of these are conversely arranged, the electrode 2112 and the optical transceiver 2102 can be separated farther from each other. Therefore, it is possible to minimize possibilities that lens performance of the optical transceiver 2102 may be affected by scattered solder during manufacturing or heat generated during soldering. In addition, the signal line 2105 does not extend to a space of the cutout portion. Accordingly, the space can be effectively utilized, and the optical transceiver 2102 can be configured to have a larger lens size.

**[0032]** Here, Fig. 4 is a view for describing a problem in a case where the ultrasound transceiver 2101 is arranged on the distal portion side of the catheter and the optical transceiver 2102 is arranged on the drive shaft 2104 side. A corner 401 in Fig. 4 may become an obstacle

of the light emitted from the optical transceiver 2102. However, in a case where the optical transceiver 2102 is moved to the ultrasound transceiver 2101 side, a distance from the electrode 2112 becomes shorter. Consequently, it is not preferable in that not only the optical transceiver 2102 is easily affected by the soldering, but also the soldering itself is less likely to be performed.

**[0033]** In addition, it is also conceivable to obliquely cut the corner 401. However, since a diameter of the drive shaft 2104 is as very small as approximately 0.5 mm, it is difficult to carry out processing work for the corner 401. In addition, since the signal line 2105 extends to the space of the cutout portion, it is difficult to effectively utilize the space due to the influence of wiring. According to the arrangement configuration in the present embodiment illustrated in Figs. 2 and 3, it is possible to solve these problems.

**[0034]** Subsequently, Figs. 5A and 5B are views for describing a relationship between an emitting direction of the ultrasound wave from the ultrasound transceiver 2101 and an emitting direction of the light from the optical transceiver 2102 . Fig. 5A illustrates a case where the respective emitting directions cross each other according to a configuration example in the related art illustrated in Fig. 4. Fig. 5B illustrates a case where the respective emitting directions are parallel to each other according to a configuration example in the embodiment of the present invention in Fig. 2. Even in a case where the emitting directions cross each other as illustrated in Fig. 5A, it is possible to acquire an IVUS observation cross-sectional image and an OCT observation cross-sectional image. However, the emitting direction of the ultrasound wave and the emitting direction of the light are different from each other. Accordingly, it is difficult to acquire the IVUS observation cross-sectional image and the OCT observation cross-sectional image for substantially the same cross section.

**[0035]** In contrast, if the emitting directions are substantially parallel to each other as illustrated in Fig. 5B, it is possible to always acquire a substantially parallel image at regular intervals. Based on a rotation speed of the drive shaft 2104, a pullback speed, a beam emitting interval, and the like, respective frames are shifted from one another. In this manner, it is possible to acquire the IVUS observation cross-sectional image and the OCT observation cross-sectional image for substantially the same cross section. Therefore, improved accuracy of intravascular diagnosis can be expected.

**[0036]** Furthermore, Figs. 6A and 6B are views for describing a case where the electrode 2112 is affected by the emitting direction of the light from the ultrasound transceiver 2101. Fig. 6A illustrates a case of rearward emitting (arrow 601) according to a configuration example in the embodiment of the present invention in Fig. 2, and Fig. 6B illustrates a case of forward emitting (arrow 602) according to a configuration example in the related art illustrated in Fig. 4. Here, the rearward emitting means emitting in which the emitting direction of the light from the ultrasound transceiver 2101 is a direction tilting to the drive shaft 2104 side from a direction orthogonal to the drive shaft 2104. In addition, the forward emitting means emitting in which the emitting direction of the light from the ultrasound transceiver 2101 is a direction tilting to the catheter distal portion side from the direction orthogonal to the drive shaft 2104.

**[0037]** If the light is emitted forward, the emitting of the light from the ultrasound transceiver 2101 for IVUS increases exposed wiring of the signal line 2105 to the cutout portion space. Accordingly, the exposed wiring can be reduced by emitting the light rearward. In this manner, it is possible to effectively utilize an empty space. In addition, if the light is emitted forward, a load is likely to be applied to the electrode 2112, and joining strength of the soldering is weakened. The sensor is likely to be damaged after being detached from the solder 2113. From this point of view, the rearward emitting is suitable.

