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(54) ULTRASONIC PROBE UNIT, ULTRASONIC PROBE, AND ULTRASONIC APPARATUS

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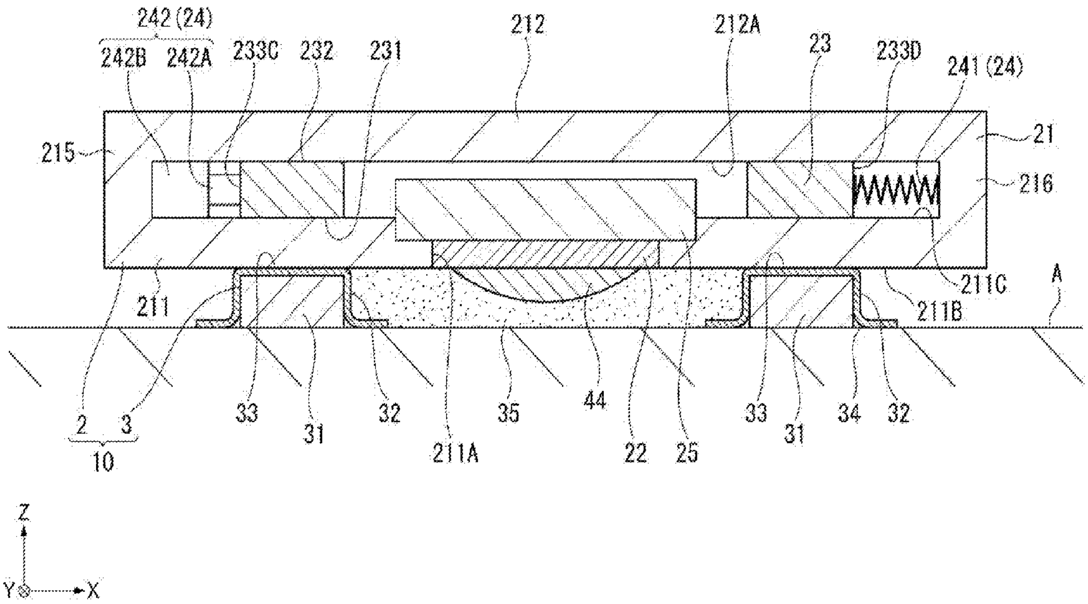
(57) **ABSTRACT**

An ultrasonic probe unit is provided with an ultrasonic probe, and a fixation section adapted to fix the ultrasonic probe to a living body, the ultrasonic probe includes an ultrasonic device adapted to perform transmission and reception of an ultrasonic wave, a probe-side magnet, and a displacement mechanism adapted to adjust a relative positional relationship between the ultrasonic device and the probe-side magnet, and the fixation section includes a fixation surface to be fixed to the living body, and a fixation section-side magnet a relative position of which to the probe-side magnet is fixed to thereby fix the ultrasonic probe to the living body.



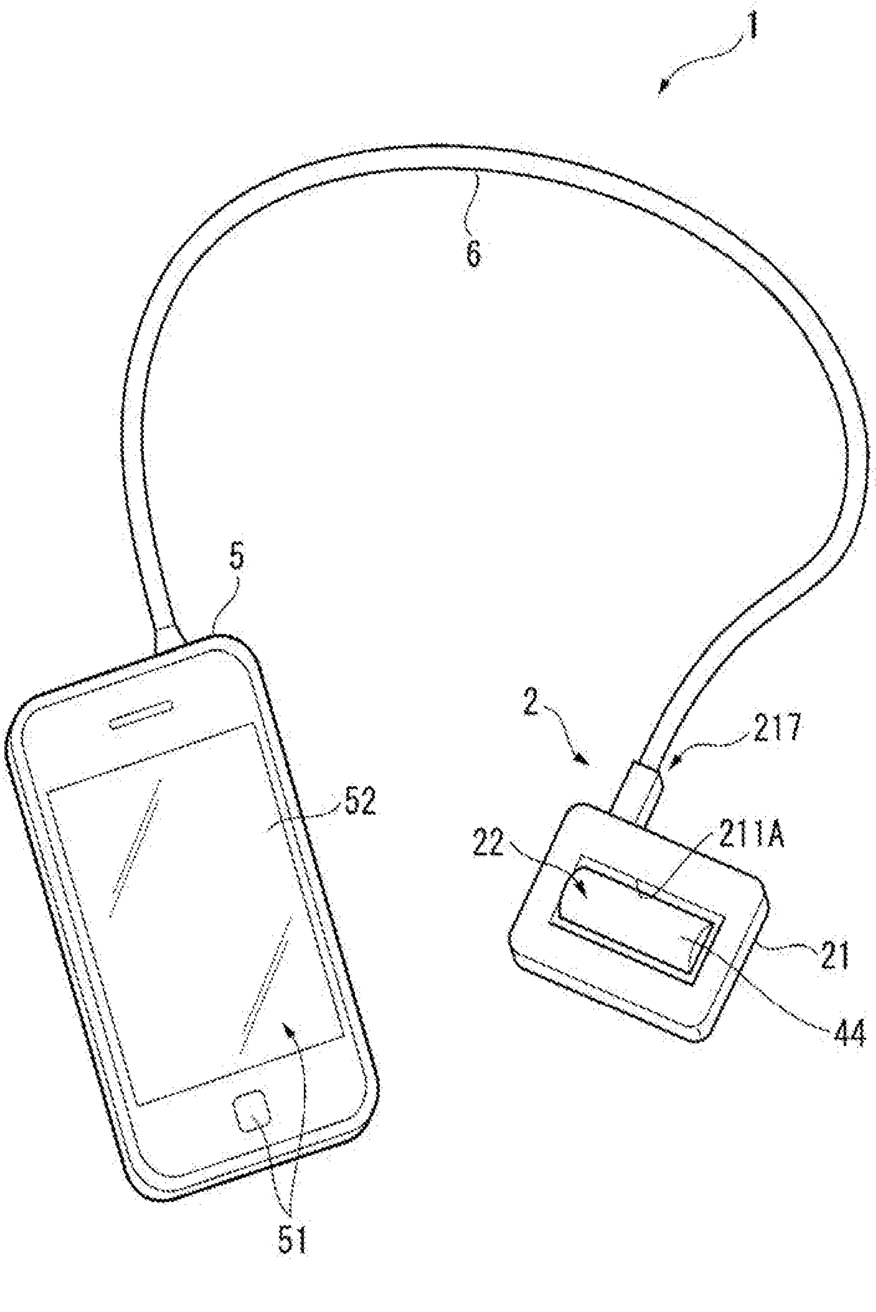
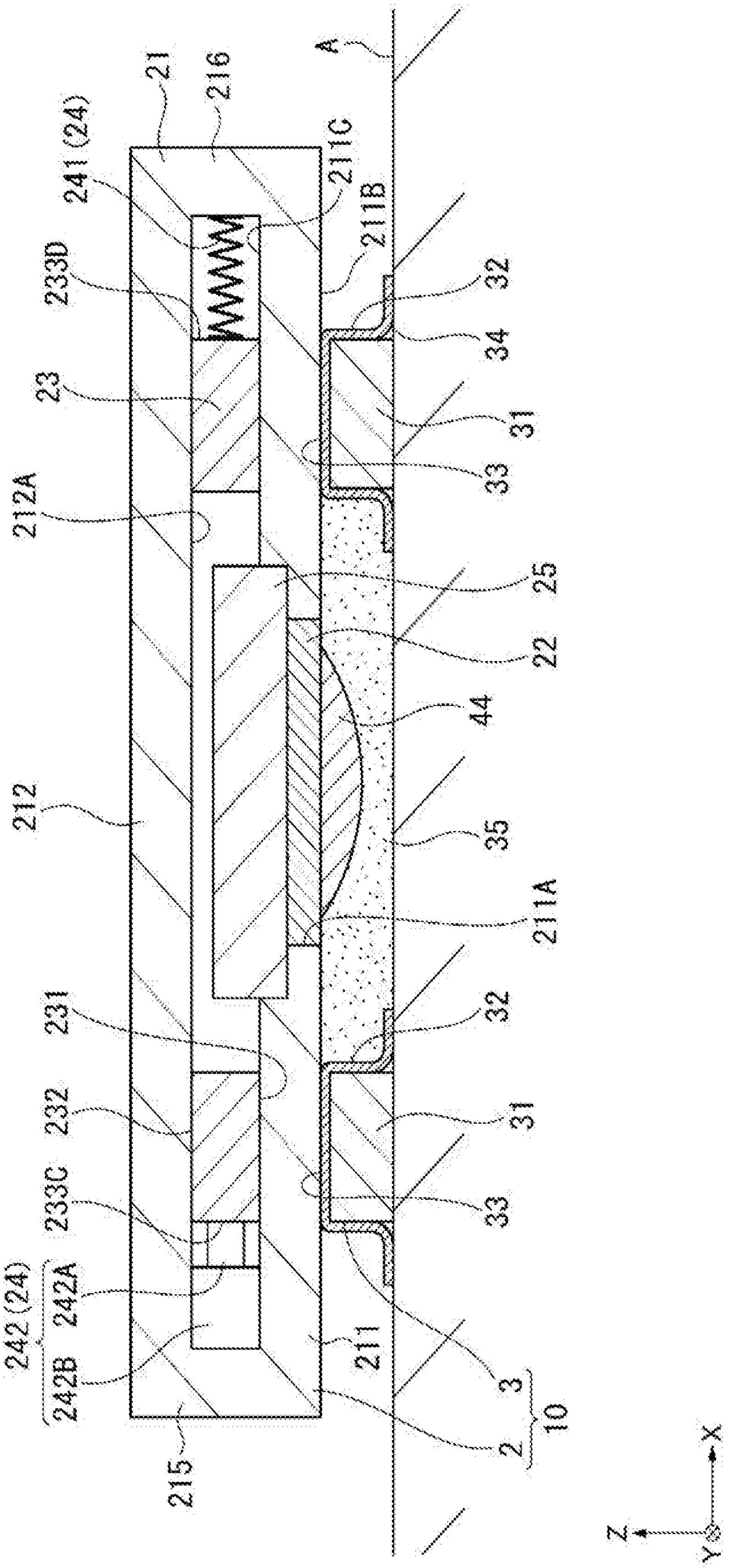


FIG. 1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211A
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242B
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Z
Y

FIG. 2

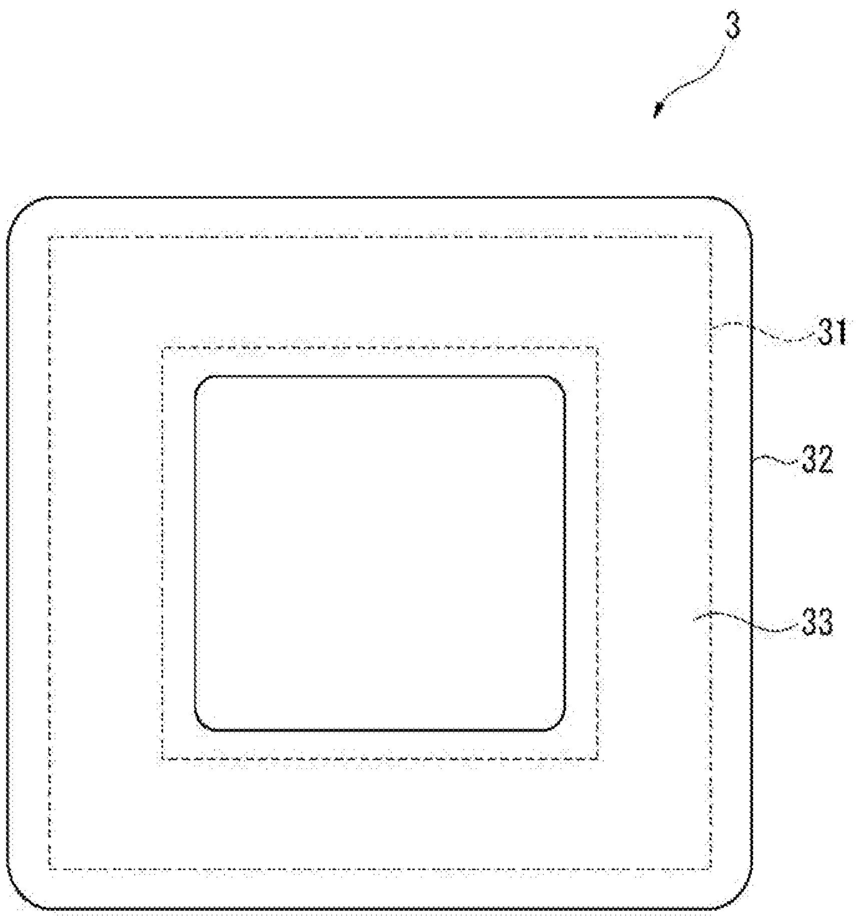
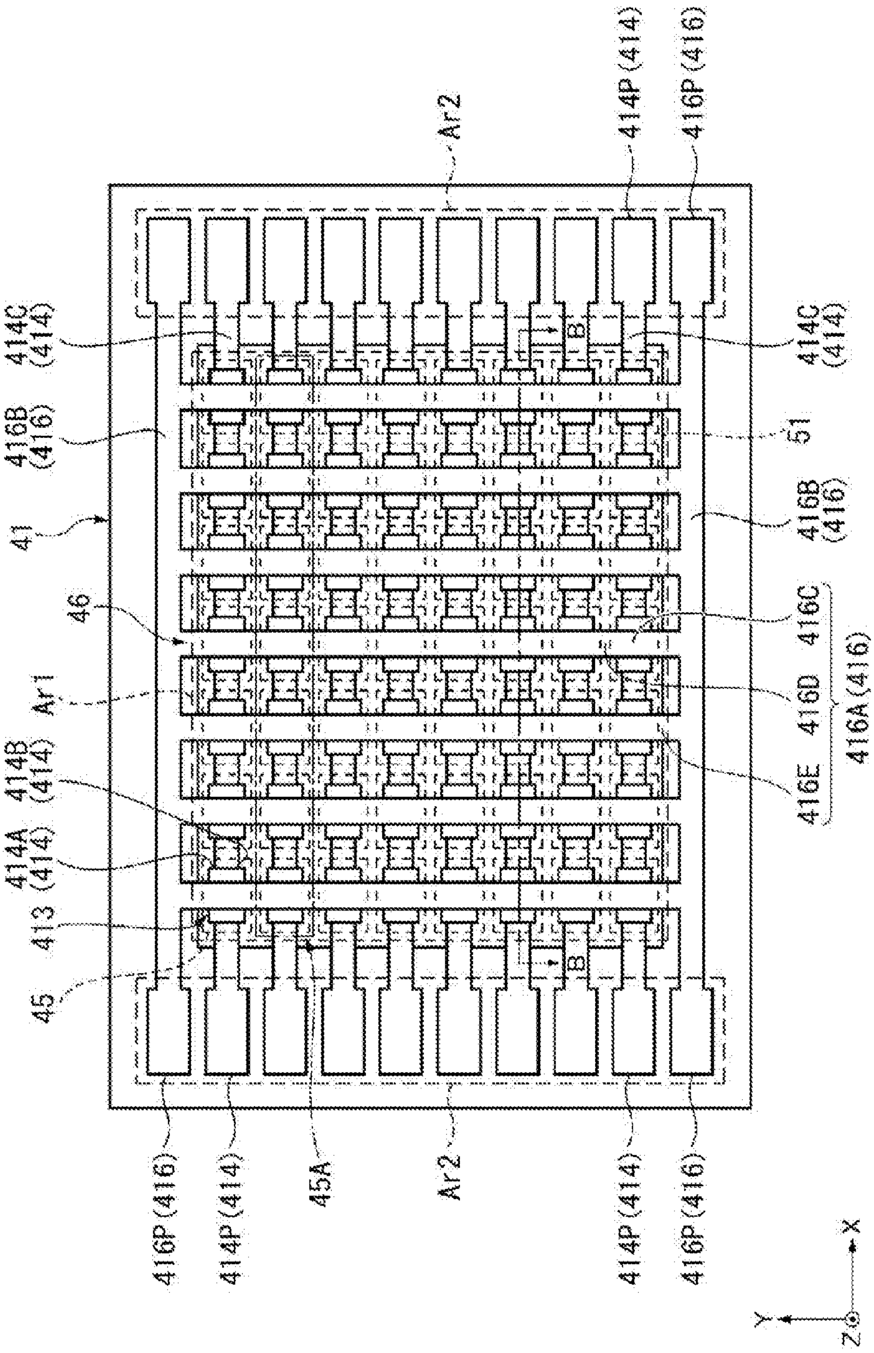
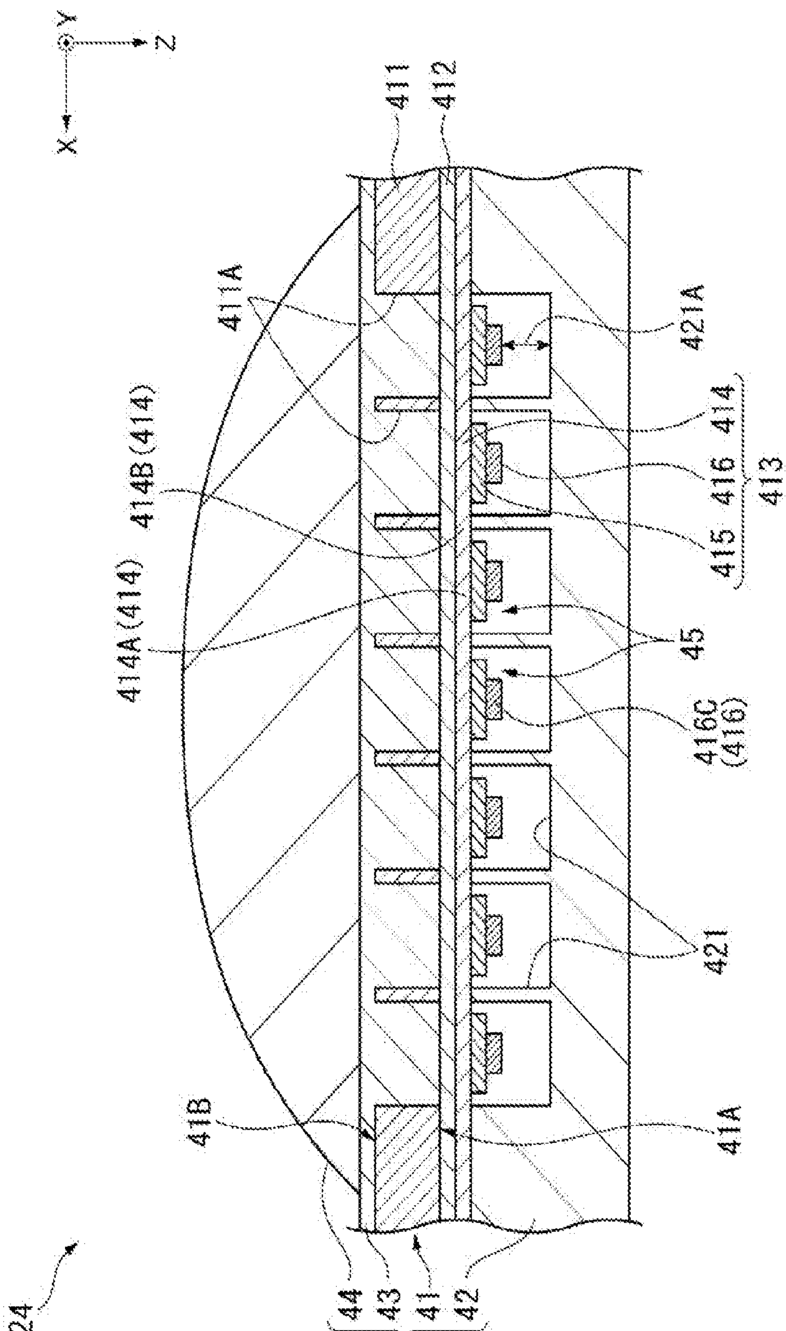


FIG. 3



414C (414)
416B (416)
41
46
Ar1
414B (414)
414A (414)
413
45
Ar2
414P (414)
416P (416)
B
51
416C
416D
416E
416A (416)
45A
X
Y
Z

FIG. 4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Y
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414
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(416)
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41B
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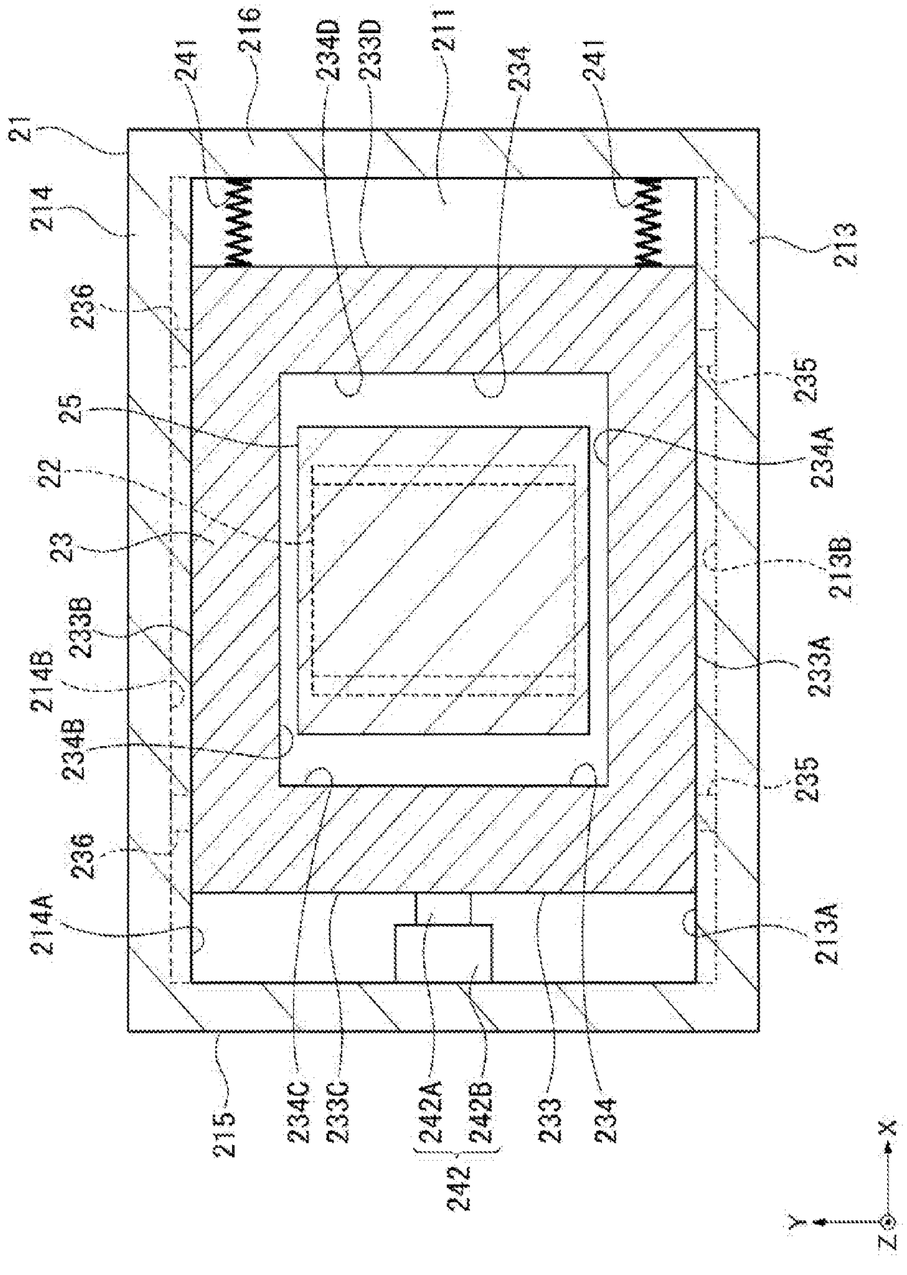
24
44
43
41
42
22

FIG. 5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235
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Y
Z

FIG. 6

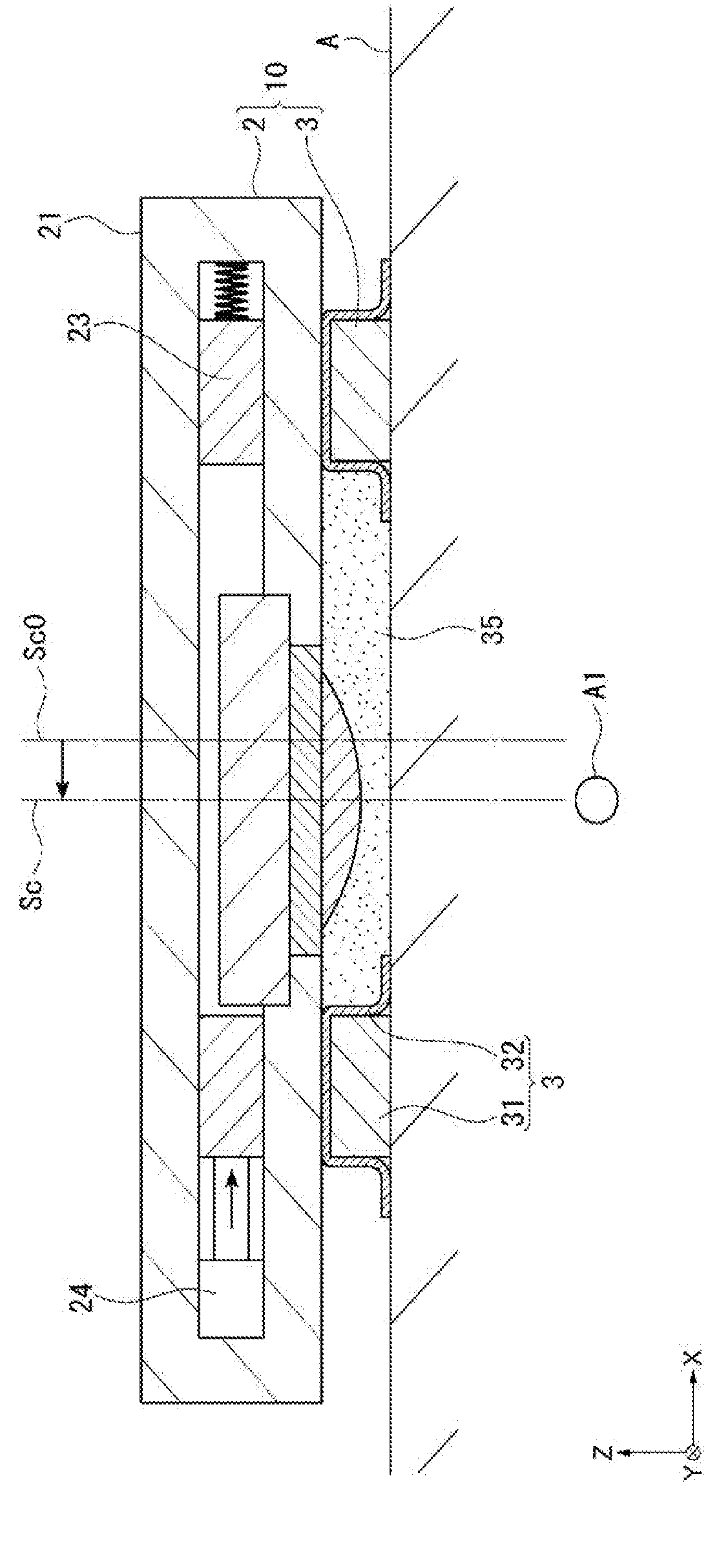
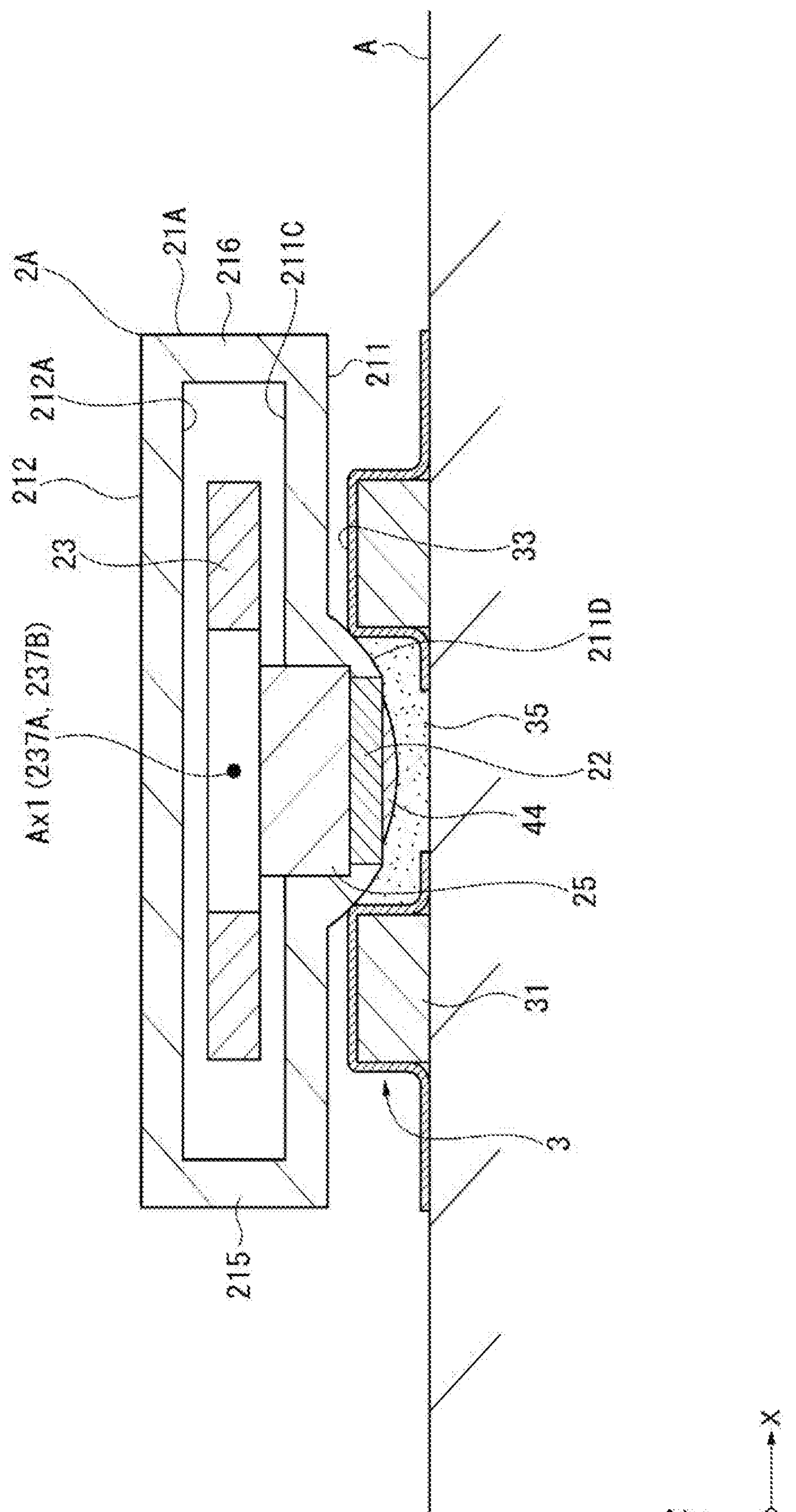