**[0038]** Note that in a case where the light and the ultrasound wave are emitted in the direction orthogonal to the drive shaft 2104, mainly the intensity of the reflected wave and the reflected light from the catheter sheath 230 is strong, thereby affecting a tomographic image to be acquired. Accordingly, as in the forward emitting or the rearward emitting, it is desirable to emit the light and the ultrasound wave in a direction shifted from the vertical direction. Note that in Figs. 6A and 6B, description has been made on the assumption of the configuration example in Fig. 4. However, even in the configuration example in Figs. 2 and 3, the exposed wiring of the signal line 2105 to the cutout portion space decreases. If the light and the ultrasound wave are emitted forward, the load is still likely to be applied to the electrode 2112. Therefore, it is desirable to similarly emit the light and the ultrasound wave rearward.

**[0039]** As described above, the imaging probe for diagnosis 101 according to the present embodiment includes the imaging core 210 having the drive shaft 2104 internally provided with the optical fiber 2106 and the signal line 2105. The imaging probe for diagnosis 101 includes the optical transceiver 2102 that is disposed in one end of the optical fiber 2106, and the ultrasound transceiver 2101 that is joined to the signal line 2105. The optical transceiver 2102 is arranged on the distal side of the imaging core 210 from the ultrasound transceiver 2101.

**[0040]** The emitting direction of the ultrasound wave emitted from the ultrasound transceiver 2101 and the emitting direction of the light emitted from the optical transceiver 2102 are substantially parallel to each other, and are directions (rearward emitting) which further tilt to the proximal side (side where the drive shaft 2104 is present) of the drive shaft 2104 than the direction orthogonal to the drive shaft 2104.

**[0041]** In this way, an arrangement relationship between the ultrasound transceiver 2101 and the optical transceiver 2102 is configured as in the example illustrated in Figs. 2 and 3. Accordingly, it is possible to min-

imize possibilities that lens performance may be affected by the scattered joining material during manufacturing of the imaging core 210 or the heat generated during joining. Furthermore, the light and the ultrasound wave are emitted rearward as illustrated in Fig. 5B. In this manner, it is possible to effectively utilize the space and to improve the joining strength.

**[0042]** Without being limited to the above-described embodiments, the present invention can be changed and modified in various ways without departing from the scope of the present invention. Therefore, in order to officially announce the scope of the present invention, claims are appended as follows.

## Claims

1. An imaging probe (101) for diagnosis which includes an imaging core (210) having a drive shaft (2104) internally provided with an optical fiber (2106) and a signal line (2105), comprising:

   an optical transceiver (2102) that is disposed in one end of the optical fiber (2106); and
   an ultrasound transceiver (2101) that is joined to the signal line (2105),
   wherein the optical transceiver (2102) is arranged on a distal side of the imaging core (210) from the ultrasound transceiver (2101), and
   wherein an emitting direction of an ultrasound wave emitted from the ultrasound transceiver (2101) and an emitting direction of light emitted from the optical transceiver (2102) are substantially parallel to each other,
   **characterized in that** the emitting direction of an ultrasound wave emitted from the ultrasound transceiver (2101) and the emitting direction of light emitted from the optical transceiver (2102) are directions which are further tilted to a proximal side of the drive shaft (2104) than a direction orthogonal to the drive shaft (2104), and
   the signal line (2105) and the ultrasound transceiver (2101) are joined to each other by soldering.

2. The imaging probe (101) for diagnosis according to Claim 1,
   wherein the ultrasound transceiver (2101) has a backing member (2107),
   wherein a groove portion (2107a) is disposed in the backing member (2107), and
   wherein the optical fiber (2106) extends through the groove portion (2107a).

3. The imaging probe (101) for diagnosis according to Claim 1 or 2,
   wherein a central axis of the optical fiber (2106) is eccentric from a central axis of the drive shaft (2104).

4. The imaging probe (101) for diagnosis according to any one of Claims 1 to 3,
   wherein the signal line (2105) and the ultrasound transceiver (2101) are joined to each other in one end on a side far from the optical transceiver (2102), which is one end of the ultrasound transceiver (2101).

5. The imaging probe (101) for diagnosis according to any one of Claims 1 to 4,
   wherein the imaging core (210) is further provided with a housing (2103) which is disposed in one end of the drive shaft (2104) and which has a cutout portion, and
   wherein the optical transceiver (2102) and the ultrasound transceiver (2101) are installed in the housing (2103).

## Patentansprüche

1. Bildgebungssonde (101) zur Diagnose, die einen Bildgebungskern (210) mit einer Antriebswelle (2104), die intern mit einer optischen Faser (2106) und einer Signalleitung (2105) versehen ist, beinhaltet, umfassend:

   einen optischen Sender-Empfänger (2102), der an einem Ende der optischen Faser (2106) angeordnet ist; und
   einen Ultraschallsender-Empfänger (2101), der mit der Signalleitung (2105) verbunden ist,
   wobei der optische Sender-Empfänger (2102) auf einer distalen Seite des Bildgebungskerns (210) von dem Ultraschallsender-Empfänger (2101) angeordnet ist, und
   wobei eine Senderichtung einer von dem Ultraschallsender-Empfänger (2101) abgestrahlten Ultraschallwelle und eine Senderichtung des von dem optischen Sender-Empfänger (2102) abgestrahlten Lichts im Wesentlichen parallel zueinander sind,
   **dadurch gekennzeichnet, dass** die Abstrahlrichtung einer von dem Ultraschallsender-Empfänger (2101) abgestrahlten Ultraschallwelle und die Abstrahlrichtung des von dem optischen Sender-Empfänger (2102) abgestrahlten Lichts Richtungen sind, die weiter zu einer proximalen Seite der Antriebswelle (2104) abgewinkelt sind, als eine Richtung orthogonal zur Antriebswelle (2104), und
   die Signalleitung (2105) und der Ultraschallsender-Empfänger (2101) durch Löten miteinander verbunden sind.

2. Bildgebungssonde (101) zur Diagnose nach Anspruch 1,
   wobei der Ultraschallsender-Empfänger (2101) ein

Unterstützungselement (2107) aufweist,
wobei ein Nutabschnitt (2107a) in dem Unterstützungselement (2107) angeordnet ist, und
wobei sich die optische Faser (2106) durch den Nutabschnitt (2107a) erstreckt.

**3.** Bildgebungssonde (101) zur Diagnose nach Anspruch 1 oder 2,
wobei eine Mittelachse der optischen Faser (2106) exzentrisch zu einer Mittelachse der Antriebswelle (2104) ist.

**4.** Bildgebungssonde (101) zur Diagnose nach einem der Ansprüche 1 bis 3,
wobei die Signalleitung (2105) und der Ultraschallsender-Empfänger (2101) an einem Ende auf einer Seite fernab von dem optischen Sender-Empfänger (2102), das ein Ende des Ultraschallsender-Empfängers (2101) ist, miteinander verbunden sind.

**5.** Bildgebungssonde (101) zur Diagnose nach einem der Ansprüche 1 bis 4,
wobei der Bildgebungskern (210) ferner mit einem Gehäuse (2103) versehen ist, das in einem Ende der Antriebswelle (2104) angeordnet ist und das einen ausgeschnittenen Abschnitt aufweist, und
wobei der optische Sender-Empfänger (2102) und der Ultraschallsender-Empfänger (2101) in dem Gehäuse (2103) installiert sind.