FIG. 7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211D
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3
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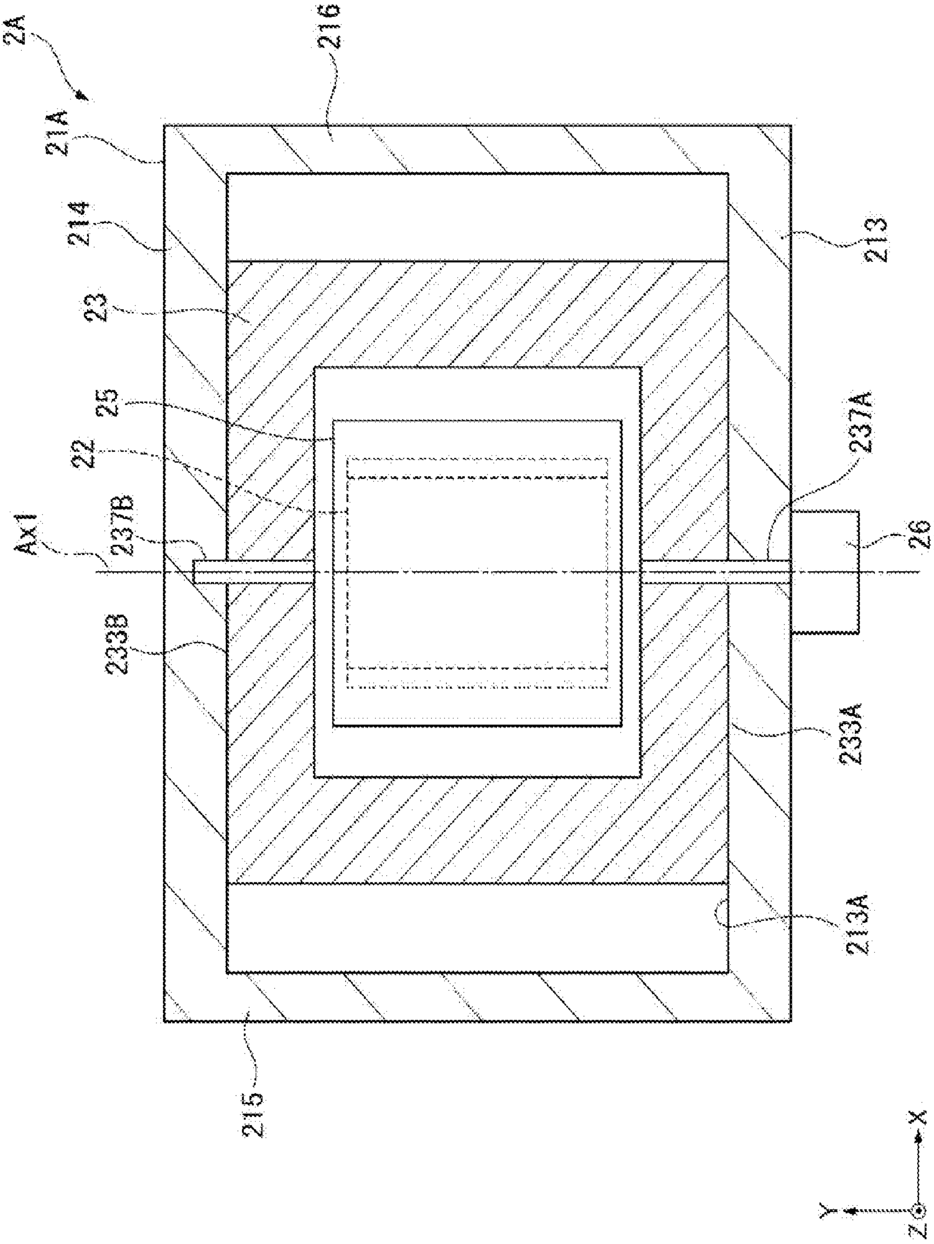
X
Z
Y

FIG. 8


2A
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Ax1
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237A
26
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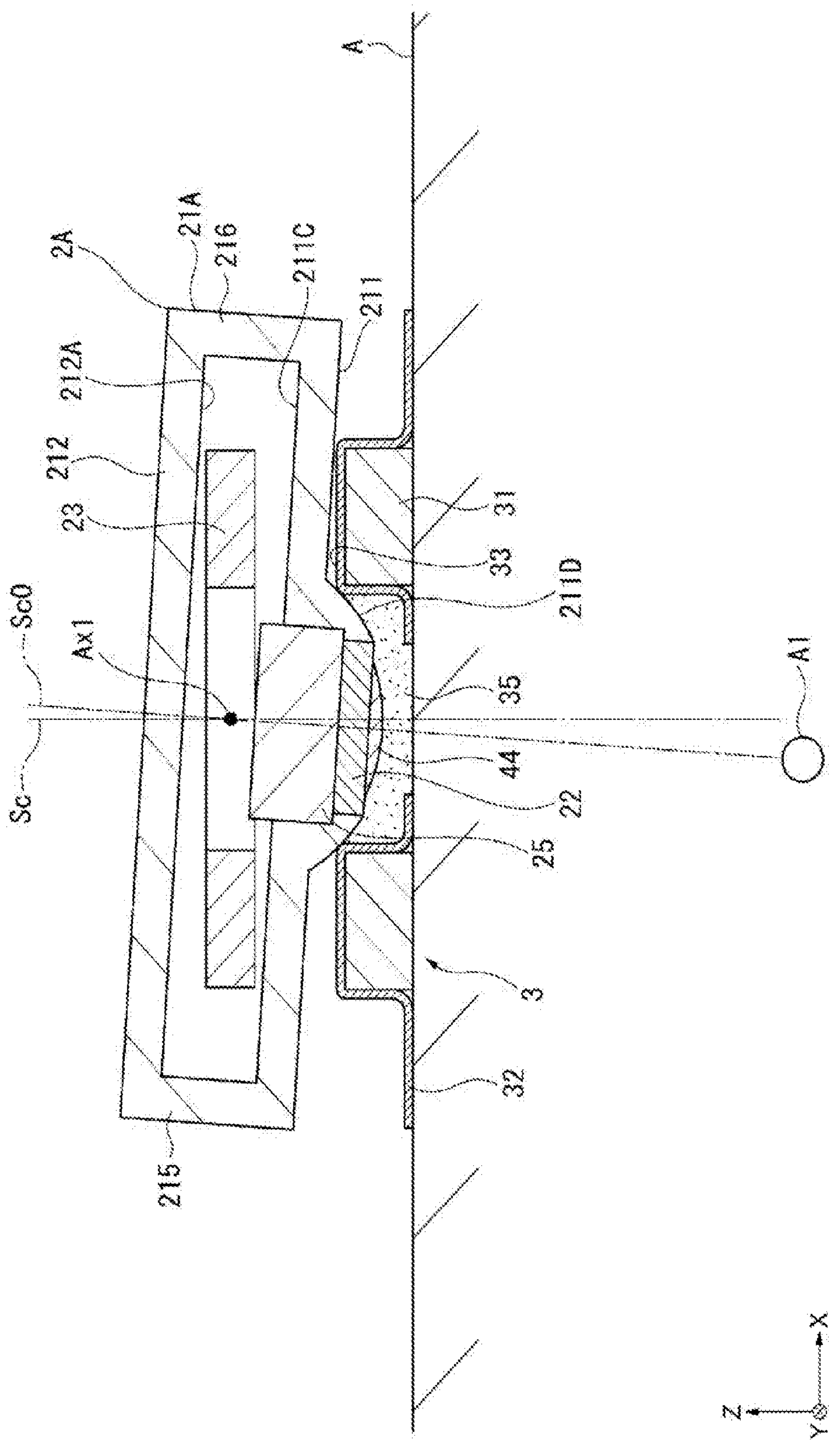
213A
X
Y
Z

FIG. 9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X
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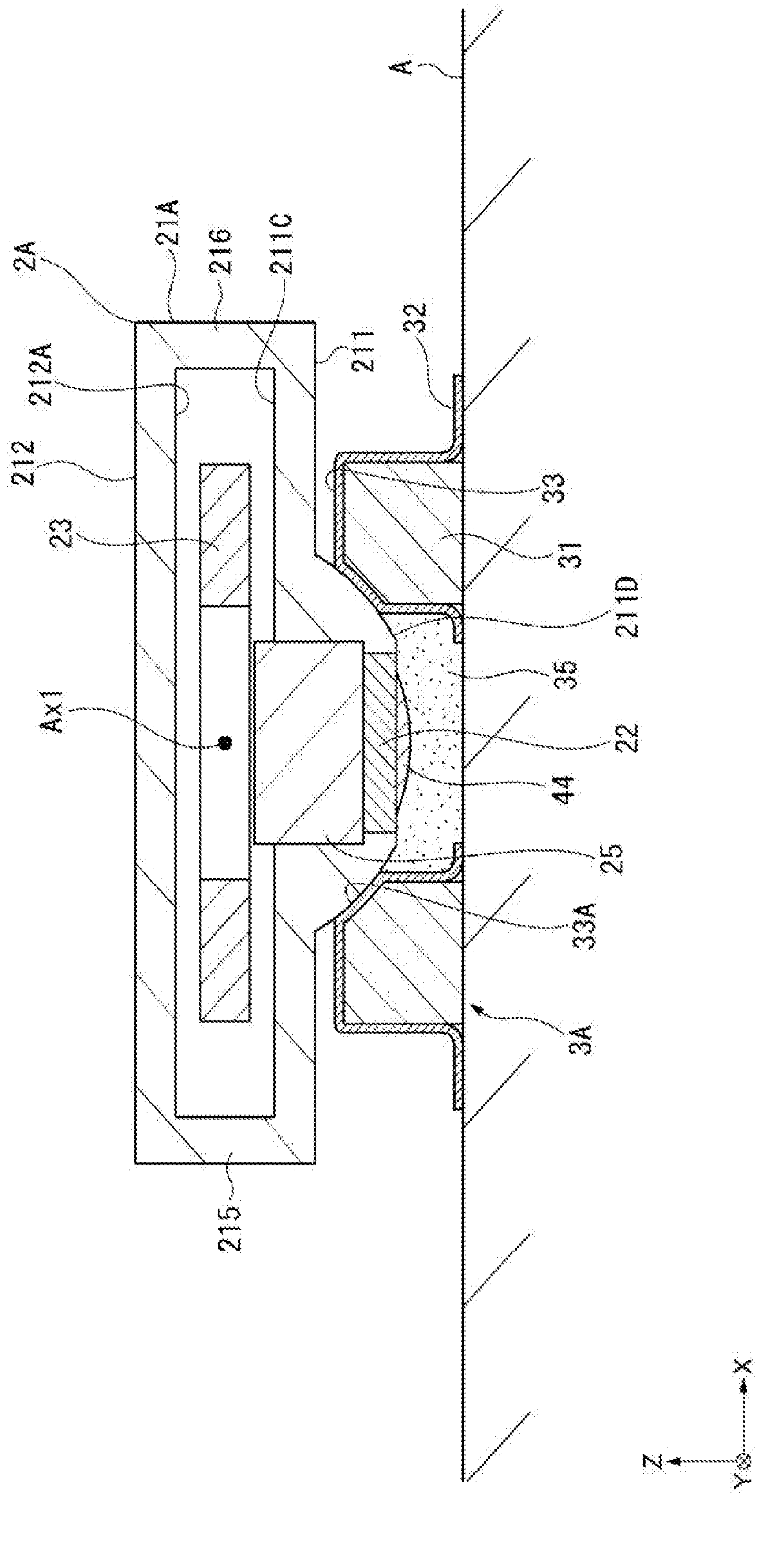
Y