**Revendications**

**1.** Sonde d'imagerie (101) pour diagnostic qui comprend une partie centrale d'imagerie (210) ayant un arbre d'entraînement (2104) muni de façon interne d'une fibre optique (2106) et d'une ligne de signal (2105), comprenant :

un émetteur-récepteur optique (2102) qui est disposé dans une extrémité de la fibre optique (2106) ; et
un émetteur-récepteur à ultrasons (2101) qui est relié à la ligne de signal (2105),
où l'émetteur-récepteur optique (2102) est arrangé sur un côté distal de la partie centrale d'imagerie (210) par rapport à l'émetteur-récepteur à ultrasons (2101), et
où une direction d'émission d'une onde ultrasonore émise depuis l'émetteur-récepteur à ultrasons (2101) et une direction d'émission de lumière émise depuis l'émetteur-récepteur optique (2102) sont sensiblement parallèles l'une à l'autre, **caractérisée en ce que** la direction d'émission d'une onde ultrasonore émise depuis l'émetteur-récepteur à ultrasons (2101) et la direction d'émission de lumière émise depuis l'émetteur-récepteur optique (2102) sont des directions qui sont plus inclinées vers un côté proximal de l'arbre d'entraînement (2104), qu'une direction orthogonale à l'arbre d'entraînement (2104), et
la ligne de signal (2105) et l'émetteur-récepteur à ultrasons (2101) sont reliés l'un à l'autre par brasage.

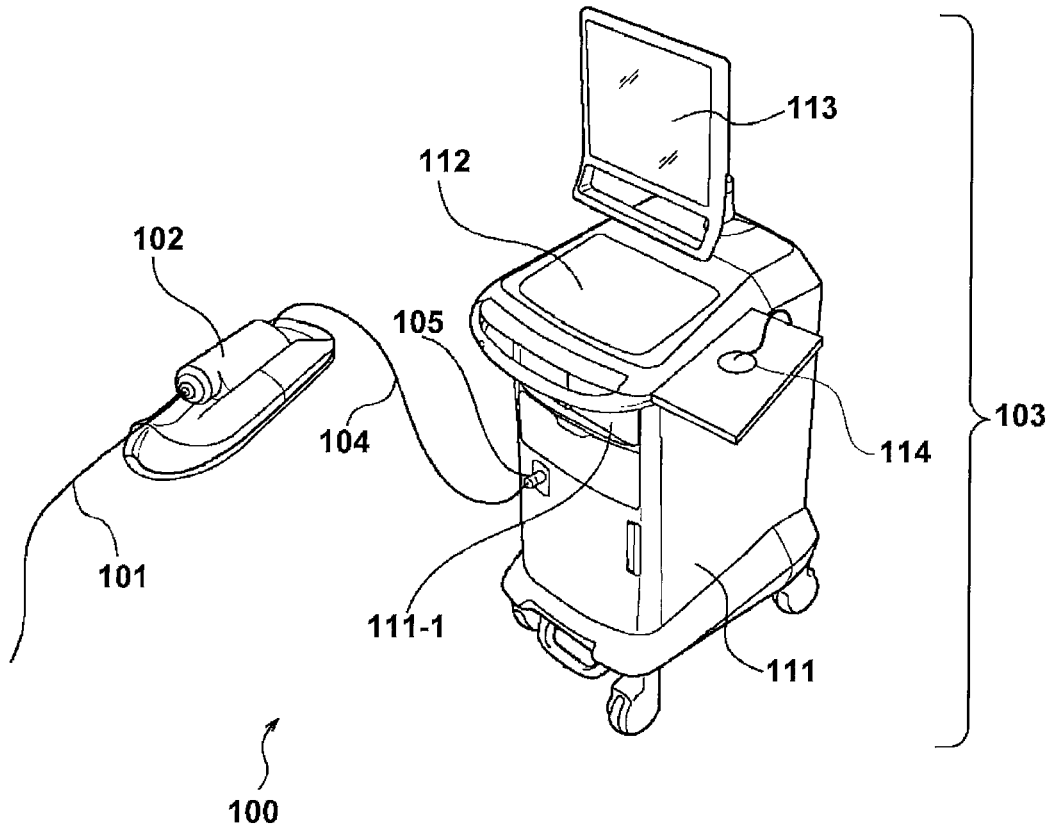
**2.** Sonde d'imagerie (101) pour diagnostic selon la revendication 1,
dans laquelle l'émetteur-récepteur à ultrasons (2101) comprend un élément de support (2107),
dans laquelle une partie rainure (2107a) est disposée dans l'élément de support (2107), et
dans laquelle la fibre optique (2106) s'étend à travers la partie rainure (2107a).

**3.** Sonde d'imagerie (101) pour diagnostic selon la revendication 1 ou 2,
dans laquelle un axe central de la fibre optique (2106) est excentrique par rapport à un axe central de l'arbre d'entraînement (2104).

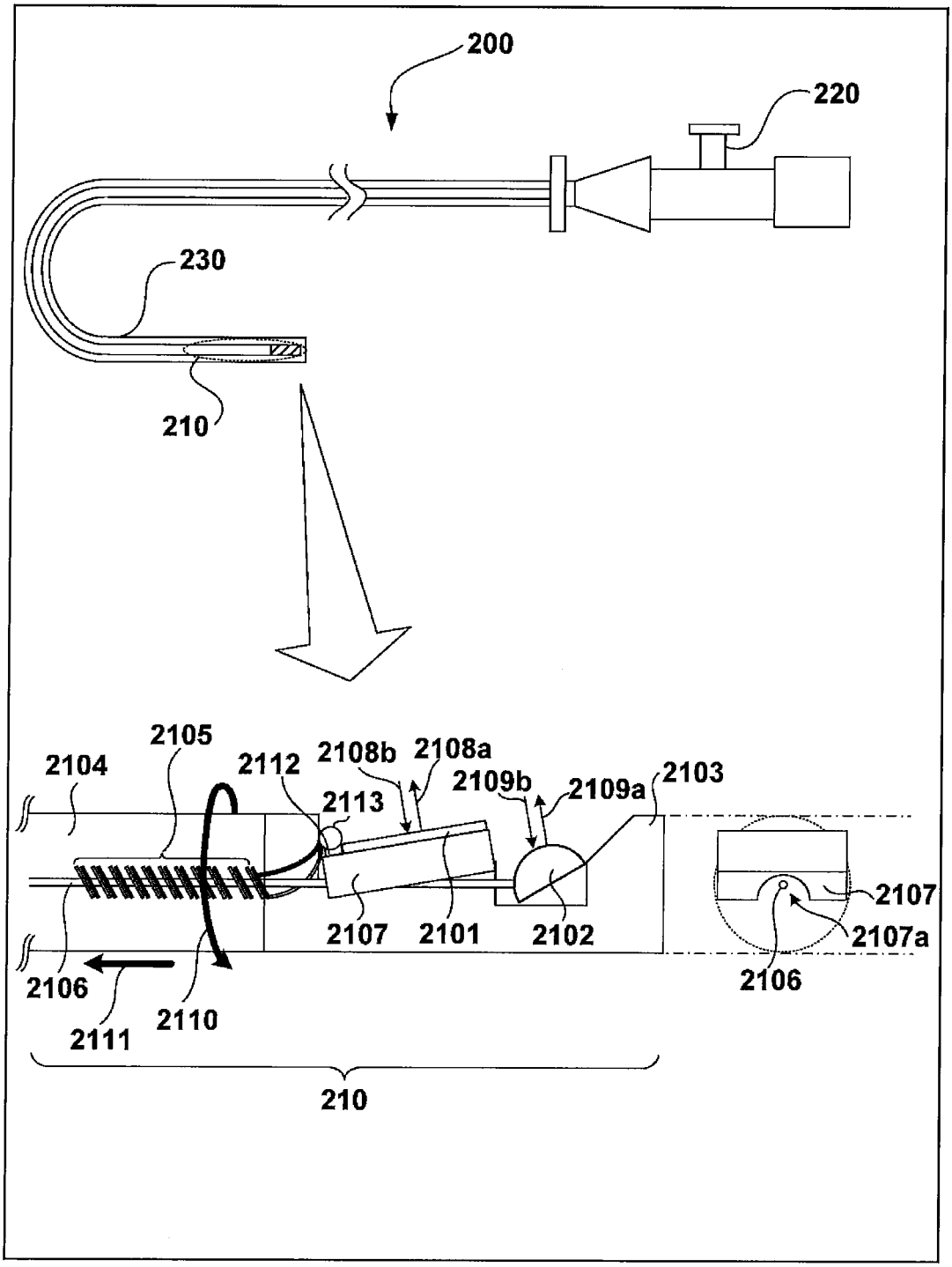
**4.** Sonde d'imagerie (101) pour diagnostic selon l'une quelconque des revendications 1 à 3,
dans laquelle la ligne de signal (2105) et l'émetteur-récepteur à ultrasons (2101) sont reliés l'un à l'autre dans une extrémité d'un côté éloigné de l'émetteur-récepteur optique (2102), qui est une extrémité de l'émetteur-récepteur à ultrasons (2101).