FIG.10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3A
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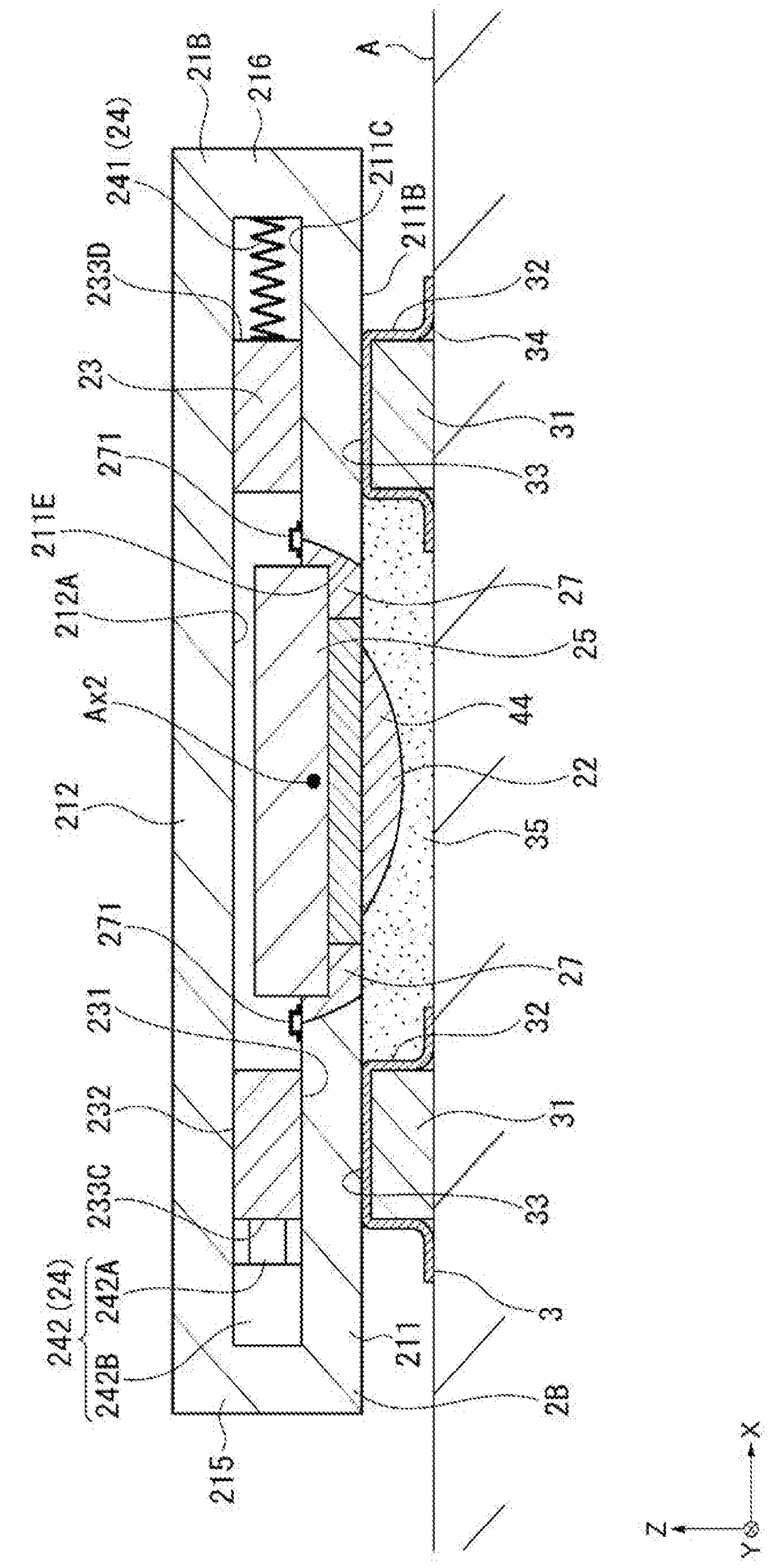
Y

FIG. 11



21B
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212
35
271
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233C
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242 (24)
242A
242B
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2B
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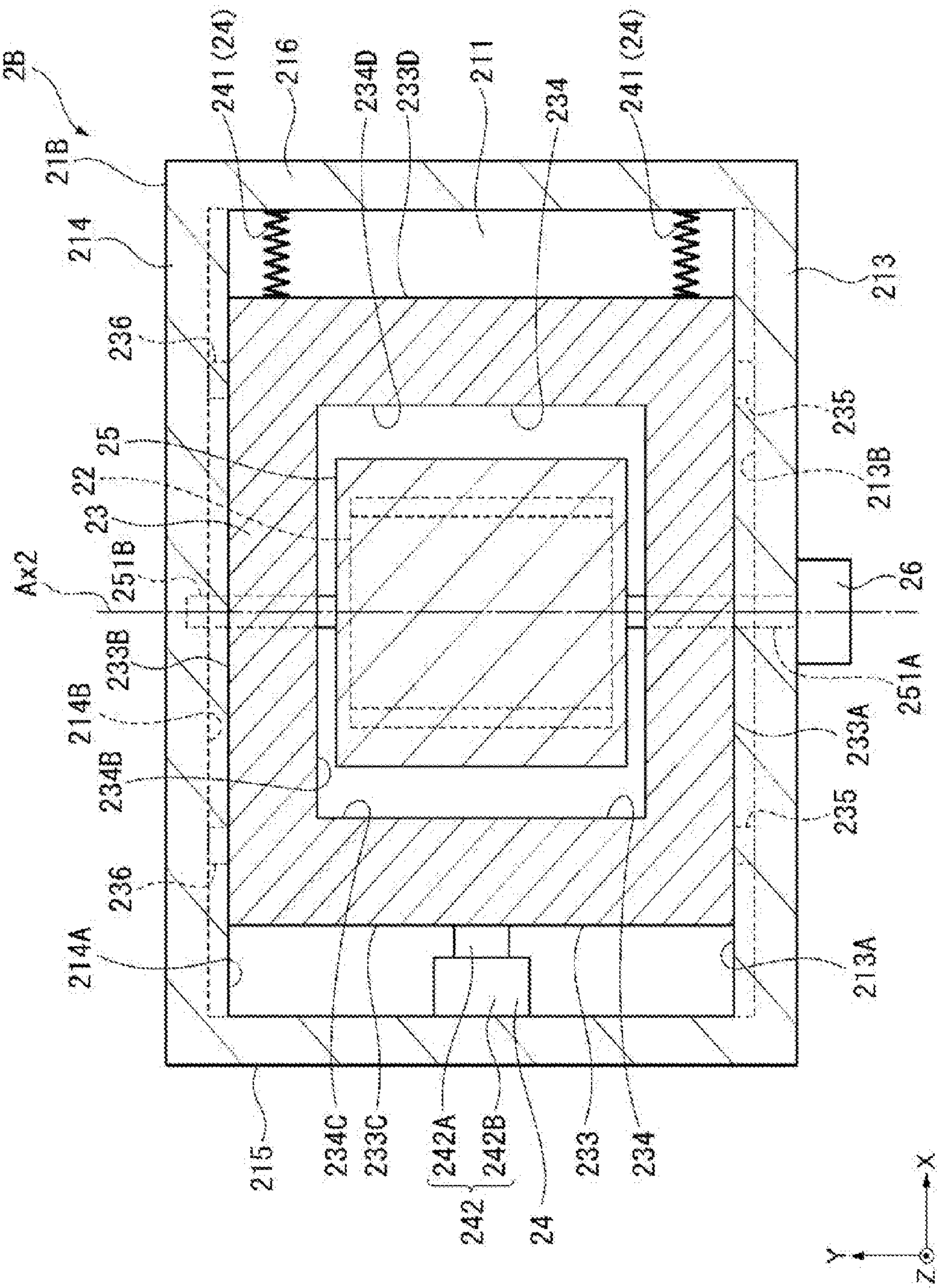
X
Z
Y

FIG. 12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Ax2
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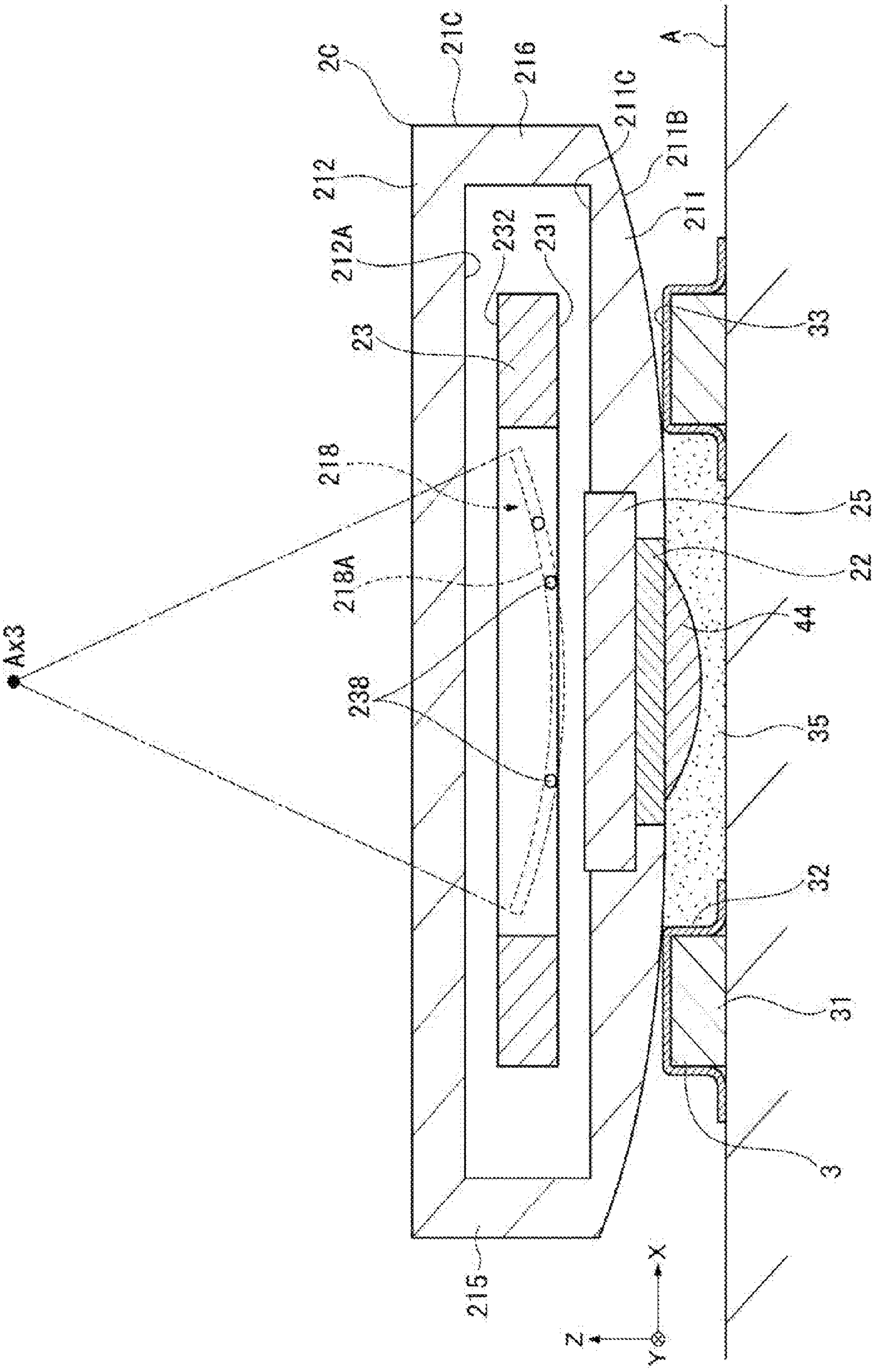
211
234
241 (24)
213
235
213B
26
251A
233A
235
213A
215
234C
233C
242A
242B
242
24
233
234
Y
X
Z

FIG.13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3
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Z
X
Y

FIG. 14

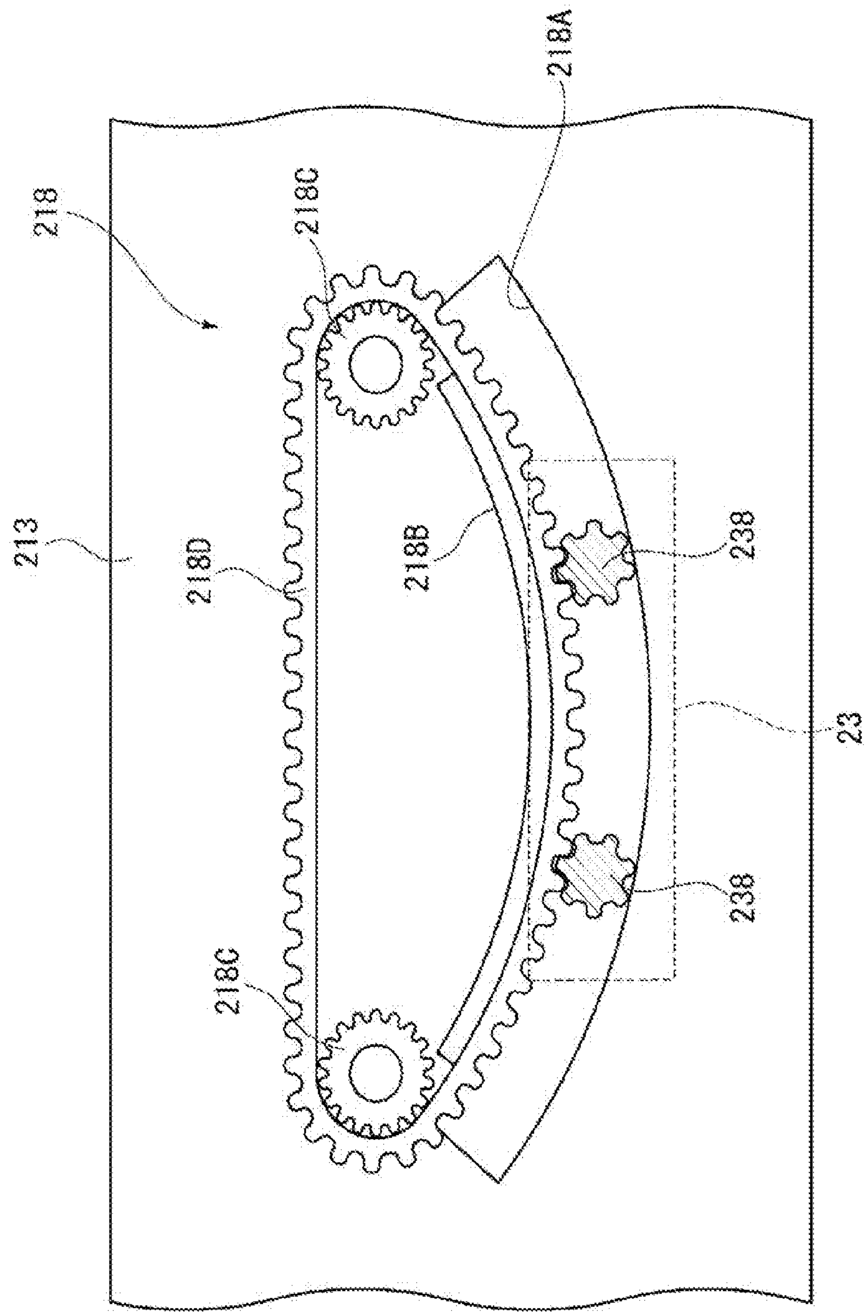

FIG.15

ULTRASONIC PROBE UNIT, ULTRASONIC PROBE, AND ULTRASONIC APPARATUS

BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to an ultrasonic probe unit, an ultrasonic probe, and an ultrasonic apparatus.

[0003] 2. Related Art

[0004] In the past, there has been known an ultrasonic probe unit for transmitting an ultrasonic wave to the inside of a measurement object (e.g., a living body) with an ultrasonic probe fixedly adhering to the measurement object (see, e.g., JP-A-2011-62373 (Document 1)).

[0005] In Document 1, there is a description related to an ultrasonic oscillation unit equipped with an ultrasonic oscillator and a fixation device. The fixation device of the ultrasonic oscillation unit has an oscillator support device for supporting an ultrasonic oscillator, and a body surface-side fixation device to be fixed to a body surface. The oscillator support device has a cylinder part for supporting the ultrasonic oscillator, and a flange part disposed on one end (body surface side) of the cylinder part, and by connecting the flange part to the body surface-side fixation device fixed to the body surface, the ultrasonic oscillator is fixed to the living body.

[0006] Further, as a detaching/attaching configuration between the body surface-side fixation device and the flange part, there are cited (i) a configuration in which the body surface-side fixation device is provided with an iron paper, the flange part is formed of a magnet, and the flange part and the body surface-side fixation device are connected with the magnetic force, (ii) a configuration in which a body surface side and a flange part side of the body surface-side fixation device are each formed of an adhesive surface, and the flange part formed of resin is made to fixedly adhere to the adhesive surface of the body surface-side fixation device, and (iii) a configuration in which a female engagement device provided to the flange part is engaged with a male engagement device provided to the body surface-side fixation device to thereby achieve the fixation.

[0007] Incidentally, in the device described in Document 1 described above, when the ultrasonic probe (the ultrasonic oscillator) is fixed to the body surface with the fixation device, the position where the ultrasonic wave is transmitted is fixed. However, in some cases, the region to be the measurement object is shifted from the direction (e.g., immediately below the ultrasonic probe) in which the ultrasonic wave is transmitted from the ultrasonic probe, and in this case, in the device described in Document 1 described above, it is necessary to fix the ultrasonic probe again to a correct position. Specifically, it is necessary to detach the oscillator support device from the body surface-side fixation device, then detach the body surface-side fixation device from the body surface, then stick the body surface-side fixation device to a correct position, and then attach the oscillator support device. Further, on this occasion, if the direction in which the ultrasonic wave is transmitted from the ultrasonic probe departs from the region of the measurement object, it is necessary to repeat the sequence described above to adjust the position. Therefore, in the fixation configuration of the ultrasonic probe in the related art, there is a problem that the fixation configuration is accompanied by the extremely cumbersome operation.

SUMMARY

[0008] An advantage of some aspects of the invention is to provide an ultrasonic probe unit, an ultrasonic probe, and an ultrasonic apparatus allowing a user to easily fix the ultrasonic probe to the object at a desired position.

[0009] An ultrasonic probe unit according to an application example of the invention includes an ultrasonic probe, and a fixation section adapted to fix the ultrasonic probe to an object, the ultrasonic probe includes an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave, a first fixation section, and an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section, and the fixation section includes a fixation surface to be fixed to the object, and a second fixation section a relative position of which to the first fixation section is fixed to thereby fix the ultrasonic probe to the object.

[0010] In this application example, the ultrasonic probe unit is provided with the fixation section and the ultrasonic probe. By fixing the fixation surface to the object, the fixation section is fixed to the object. In the ultrasonic probe, by fixing the relative position between the first fixation section provided to the ultrasonic probe and the second fixation section provided to the fixation section, the ultrasonic probe is fixed to the object. Here, the fixing method of the relative position between the first fixation section and the second fixation section is not particularly limited, and there can be cited a configuration of, for example, using a magnet as either one of the first fixation section and the second fixation section, and using a magnet or a magnetic material as the other. Besides the above, it is also possible to adopt a configuration of using a male engagement section as the first fixation section, using a female engagement section as the second fixation section, and making these sections engage with each other, or it is also possible to adopt a configuration of fixing by bonding (adhesively) the first fixation section to the second fixation section.

[0011] Further, in this application example, the ultrasonic probe is provided with the adjustment section for adjusting the relative positional relationship between the ultrasonic device and the first fixation section. As described above, when fixing the ultrasonic probe to the object, the relative position between the first fixation section and the second fixation section is fixed. Therefore, if the relative positional relationship between the ultrasonic device and the first fixation section is adjusted by the adjustment section, the relative position of the ultrasonic device to the object changes.

[0012] Therefore, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object when fixing the fixation section to the object, and fixing the ultrasonic probe to the fixation section, it is possible to easily adjust the position of the ultrasonic device relatively to the object using the adjustment section. Therefore, in this application example, it is possible to easily fix the ultrasonic probe to the desired position for the object.

[0013] In the ultrasonic probe unit according to the application example, it is preferable that the adjustment section has a displacement mechanism adapted to displace the first fixation section relatively to the ultrasonic device.

[0014] In the application example with this configuration, the first fixation section is displaced relatively to the ultrasonic device using the displacement mechanism. Thus, similarly to the application example described above, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object, it is possible to easily adjust the relative position of the ultrasonic device to the object to an appropriate position by relatively displacing the first fixation section to the ultrasonic device using the displacement mechanism.

[0015] In the ultrasonic probe unit according to the application example, it is preferable that the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave, and the displacement mechanism displaces the first fixation section relatively to the ultrasonic device in a plane parallel to the device surface.

[0016] In the application example with this configuration, the displacement mechanism relatively displaces the ultrasonic device and the first fixation section to each other in a plane parallel to the device surface. Therefore, even in the case in which the positional relationship between the ultrasonic device and the first fixation section is adjusted by the displacement mechanism, the distance between the ultrasonic device and the object is not changed. Therefore, the distance (the depth) between the ultrasonic device and the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object is not changed, and the transmission process and the reception process of the ultrasonic wave high in accuracy can be performed.

[0017] In the ultrasonic probe unit according to the application example, it is preferable that the ultrasonic device has a one-dimensional array structure in which a plurality of ultrasonic transducers is arranged along a first direction parallel to the device surface, and the displacement mechanism displaces the first fixation section relatively to the ultrasonic device along a second direction crossing the first direction.

[0018] In the application example with this configuration, the ultrasonic device has the ultrasonic transducers arranged in the first direction. In such a configuration, when transmitting the ultrasonic wave, for example, by controlling the transmission timings of the ultrasonic waves of the respective ultrasonic transducers arranged along the first direction, it becomes possible to control the transmission direction of the ultrasonic wave in a plane (a scan plane) including the first direction, in which the ultrasonic transducers are arranged, and perpendicular to the device surface. In contrast, in the second direction crossing the first direction, even by controlling the transmission timings of the ultrasonic waves of the respective ultrasonic transducers, the transmission direction of the ultrasonic wave cannot be changed. Therefore, in the ultrasonic device having the one-dimensional array structure, in the case in which the transmission direction of the ultrasonic wave, and the transmission target of the ultrasonic wave in the object are shifted from each other along the second direction, it becomes difficult to correct the shift only by the transmission control of each of the ultrasonic transducers. In contrast, in the application example, the first fixation section and the ultrasonic device are displaced along the second direction relatively to each other using the displacement mechanism, and thus, the scan plane can be displaced along the second direction. Therefore, as described above, even in the case in which the transmission direction of the ultrasonic wave and the transmission target of the ultrasonic wave in the object are shifted from each other along the second direction, the shift can easily be corrected by the displacement mechanism.

[0019] In the ultrasonic probe unit according to the application example, it is preferable that the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave, the ultrasonic probe has a contact surface having contact with the fixation section and parallel to the device surface, and the fixation section has a plane along the contact surface.

[0020] In the application example with this configuration, the ultrasonic probe has the contact surface parallel to the device surface. Thus, it is possible to smoothly change the relative position between the ultrasonic probe and the fixation section.

[0021] Specifically, in the case in which the ultrasonic device is fixed to the housing of the ultrasonic probe provided with the contact surface, and the first fixation section is made movable relatively to the housing, when fixing the relative position of the first fixation section to the second fixation section of the fixation section, and then moving the first fixation section and the ultrasonic device relatively to each other, the ultrasonic device and the housing move relatively to the fixation section. On this occasion, in the application example, since the fixation section has the surface along the contact surface, the contact surface is guided by the plane, and thus, it becomes possible to smoothly displace the housing.

[0022] In the ultrasonic probe unit according to the application example, it is preferable that the displacement mechanism displaces the first fixation section.

[0023] As the displacement mechanism, it is possible to adopt a configuration of moving the ultrasonic device relatively to the first fixation section. However, there is a possibility that the transmission characteristic and the reception characteristic of the ultrasonic wave vary due to the stress applied to the ultrasonic device. In contrast, by adopting the configuration of moving the first fixation section, the problem described above can be suppressed.

[0024] In the ultrasonic probe unit according to the application example, it is preferable that the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave, and the adjustment section includes a rotary mechanism adapted to rotate at least one of the ultrasonic device and the first fixation section around a rotational axis crossing a normal line of the device surface.

[0025] In the application example with this configuration, at least either one of the ultrasonic device and the first fixation section is rotated by the rotary mechanism. On this occasion, for example, the transmission direction of the ultrasonic wave of the ultrasonic device and the reception direction of the ultrasonic wave, in which the ultrasonic wave can be received with high sensitivity, can be rotated around the rotational axis. Therefore, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object, it is possible to easily adjust the angle of the ultrasonic device with respect to the object using the rotary mechanism.

[0026] In the ultrasonic probe unit according to the application example, it is preferable that the ultrasonic device has a one-dimensional array structure in which a plurality of ultrasonic transducers is arranged along a first direction parallel to the device surface, and the rotational axis is parallel to the first direction.

[0027] In the application example with this configuration, the ultrasonic device has the ultrasonic transducers arranged in the first direction. In such a configuration, similarly to the application example described above, when transmitting the ultrasonic wave, for example, it becomes possible to control the transmission direction of the ultrasonic wave in the scan plane including a straight line along the first direction, in which the ultrasonic transducers are arranged, and perpendicular to the device surface, but the transmission direction of the ultrasonic wave cannot be changed in the second direction crossing the first direction. In contrast, by rotating at least one of the ultrasonic transducer and the first fixation section around the rotational axis parallel to the first direction as in the application example, it is possible to rotate (tilt) the scan plane. Therefore, even in the case in which the transmission direction of the ultrasonic wave and the transmission target of the ultrasonic wave in the object are shifted from each other along the second direction, the shift can easily be corrected by the rotary mechanism.

[0028] In the ultrasonic probe unit according to the application example, it is preferable that the rotary mechanism rotates the ultrasonic device.

[0029] In the application example with this configuration, by rotating the ultrasonic device, the scan plane is rotated (tilted). In this case, by combining the displacement of the first fixation section relatively to the ultrasonic device along the device surface and the rotation of the ultrasonic device with each other, the transmission/reception direction of the ultrasonic wave of the ultrasonic device can more accurately be adjusted.

[0030] In the ultrasonic probe unit according to the application example, it is possible that the rotary mechanism has a configuration of rotating the first fixation section.

[0031] In this case, no stress is applied to the ultrasonic device by the rotary mechanism, and the deterioration of the transmission characteristics and the reception characteristics of the ultrasonic wave in the ultrasonic device can be suppressed.

[0032] In the ultrasonic probe unit according to the application example described above, it is preferable that the ultrasonic probe has a contact surface having contact with the fixation section, and the contact surface is curved convexly toward a direction from the device surface toward the fixation section when being cut by a plane perpendicular to the rotational axis.

[0033] In the application example with this configuration, the ultrasonic probe has the contact surface curved convexly. Therefore, in the case in which the ultrasonic device is fixed to the housing of the ultrasonic probe provided with the contact surface, and the first fixation section is made movable relatively to the housing, when fixing the relative position of the first fixation section to the second fixation section of the fixation section, and then rotating the first fixation section relatively to the ultrasonic device, the ultrasonic device and the housing rotate around the rotational axis. On this occasion, in the application example, since the contact surface is curved convexly, when rotating the housing, there is no chance for a part of the housing to have contact with the fixation section to hinder the rotation, and thus, smooth positioning can be achieved.

[0034] In the ultrasonic probe unit according to the application example, it is preferable that the fixation section has a curved surface curved along the contact surface.

[0035] In the case in which the contact surface of the housing is curved as described above, by providing the fixation section also with the curved surface curved along the contact surface, it becomes possible to smoothly move the housing with the contact surface guided by the curved surface.