**5.** Sonde d'imagerie (101) pour diagnostic selon l'une quelconque des revendications 1 à 4,
dans laquelle la partie centrale d'imagerie (210) est en outre munie d'un boîtier (2103) qui est disposé dans une extrémité de l'arbre d'entraînement (2104) et qui a une partie découpée, et
dans laquelle l'émetteur-récepteur optique (2102) et l'émetteur-récepteur à ultrasons (2101) sont installés dans le boîtier (2103).

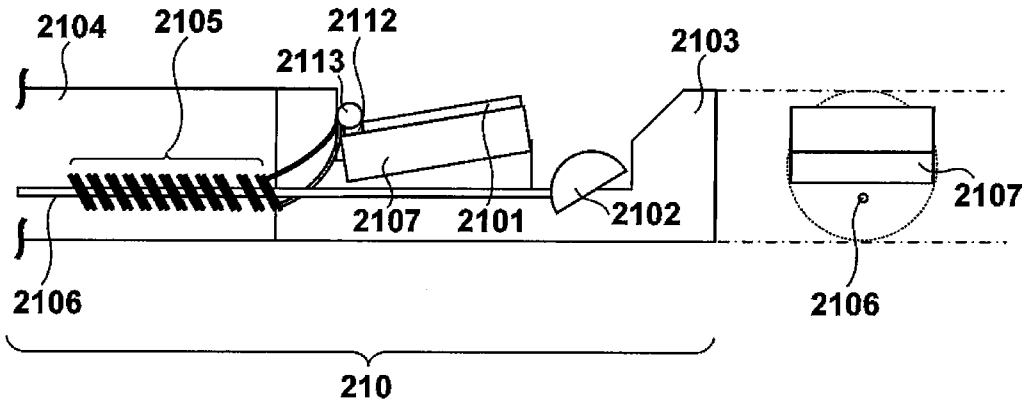
[FIG.1]



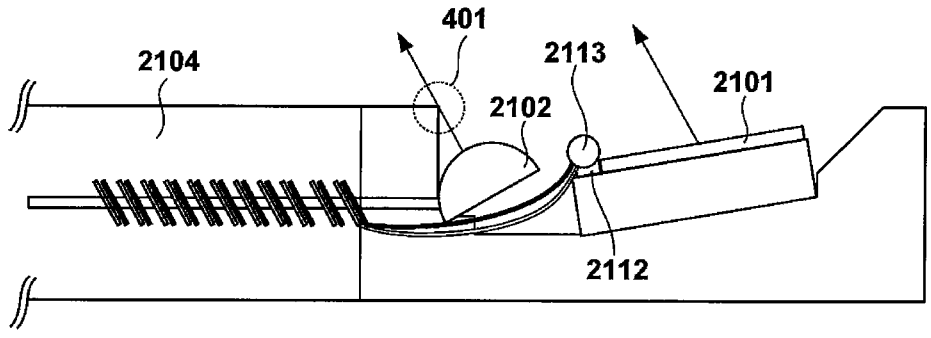
[FIG.2]


200
220
230
210
2105
2104
2112
2108b
2108a
2109b
2109a
2103
2113
2107
2101
2102
2107
2107a
2106
2106
2111
2110
210