[0036] It is preferable that the ultrasonic probe of the application example includes an acoustic lens protruding from a contact surface having contact with the fixation section toward the object.

[0037] In the application example with this configuration, the ultrasonic probe is provided with the acoustic lens. Therefore, it is possible to converge the ultrasonic transmitted from the ultrasonic device at a predetermined position in the measurement object, and further, it is possible to uniformly spread the ultrasonic wave reflected at the predetermined position to the entire area of the ultrasonic device. Therefore, it is possible to improve the efficiency of the transmission and reception process of the ultrasonic wave.

[0038] In the ultrasonic probe unit according to the application example, it is preferable that the fixation section has a frame body adapted to house the acoustic lens.

[0039] In the application example with this configuration, the fixation section has the frame body capable of housing the acoustic lens. In such a configuration, by housing the acoustic lens in the frame body, the acoustic lens does not hinder the adjustment of the relative position between the ultrasonic device and the first fixation section, and the adjustment operation can be performed smoothly. Further, since the frame can be filled with the acoustic matching material such as gel, a drop in output of the ultrasonic wave between the object and the ultrasonic probe can be suppressed.

[0040] In the ultrasonic probe unit according to the application example, it is preferable that the first fixation section and the second fixation section are each a magnet.

[0041] In the application example with this configuration, it is possible to fix the ultrasonic probe to the fixation section with a simple configuration. Further, since there is adopted the configuration of applying the magnetic force between the first fixation section and the second fixation section to fix the ultrasonic probe to the fixation section, positioning of the ultrasonic probe is easily performed compared to the configuration of, for example, making the click part engage with the engagement part.

[0042] An ultrasonic probe according to an application example of the invention is an ultrasonic probe to be fixed to a fixation section fixed to an object, including an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave, a first fixation section a relative position of which to a second fixation section provided to the fixation section is fixed to thereby fix the ultrasonic probe to the fixation section, and an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section.

[0043] In this application example, similarly to the application example described above, by adjusting the relative positional relationship between the ultrasonic device and the first fixation section using the adjustment section, it is possible to change the relative position of the ultrasonic device to the object. Therefore, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object, it is possible to easily adjust the relative position of the ultrasonic device to the object using the adjustment section, and thus, it is possible to easily fix the ultrasonic probe to the desired position of the object.

[0044] An ultrasonic apparatus according to an application example of the invention includes an ultrasonic probe, a fixation section adapted to fix the ultrasonic probe to an object, and a control section adapted to control the ultrasonic probe, the ultrasonic probe includes an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave, a first fixation section, and an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section, and the fixation section includes a fixation surface to be fixed to the object, and a second fixation section a relative position of which to the first fixation section is fixed to thereby fix the ultrasonic probe to the object.

[0045] In this application example, similarly to the application example described above, by adjusting the relative positional relationship between the ultrasonic device and the first fixation section using the adjustment section, it is possible to easily fix the ultrasonic probe to the desired position of the object. Therefore, in the ultrasonic apparatus, in the case of, for example, measuring the measurement target at a predetermined depth in the object, the measurement result with respect to the measurement target can accurately be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0047] FIG. **1** is a diagram showing a schematic configuration of an ultrasonic apparatus according to a first embodiment of the invention.

[0048] FIG. **2** is a schematic cross-sectional view of an ultrasonic probe and a fixation section in the case of fixing the ultrasonic probe to a body surface of a living body in the first embodiment.

[0049] FIG. **3** is a plan view showing a general configuration of the fixation section in the first embodiment.

[0050] FIG. **4** is a plan view of an element substrate of an ultrasonic device according to the first embodiment viewed from a sealing plate side.

[0051] FIG. **5** is a cross-sectional view of the ultrasonic device cut along the line B-B shown in FIG. **4**.

[0052] FIG. **6** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe according to the first embodiment along the X-Y plane.

[0053] FIG. **7** is a diagram schematically showing the condition in which a scan plane of the ultrasonic probe has been changed in the first embodiment.

[0054] FIG. **8** is a schematic cross-sectional view of an ultrasonic probe according to a second embodiment and a fixation section in the case of fixing the ultrasonic probe to a body surface of a living body.

[0055] FIG. **9** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe according to the second embodiment along the X-Y plane.

[0056] FIG. **10** is a diagram schematically showing the condition in which the angle of the scan plane of the ultrasonic probe has been changed in the second embodiment.

[0057] FIG. **11** is a schematic cross-sectional view of an ultrasonic probe according to a modified example of the second embodiment and a fixation section in the case of fixing the ultrasonic probe to a body surface of a living body.

[0058] FIG. **12** is a schematic cross-sectional view of an ultrasonic probe according to a third embodiment and a fixation section in the case of fixing the ultrasonic probe to a body surface.

[0059] FIG. **13** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe according to the third embodiment along the X-Y plane.

[0060] FIG. **14** is a schematic cross-sectional view of an ultrasonic probe according to a modified example and a fixation section in the case of fixing the ultrasonic probe to a body surface.

[0061] FIG. **15** is a diagram for explaining an outline of a swing mechanism (an adjustment section) of a probe-side magnet in the modified example shown in FIG. **14**.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

First Embodiment

[0062] An ultrasonic apparatus according to the first embodiment will hereinafter be described with reference to the accompanying drawings.

[0063] FIG. **1** is a diagram showing a schematic configuration of an ultrasonic apparatus **1** according to the first embodiment.

[0064] FIG. **2** is a schematic cross-sectional view of an ultrasonic probe **2** and a fixation section **3** in the case of fixing the ultrasonic probe **2** to a body surface of a living body in the first embodiment.

[0065] As shown in FIG. **1**, the ultrasonic apparatus **1** according to the present embodiment is provided with an ultrasonic probe **2**, and a control device **5** (a control section) electrically connected to the ultrasonic probe **2** via, for example, a cable **6**.

[0066] The ultrasonic apparatus **1** is a device for measuring a shape and a state (e.g., blood flow) of a part (e.g., an organ such as a blood vessel or a liver) in a living body A as an object by fixing the ultrasonic probe **2** to the body surface of the living body A via the fixation section **3** to transmit (perform a transmission process of) an ultrasonic wave, and then receive (perform a reception process of) the ultrasonic wave reflected by the part in the living body A. In other words, the fixation section **3** (see FIG. **2**) has a function of fixing the ultrasonic probe **2** to the living body A, and at the same time propagating the ultrasonic wave between the ultrasonic probe **2** and the living body A. Further, in the present embodiment, the ultrasonic probe **2** and the fixation section **3** constitute an ultrasonic probe unit **10**.

[0067] In such an ultrasonic apparatus **1**, in order to perform measurement of a predetermined measurement target part of the living body A, firstly, the fixation section **3** is fixed to the body surface of the living body A, and then the ultrasonic probe **2** is fixed to the fixation section **3**. Thus, it is possible to easily fix the ultrasonic probe **2** to the body surface.

[0068] Incidentally, although the detailed configuration will be described later, the ultrasonic probe **2** according to the present embodiment has an ultrasonic device **22** for outputting an ultrasonic wave, and the ultrasonic device **22** has a one-dimensional array structure having a plurality of ultrasonic transducer groups **45**A (see FIG. **4**) arranged in the Y direction (a first direction, a scanning direction). In such an ultrasonic probe **2**, the ultrasonic wave output from the ultrasonic device **22** propagates along a plane (scan plane) passing through the center in the X direction (a second direction, a slicing direction) of each of the ultrasonic transducer groups **45**A and perpendicular to the X direction. Therefore, although accurate ultrasonic measurement can be achieved in the case in which the measurement object exists in the scan plane, in the case in which, for example, the measurement object exists at a position distant in the X direction (the slicing direction) from the scan plane, the accurate ultrasonic measurement cannot be achieved in some cases. In contrast, the ultrasonic probe **2** according to the present embodiment is configured so that the position of the ultrasonic device **22** can be adjusted along the X direction with respect to the fixation section **3**. Thus, the position of the ultrasonic device **22** can be adjusted so that the measurement object is disposed along the scan plane, and it is possible to perform the accurate ultrasonic measurement.

[0069] Hereinafter, the ultrasonic probe unit **10** according to the present embodiment will be described in detail.

Configuration of Fixation Section **3**

[0070] FIG. **3** is a plan view showing a general configuration of the fixation section **3** in the first embodiment.

[0071] As shown in FIG. **2** and FIG. **3**, the fixation section **3** is provided with a fixation section-side magnet **31** as a second fixation section, and a fixation tape **32** for fixing the fixation section-side magnet **31** to the body surface of the living body A. Further, the fixation section **3** is provided with a probe-opposed surface **33**, which is a surface on a +Z side defining the direction perpendicular to the X-Y plane as the Z direction (assuming that the −Z side corresponds to the living body A side), and a fixation surface **34**, which is a surface on the −Z side, and is fixed to the body surface of the living body A. In the present embodiment, the probe-opposed surface **33** is formed to have a roughly flat shape, and by fixing the ultrasonic probe **2** to the probe-opposed surface **33** so as to have contact with each other with the fixation surface **34** fixed to the living body, the ultrasonic probe **2** is fixed to the body surface.

[0072] Further, the fixation section **3** is shaped like a frame in a planar view viewed from the Z direction, and an acoustic lens **44** described later of the ultrasonic probe **2** can be housed inside the frame. Specifically, in the planar view described above, the fixation section **3** is shaped like a rectangular frame, and an acoustic matching material **35** such as gel is disposed in the opening part (inside the rectangular frame) formed in a central part of the fixation section **3**. The acoustic matching material **35** has an equivalent acoustic impedance to that of the body surface, and is capable of preventing a gap between the acoustic lens **44** and the body surface from occurring in the case in which the ultrasonic probe **2** is fixed to the fixation section **3**.

[0073] The fixation section-side magnet **31** is a frame-like member having a rectangular outer shape in the planar view viewed along the Z direction, and having an opening in the central part. The fixation section-side magnet **31** is preferably configured as, for example, a single bulk member, and can thus suppress deformation of the fixation section-side magnet **31**. It should be noted that as the fixation section-side magnet **31**, a sheet-like magnet having elasticity can also be used. In this case, it is possible to make the fixation section-side magnet **31** adhere along the body surface, and separation from the body surface and misalignment of the fixation section **3** can be prevented.

[0074] The fixation tape **32** has a adhesive surface having an adherence property, and are made to adhere to the body surface in the state of covering the fixation section-side magnet **31** with the adhesive surface side. Thus, the fixation section-side magnet **31** is fixed to the body surface. In other words, a part of the adhesive surface of the fixation tape **32** to be made to adhere to the body surface and a surface of the fixation section-side magnet **31** to be made to have contact with the body surface form the fixation surface **34**.

[0075] It should be noted that although in the present embodiment, there is illustrated the configuration of fixing the fixation section-side magnet **31** to the body surface with the fixation tape **32**, it is also possible to form an adhesive surface in the surface on the −Z side of the fixation section-side magnet to fix the fixation section-side magnet **31** to the body surface. Further, it is also possible to fix the fixation section-side magnet **31** to the body surface using a fixing jig.

Configuration of Ultrasonic Probe **2**

[0076] The ultrasonic probe **2** is provided with a housing **21**, the ultrasonic device **22** fixed to the inside of the housing **21** and partially exposed to the outside, a probe-side magnet **23** disposed inside the housing **21** so as to be able to move along the X direction relatively to the housing **21**, and forming a first fixation section, a displacement mechanism **24** for displacing the probe-side magnet **23** with respect to the housing **21**, and a wiring board **25** provided with a driver circuit for controlling the ultrasonic device **22**, and so on. In the ultrasonic probe **2**, the relative position between the fixation section-side magnet **31** and the probe-side magnet **23** attracting each other with magnetic force is uniquely determined, and thus, the ultrasonic probe **2** is fixed to the fixation section **3**. In the present embodiment, the probe-side magnet **23** can be displaced along the X direction with respect to the housing **21** (i.e., the ultrasonic device **22**) in the ultrasonic probe **2**. Here, even if the probe-side magnet **23** is displaced with respect to the housing **21**, the relative position between the probe-side magnet **23** and the fixation section-side magnet **31** does not change. Therefore, the relative position of the ultrasonic device **22** to the fixation section **3** is changed, and thus, it is possible to change the relative position of the ultrasonic device **22** to the body surface.

Configuration of Ultrasonic Device **22**

[0077] FIG. **4** is a plan view of an element substrate **41** in the ultrasonic device **22** viewed from a sealing plate **42** side. FIG. **5** is a cross-sectional view of the ultrasonic device **22** cut along the line B-B shown in FIG. **4**.

[0078] As shown in FIG. 5, the ultrasonic device 22 is constituted by the element substrate 41, the sealing plate 42, an acoustic matching layer 43, and the acoustic lens 44.

Configuration of Element Substrate 41

[0079] As shown in FIG. 5, the element substrate 41 is provided with a substrate main body part 411, a vibrating film 412 disposed on the sealing plate 42 side of the substrate main body part 411, and piezoelectric elements 413 stacked on the vibrating film 412. Here, in the following description, a surface of the element substrate 41 opposed to the sealing plate 42 is referred to as a rear surface 41A, and a surface located on the opposite side to the rear surface 41A is referred to as an operating surface 41B (corresponding to a device surface). It should be noted that the normal direction of the operating surface 41B is assumed to roughly coincide with the Z direction. Further, in a planar view of the element substrate 41 viewed from the thickness direction of the substrate, a central area of the element substrate 41 forms an array region Ar1, and in the array region Ar1, a plurality of ultrasonic transducers 45 is arranged in a matrix.

[0080] The substrate main body part 411 is a semiconductor substrate made of, for example, Si. Inside the array region Ar1 in the substrate main body part 411, there are disposed aperture parts 411A corresponding respectively to the ultrasonic transducers 45. Further, the aperture parts 411A are closed by the vibrating film 412 disposed on the rear surface 41A side of the substrate main body part 411.