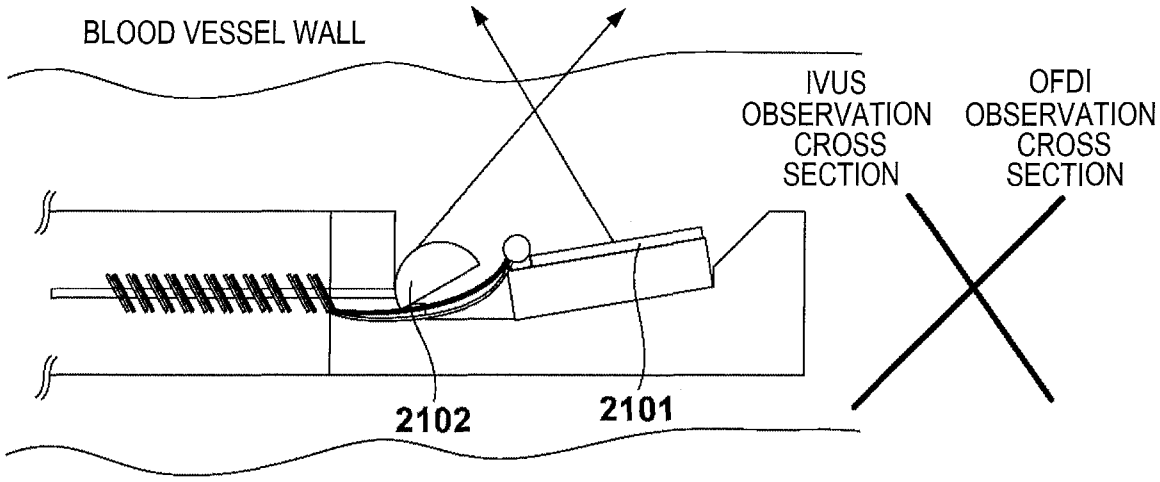
[FIG.3]


2104
2105
2112
2113
2103
2107
2101
2102
2107
2106
2106
210

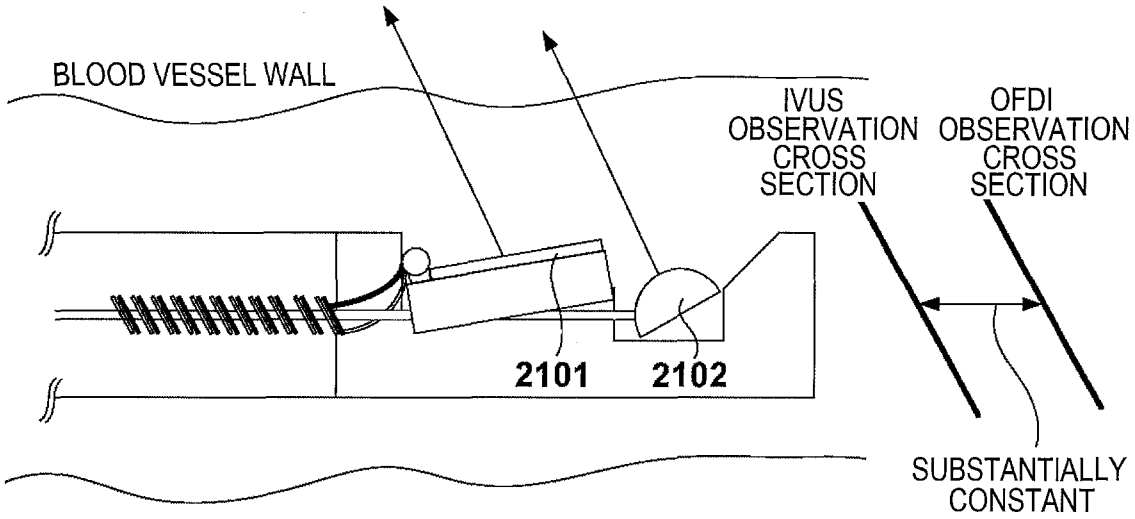
[FIG.4]


401
2104
2113
2101
2102
2112

[FIG. 5A]