[0081] The vibrating film 412 is formed of, for example, SiO_2 or a laminated body of SiO_2 and ZrO_2, and is disposed so as to cover the entire area on the rear surface 41A side of the substrate main body part 411. The thickness dimension of the vibrating film 412 becomes sufficiently small one with respect to that of the substrate main body part 411. In the case of forming the substrate main body part 411 using Si and forming the vibrating film 412 using SiO_2, by performing an oxidation treatment on, for example, the surface on the rear surface 41A side of the substrate main body part 411, it becomes possible to easily form the vibrating film 412 having a desired thickness dimension. Further, in this case, by performing an etching treatment on the substrate main body part 411 using the vibrating film 412 made of SiO_2 as an etching stopper, it becomes possible to easily form the opening parts 411A described above.

[0082] Further, as shown in FIG. 5, on the vibrating film 412 closing each of the opening parts 411A, there are disposed the piezoelectric elements 413 each of which is a laminated body of a lower-part electrode 414, a piezoelectric film 415, and an upper-part electrode 416. Here, the vibrating film 412, which closes the aperture part 411A, and the piezoelectric element 413 constitute a single ultrasonic transducer 45.

[0083] In such an ultrasonic transducer 45, by applying a rectangular-wave voltage having a predetermined frequency between the lower-part electrode 414 and the upper-part electrode 416, it is possible to vibrate the vibrating film 412 in an opening region of each of the opening parts 411A to transmit the ultrasonic wave. Further, when the vibrating film 412 is vibrated by the ultrasonic wave reflected by the object, an electrical potential difference occurs between an upper part and a lower part of the piezoelectric film 415. Therefore, by detecting the electrical potential difference occurring between the lower-part electrode 414 and the upper-part electrode 416, it becomes possible to detect the ultrasonic wave received.

[0084] Further, in the present embodiment, as shown in FIG. 4, the ultrasonic transducer array 46 is configured by arranging a plurality of such ultrasonic transducers 45 as described above in the predetermined array region Ar1 of the element substrate 41 along the X direction (the slicing direction) and the Y direction (the scanning direction) crossing (perpendicular to, in the present embodiment) the X direction.

[0085] Here, the lower-part electrode 414 is formed so as to be shaped like a straight line along the X direction. Specifically, the lower-part electrode 414 is constituted by lower-part electrode main bodies 414A, each of which is disposed straddling the plurality of ultrasonic transducers 45 arranged along the X direction, and located between the piezoelectric films 415 and the vibrating film 412, lower-part electrode lines 414B each connecting the lower-part electrode main bodies 414A adjacent to each other, and lower-part terminal electrode lines 414C each extracted to one of terminal regions Ar2 located outside the array region Ar1. Therefore, in the ultrasonic transducers 45 arranged in the X direction, the lower-part electrodes 414 are in the same potential.

[0086] Further, the lower-part terminal electrode lines 414C each extend to the terminal region Ar2 located outside the array region Ar1, and respectively constitute first electrode pads 414P in the terminal region Ar2. The first electrode pads 414P are respectively connected to terminal parts provided to the wiring board 25.

[0087] On the other hand, as shown in FIG. 4, the upper-part electrode 416 has element electrode parts 416A each disposed straddling the plurality of ultrasonic transducers 45 arranged along the Y direction, and common electrode parts 416B each connecting end parts of the element electrode parts 416A extending in parallel to each other. The element electrode parts 416A each have upper-part electrode main bodies 416C each stacked on the piezoelectric film 415, upper-part electrode lines 416D each connecting the upper-part electrode main bodies 416C adjacent to each other, and upper-part terminal electrodes 416E extending outward along the Y direction from the respective ultrasonic transducers 45 disposed on the both end parts in the Y direction.

[0088] The common electrode parts 416B are disposed respectively in a +Y side end part and a −Y side end part of the array region Ar1. The common electrode part 416B located on the +Y side connects the upper-part terminal electrodes 416E to each other, which extend toward the +Y side from the ultrasonic transducers 45 disposed in the +Y side end part out of the plurality of ultrasonic transducers 45 disposed along the Y direction. The common electrode part 416B located in the −Y side end part connects the upper-part terminal electrodes 416E extending toward the −Y side to each other. Therefore, in the ultrasonic transducers 45 located inside the array region Ar1, the upper-part electrodes 416 are in the same potential. Further, the pair of common electrode parts 416B described above are disposed along the X direction, and the end parts are each extracted from the array region Ar1 to the terminal region Ar2. Further, the common electrode parts 416B constitute second electrode pads 416P to be connected to the terminal parts of the wiring board 25 in the terminal region Ar2.

[0089] In such an ultrasonic transducer array **46** as described above, there is formed a one-dimensional array structure in which the ultrasonic transducers **45** connected by the lower part electrode **414** to each other and arranged in the X direction constitute one ultrasonic transducer group **45**A, and the plurality of ultrasonic transducer groups **45**A is arranged along the Y direction.

Configuration of Sealing Plate **42**

[0090] The sealing plate **42** is formed to have the same planar shape when viewed from the thickness direction as that of, for example, the element substrate **41**, and is formed of a semiconductor substrate made of Si or the like, or an insulator substrate. It should be noted that the material and the thickness of the sealing plate **42** affect the frequency characteristics of the ultrasonic transducer **45**, and are therefore preferably set based on the central frequency of the ultrasonic wave transmitted/received by the ultrasonic transducer **45**.

[0091] Further, the sealing plate **42** is provided with a plurality of concave grooves **421**, which correspond respectively to the opening parts **411**A of the element substrate **41**, formed in an array-opposed area opposed to the array region Ar**1** of the element substrate **41**.

[0092] Thus, it results that a gap **421**A having a predetermined dimension is provided between the element substrate **41** and the area (inside the opening part **411**A) vibrated by the ultrasonic transducer **45** in the vibrating film **412**, and the vibration of the vibrating film **412** is prevented from being hindered. Further, it is possible to suppress the problem (cross talk) that the back wave from one ultrasonic transducer **45** enters another ultrasonic transducer **45** adjacent to that ultrasonic transducer **45**.

[0093] Further, when the vibrating film **412** vibrates, an ultrasonic wave is also emitted toward the sealing plate **42** side (the rear surface **41**A side) as the back wave in addition to the aperture part **411**A side (the operating surface **41**B side). The back wave is reflected by the sealing plate **42**, and is then emitted again toward the vibrating film **412** side via the gap **421**A. On this occasion, if the phase of the reflected back wave and the phase of the ultrasonic wave emitted from the vibrating film **412** toward the operating surface **41**B side are shifted from each other, the ultrasonic wave is attenuated. Therefore, in the present embodiment, the groove depth of each of the concave grooves **421** is set so that the acoustic distance in the gap **421**A becomes an odd multiple of a quarter ($\lambda/4$) of the wavelength λ of the ultrasonic wave. In other words, the thickness dimensions of the variety of parts of the element substrate **41** and the sealing plate **42** are set taking the wavelength λ of the ultrasonic wave emitted from the ultrasonic transducers **45** into consideration.

[0094] Further, it is also possible for the sealing plate **42** to have a configuration in which, for example, opening parts (not shown) are disposed at positions opposed to the terminal regions Ar**2** of the element substrate **41** so as to correspond to the respective electrode pads **414**P, **416**P disposed in the terminal regions Ar**2**. On this occasion, by providing through electrodes (TSV; through-silicon via) penetrating the sealing plate **42** in the thickness direction to the respective opening parts, the electrode pads **414**P, **416**P are connected to the terminal parts in the wiring board **25** via the through electrodes, respectively. Further, it is also possible to adopt a configuration in which, for example, FPC (flexible printed circuits), cable lines, wires, or the like are inserted into the opening parts to connect the electrode pads **414**P, **416**P and the wiring board **25** to each other.

Configuration of Acoustic Matching Layer **43** and Acoustic Lens **44**

[0095] As shown in FIG. **5**, the acoustic matching layer **43** is disposed on the operating surface **41**B side of the element substrate **41**. Specifically, the acoustic matching layer **43** is formed so as to fill in the aperture parts **411**A of the element substrate **41**, and to have a predetermined thickness dimension from the operating surface **41**B side of the substrate main body part **411**.

[0096] The acoustic lens **44** is disposed on the acoustic matching layer **43**, and is exposed to the outside from the sensor window **211**A of the housing **21** as shown in FIG. **1** and FIG. **2**. As shown in FIG. **5**, the acoustic lens **44** has a cylindrical shape the surface shape of which is an arc-like shape in a cross-sectional view along the X direction (the slicing direction).

[0097] It should be noted that the acoustic matching layer and the acoustic lens **44** efficiently propagate the ultrasonic wave emitted from the ultrasonic transducers **45** to the living body A as the measurement object, and further propagate the ultrasonic wave, which has been reflected in the living body A, to the ultrasonic transducers **45** with efficiency. Therefore, the acoustic matching layer **43** and the acoustic lens **44** are set to have an acoustic impedance intermediate between the acoustic impedance of the ultrasonic transducers **45** of the element substrate **41** and the acoustic impedance of the living body. As a material having such acoustic impedance as described above, there can be cited, for example, silicone.

Configuration of Wiring Board **25**

[0098] The wiring board **25** is a substrate to which the ultrasonic device **22** is fixed, and is provided with the terminal parts electrically connected to the respective electrode pads **414**P, **416**P. Further, the wiring board **25** is provided with a driver circuit for driving the ultrasonic device **22**, and so on. Specifically, the wiring board **25** is provided with a transmission circuit for transmitting the ultrasonic wave from the ultrasonic transducer array **46**, a reception circuit for processing the received signal in the case in which the ultrasonic wave has been received by the ultrasonic transducer array **46**, and so on. Further, the wiring board **25** is connected to the control device **5** via the cable **6** or the like, and drives the ultrasonic device **22** based on an instruction from the control device **5**.

[0099] The ultrasonic device **22** and the wiring board **25** constitute the ultrasonic sensor.

Configuration of Housing **21**

[0100] FIG. **6** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe **2** along the X-Y plane.

[0101] The housing **21** is formed so as to be shaped like a box having a roughly rectangular planar shape as shown in FIG. **1**, and is provided with a bottom surface part **211** on the −Z side, a top surface part **212** on the +Z side, a first side surface part **213** on the −Y side, a second side surface part **214** on the +Y side, a third side surface part **215** on the −X side, and a fourth side surface part **216** of the +X side as shown in FIG. **2** or FIG. **6**. In an internal space formed by these parts **211** through **216**, there are housed the ultrasonic device **22**, the probe-side magnet **23**, and the displacement mechanism **24**.

[0102] As shown in FIG. **2**, the bottom surface part **211** has a sensor window **211**A located on the −Z side of the housing **21** and exposing a part (the acoustic lens **44**) of the ultrasonic device **22**, a contact surface **211**B as a surface located on the −Z side, and an inner bottom surface **211**C as a surface located on the +Z side, and the ultrasonic device **22** is fixed to the bottom surface part **211**. The contact surface **211**B is a surface having contact with the probe-opposed surface **33** of the fixation section **3**, and is formed to have a roughly flat shape. The inner bottom surface **211**C is a surface having contact with a lower surface **231** of the probe-side magnet **23** described later, and is formed to have a roughly flat shape. It should be noted that the ultrasonic device **22** is fixed to a position overlapping the sensor window **211**A.

[0103] The top surface part **212** is located on the +Z side of the housing **21**, and has a top surface **212**A formed to have a roughly flat shape. The top surface **212**A has contact with an upper surface **232** of the probe-side magnet **23** described later.

[0104] The distance in the Z direction between the bottom surface part **211** and the top surface part **212** (i.e., the distance between the inner bottom surface **211**C and the top surface **212**A) is roughly the same as or slightly longer than the thickness dimension in the Z direction of the probe-side magnet **23**. Thus, it is possible for the probe-side magnet **23** to smoothly move along the inner bottom surface **211**C and the top surface **212**A.

[0105] The first side surface part **213** is a wall part, which is located on the −Y side of the bottom surface part **211** (the top surface part **212**), and is parallel to the X-Z plane. The first side surface part **213** has a first inner surface **213**A and a first groove part **213**B. The first inner surface **213**A is a surface having contact with a first outer side surface **233**A of the probe-side magnet **23** described later, and is formed to have a roughly flat shape. The first groove part **213**B is a groove part disposed along the X direction so as to be recessed in the −Y direction from the first inner surface **213**A side. Into the first groove part **213**B, there are inserted first protruding parts **235** of the probe-side magnet **23** described later.

[0106] The second side surface part **214** is a wall part configured so as to be mirror symmetric about the X-Z plane with the first side surface part **213**. In other words, the second side surface part **214** has a second inner surface **214**A having contact with a second outer side surface **233**B of the probe-side magnet **23**, and a second groove part **214**B into which second protruding parts **236** of the probe-side magnet **23** are inserted.

[0107] The distance in the Y direction between the first side surface part **213** and the second side surface part **214** (i.e., the distance between the first inner surface **213**A and the second inner surface **214**A) is roughly the same as or slightly longer than the thickness dimension in the Y direction of the probe-side magnet **23**. Thus, it is possible for the probe-side magnet **23** to smoothly move along the first inner surface **213**A and the second inner surface **214**A. In other words, the bottom surface part **211**, the top surface part **212**, the first side surface part **213**, and the second side surface part **214** function as a guide for the probe-side magnet **23**.

[0108] The third side surface part **215** is a wall part, which is located on the −X side of the bottom surface part **211** (the top surface part **212**), and is parallel to the Y-Z plane. The fourth side surface part **216** is a wall part, which is located on the +X side of the bottom surface part **211** (the top surface part **212**), and is parallel to the Y-Z plane.

[0109] The distance between the third side surface part **215** and the fourth side surface part **216** is longer than the dimension in the X direction of the probe-side magnet **23**. In other words, spaces are formed between a surface (a third outer side surface) **233**C on the −X side of the probe-side magnet **23** and the inner surface of the third side surface part **215**, and between a surface (a fourth outer side surface) **233**D on the +X side of the probe-side magnet **23**, respectively. Thus, the spaces allowing the probe-side magnet **23** to move forward and backward along the X direction are formed inside the housing **21**.

[0110] Further, in a part (e.g., a side surface in the example shown in FIG. **1**) of the housing **21**, there is disposed an insertion hole **217** through which the cable **6** for connecting the ultrasonic probe **2** and the control device **5** to each other so as to be able to communicate with each other is inserted. The gap between the cable **6** and the insertion hole **217** is filled with, for example, a resin material to thereby ensure a waterproof property. It should be noted that although in the present embodiment, there is shown a configuration example in which the ultrasonic probe **2** and the control device **5** are connected to each other using the cable **6**, the configuration is not limited to this example, and it is also possible to, for example, connect the ultrasonic probe **2** and the control device **5** to each other with wireless communication, or dispose a variety of constituents of the control device **5** inside the ultrasonic probe **2**.