BLOOD VESSEL WALL
IVUS OBSERVATION CROSS SECTION
OFDI OBSERVATION CROSS SECTION
2102
2101

[FIG. 5B]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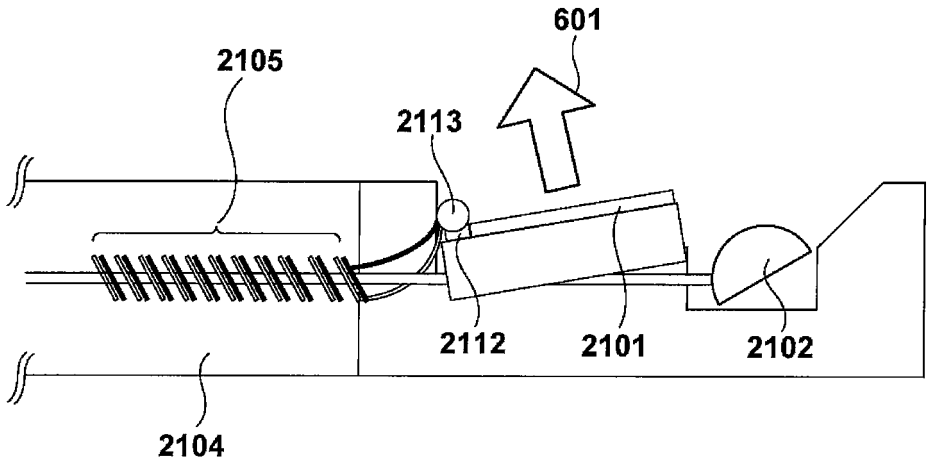
IVUS OBSERVATION CROSS SECTION
OFDI OBSERVATION CROSS SECTION
2101
2102
SUBSTANTIALLY CONSTANT

[FIG. 6A]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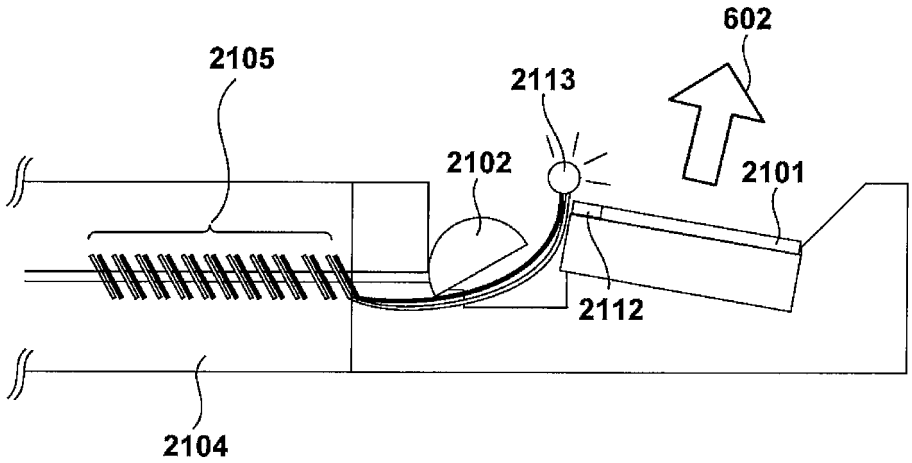
2102
2104

[FIG. 6B]


602
2105
2113
2102
2101
2112
2104

## REFERENCES CITED IN THE DESCRIPTION

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| 其他公开文献 | EP3199109A1<br>EP3199109A4 | | |
| 外部链接 | Espacenet | | |


摘要(译)

提供了一种用于诊断的成像探头，该成像探头包括成像芯，该成像芯具有在内部设置有光纤和信号线的驱动轴。 用于诊断的成像探头包括：光收发器，其布置在光纤的一端；以及超声收发器，其连接至信号线。 光学收发器被布置在超声收发器的成像芯的远端侧。 从超声波收发器发射的超声波的发射方向和从光收发器发射的光的发射方向基本上彼此平行，并且是与正交于驱动轴的方向向驱动轴的近端进一步倾斜的方向。传动轴。


[FIG.1]