Configuration of Probe-Side Magnet **23**

[0111] The probe-side magnet **23** shown in FIG. **2** and FIG. **6** is a frame-like member having a rectangular outer shape in the planar view viewed along the Z direction, and having an opening in the central part. In the present embodiment, the probe-side magnet **23** has roughly the same outer shape as that of the fixation section-side magnet **31** in the planar view viewed along the Z direction.

[0112] The probe-side magnet **23** is formed as, for example, a single bulk member, and has the rigidity with which a deformation due to the stress can be suppressed.

[0113] The probe-side magnet **23** is provided with the lower surface **231** (see FIG. **2**) on the −Z side, the upper surface **232** on the +Z side, the outer side surfaces **233**, the inner side surfaces **234**, the first protruding parts **235**, and the second protruding parts **236**.

[0114] The lower surface **231** is a surface having contact with the bottom surface part **211** of the housing **21**, and the upper surface **232** is a surface having contact with the top surface part **212**.

[0115] The outer side surfaces **233** includes the first outer side surface **233**A on the −Y side, the second outer side surface **233**B on the +Y side, the third outer side surface **233**C on the −X side, and the fourth outer side surface **233**D.

[0116] The first outer side surface **233**A has contact with the first inner surface **213**A of the housing **21**. The first outer side surface **233**A is provided with the first protruding parts **235** protruding in the −Y direction, and inserted into the first groove part **213**B. The second outer side surface **233**B has contact with the second inner surface **214**A of the housing

21. The second outer side surface **233**B is provided with the second protruding parts **236** protruding in the +Y direction, and inserted into the second groove part **214**B. The third outer side surface **233**C is opposed to, and separated in the X direction from the third side surface part **215** of the housing **21**. The fourth outer side surface **233**D is opposed to, and separated in the X direction from the fourth side surface part **216**.

[0117] The inner side surfaces **234** includes the first inner side surface **234**A located on the −Y side and parallel to the X-Z plane, the second inner side surface **234**B opposed to the first inner side surface **243**A, the third inner side surface **234**C located on the −X side, and crossing the first inner side surface **234**A and the second inner side surface **234**B, and the fourth inner side surface **234**D opposed to the third inner side surface **234**C. The ultrasonic device **22** is disposed at the position surrounded by these inner side surfaces **234**A through **234**D.

[0118] Here, the distance dimension between the third inner side surface **234**C and the fourth inner side surface **234**D is larger than the dimension in the X direction of the ultrasonic device **22**. Thus, the spaces allowing the probe-side magnet **23** to move forward and backward inside the housing **21** along the X direction are formed between the housing **21** and the probe-side magnet **23** in the X direction, and between the ultrasonic device **22** and the probe-side magnet **23**, respectively. Further, it is preferable for the distance (a sum of the distance from the ultrasonic device **22** to the third inner side surface **234**C, and the distance from the ultrasonic device **22** to the fourth inner side surface **234**D) between the ultrasonic device **22** and the probe-side magnet **23** in the X direction to be equal to or longer than the distance which the probe-side magnet **23** can move in the X direction. Thus, as described above, even in the case in which the probe-side magnet **23** moves along the X direction, the probe-side magnet **23** and the ultrasonic device **22** do not interfere with each other.

[0119] The probe-side magnet **23** is formed so that the relative position to the fixation section-side magnet **31** described above has a predetermined positional relationship. Specifically, in the present embodiment, the surface (on the living body A side) on the −Z side of the probe-side magnet **23** and the surface (on the ultrasonic probe **2** side) on the +Z side of the fixation section-side magnet **31** have magnetic poles different from each other, and attract each other to thereby fix the ultrasonic probe **2** to the fixation section **3** at a position where the probe-side magnet **23** and the fixation section-side magnet **31** overlap each other in the planar view viewed from the Z direction.

[0120] It should be noted that it is possible for the probe-side magnet **23** and the fixation section-side magnet **31** to have the magnetic poles different between the surface on the −Z side and the surface on the +Z side, or the magnetic poles different in the X-Y plane.

[0121] In the former case, there can be illustrated a configuration in which the surface on the −Z side of the probe-side magnet **23** has the south pole, and the surface on the +Z side of the fixation section-side magnet **31** has the north pole. In this case, the fixation direction of the ultrasonic probe **2** with respect to the fixation section **3** can be changed as much as an angle corresponding to the planar shapes viewed from the Z direction of the probe-side magnet **23** and the fixation section-side magnet **31**. For example, in the case in which the frame shapes of the probe-side magnet **23** and the fixation section-side magnet **31** are each a square shape, it is also possible to rotate the ultrasonic probe **2** as much as 90°, 180°, or 270° in the X-Y plane with respect to the fixation section **3** and then fix the ultrasonic probe **2** to the fixation section **3**. Further, in the case in which the frame shapes of the probe-side magnet **23** and the fixation section-side magnet **31** are each a rectangular shape, it is possible to rotate the ultrasonic probe **2** as much as 180° in the X-Y plane with respect to the fixation section **3** and then fix the ultrasonic probe **2** to the fixation section **3**.

[0122] On the other hand, in the latter case, there can be illustrated the configuration in which, for example, the +X side of the probe-side magnet **23** is the north pole, and the −X side is the south pole, and the +X side of the fixation section-side magnet **31** is the south pole, and the −X side is the north pole. In this case, the fixation direction of the ultrasonic probe **2** with respect to the fixation section **3** can uniquely be determined. Therefore, even in the case in which the ultrasonic probe **2** is slightly shifted or rotated in the X-Y plane with respect to the fixation section **3**, the magnetic force acts in the direction of achieving a balanced state, and thus it is possible to correct the position to the position where the probe-side magnet **23** and the fixation section-side magnet **31** overlap each other in the planar view.

Configuration of Displacement Mechanism **24**

[0123] The displacement mechanism **24** is an adjustment section, and is provided with a biasing section **241** for biasing the probe-side magnet **23** toward the −X direction, and a pressing section **242** for pressing the probe-side magnet **23** toward the +X direction, and moves the probe-side magnet **23** forward and backward along the X direction relatively to the housing **21**.

[0124] The biasing section **241** is, for example, a coil spring arranged so as to expand and contract along the X direction, and the end part on the +X side of the biasing section **241** is fixed to the fourth side surface part **216** of the housing **21**, and the end part on the −X side of the biasing section **241** has contact with the fourth outer side surface **233**D of the probe-side magnet **23**. In the example shown in the drawings, the probe-side magnet **23** is biased toward the −X direction with two coil springs. It should be noted that as the biasing section **241**, there can be used a leaf spring, a torsion coil spring, an elastic member such as rubber, and so on besides the coil spring.

[0125] The pressing section **242** has a pressing part **242**A having contact with the third outer side surface **233**C on the −X side of the probe-side magnet **23**, and pressing the probe-side magnet **23** toward the +X direction, which is an opposite direction to the biasing direction of the biasing section **241**, and a drive section **242**B for moving the pressing part **242**A forward and backward along the X direction. The drive section **242**B is provided with, for example, a micrometer head for converting the rotational force around the axis into the forward/backward drive force in the axial direction of a spindle (the pressing part **242**A), and a stepping motor for applying the rotational force to the micrometer head, and controls the micrometer head based on the control by the control device **5** to move the pressing part **242**A forward and backward. It should be noted that as the drive section **242**B, there can be used a variety of types of actuators for moving the pressing part **242**A forward and backward along the X direction. Further, as the pressing section **242**, it is also possible to adopt a configuration of manually moving the pressing part **242**A forward and backward. Specifically, as the pressing section **242**, it is also possible to adopt a configuration provided with the micrometer head fixed to the outside of the third side surface part **215** of the housing **21** and a spindle inserted into a through hole provided to the third side surface part **215**, and moved forward and backward along the X direction in accordance with the operation of the micrometer head.

Configuration of Control Device **5**

[0126] As shown in FIG. **1**, the control section **5** is provided with, for example, an operating section **51** and a display section **52**. Further, although not shown in the drawings, the control device **5** is provided with a storage section formed of a memory and so on, and an arithmetic section constituted by a central processing unit (CPU) and so on. Further, the control device **5** reads and then executes a variety of programs stored in the storage section with the arithmetic section to thereby output an instruction for controlling drive of the ultrasonic device **22**, form an image of the internal structure of the living body A based on the received signal input from the ultrasonic device **22** to make the display section **52** display the image, and measure the biological information such as the blood flow to make the display section **52** display the result, for example. Further, the control device **5** controls the drive of the drive section **242**B of the displacement mechanism **24** to move the pressing part **242**A forward or backward. As such a control device **5** as described above, there can be used a terminal device such as a tablet terminal, a smartphone, or a personal computer, and a dedicated terminal device for operating the ultrasonic probe **2** can also be used.

Method of Utilizing Ultrasonic Probe Unit **10**

Fixation of Ultrasonic Probe **2** Using Fixation Section **3**

[0127] In order to fix the ultrasonic probe **2** to the body surface of the living body A using the fixation section **3**, firstly, the fixation section **3** is made to adhere to the body surface. Then, the opening part (within the frame) formed in the center of the fixation section **3** is filled with the acoustic matching material **35**.

[0128] Then, the ultrasonic probe **2** is disposed on the fixation section **3** in a state in which the bottom part **211** is made to face to the body surface side. Here, due to the magnetic force of the probe-side magnet **23** and the fixation section-side magnet **31**, the ultrasonic probe **2** is aligned and then fixed to the fixation section **3** so that the probe-side magnet **23** and the fixation section-side magnet **31** have a positional relationship of being parallel to each other and overlapping each other in the planar view viewed from the Z direction as described above. In such a manner, the ultrasonic probe **2** is fixed to the body surface with the fixation section **3** (see FIG. **2**). Further, it results that the space formed by the opening part (within the frame) of the fixation section **3**, the ultrasonic probe **2**, and the body surface is filled with the acoustic matching material **35**, and thus, the bubbles are prevented from occurring between the ultrasonic probe **2** and the living body A. Specifically, in the ultrasonic probe unit **10** according to the present embodiment, even in the case of fixing the ultrasonic probe **2** to the living body A for a long period of time, the problem that the acoustic matching material **35** flows out from the space between the ultrasonic probe and the living body A is suppressed, and thus, it is possible to eliminate or ease the cumbersome operation such as refilling the space with the acoustic matching material **35** during the measurement.

Positioning of Scan Plane of Ultrasonic Probe **2**

[0129] FIG. **7** is a diagram schematically showing the condition in which the scan plane Sc of the ultrasonic probe **2** has been changed.

[0130] In the ultrasonic apparatus **1** according to the present embodiment, after fixing the ultrasonic probe **2** to the fixation section **3**, the scan plane Sc can be adjusted along the X direction. Specifically, it is possible to drive the displacement mechanism **24** based on the control by the control device **5** to adjust the relative position of the probe-side magnet **23** in the X direction to the housing **21** (the ultrasonic device **22**). For example, in the case of displacing the probe-side magnet **23** in the +X direction as shown in FIG. **7**, a predetermined positional relationship between the probe-side magnet **23** and the fixation section-side magnet **31** is restored irrespective of the positions of the housing **21** and the probe-side magnet **23** as described above. Specifically, the relative position of the probe-side magnet **23** to the fixation section-side magnet **31** does not change since the fixation section-side magnet **31** and the probe-side magnet **23** attract each other with the magnetic force. Therefore, the housing **21** and the ultrasonic device **22** fixed to the housing **21** are displaced toward the −X direction relatively to the fixation section **3**. Therefore, the scan plane Sc is displaced toward the −X direction relatively to the scan plane Sc**0** corresponding to the probe-side magnet **23** which has not yet moved. Thus, it is possible to adjust the position of the scan plane Sc so that the measurement object A**1** is located on the scan plane Sc. Similarly, by displacing the probe-side magnet **23** toward the −X direction, the position of the scan plane Sc can be moved toward the +X direction.

Functions and Advantages of First Embodiment

[0131] The ultrasonic probe unit **10** is provided with the fixation section **3** and the ultrasonic probe **2**. By fixing the probe-opposed surface **33** to the object, the fixation section **3** is fixed to the object.

[0132] In the ultrasonic probe **2**, by fixing the relative position between the probe-side magnet **23** provided to the ultrasonic probe **2** and the fixation section-side magnet **31** provided to the fixation section **3**, the ultrasonic probe **2** is fixed to the object. Further, in the present embodiment, the ultrasonic probe **2** is provided with the displacement mechanism **24** for displacing the probe-side magnet **23** along the X direction relatively to the ultrasonic device **22** to thereby adjust the relative positional relationship between the ultrasonic device **22** and the probe-side magnet **23**. As described above, when fixing the ultrasonic probe **2** to the object, the relative position between the probe-side magnet **23** and the fixation section-side magnet **31** is fixed. Therefore, if the relative positional relationship between the ultrasonic device **22** and the probe-side magnet **23** is adjusted by the displacement mechanism **24**, the relative position of the ultrasonic device **22** to the object changes.

[0133] Therefore, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object when fixing the fixation section **3** to the object, and fixing the ultrasonic probe **2** to the fixation section **3**, it is easy to adjust the position of the ultrasonic device **22** so as to be the appropriate position for the object using the displacement mechanism **24**. Therefore, in the present embodiment, it is easy to fix the ultrasonic probe **2** to the desired position for the object.

[0134] The displacement mechanism **24** displaces the ultrasonic device **22** and the probe-side magnet **23** in a plane parallel to the operating surface **41**B along the X direction (slicing direction). Therefore, even in the case in which the positional relationship between the ultrasonic device **22** and the probe-side magnet **23** is adjusted by the displacement mechanism **24**, the distance between the ultrasonic device and the object is not changed. Therefore, the distance (the depth) between the ultrasonic device **22** and the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object is not changed, and the transmission process and the reception process of the ultrasonic wave high in accuracy can be performed.

[0135] Further, in the present embodiment, the ultrasonic device **22** has the one-dimensional array structure in which the ultrasonic transducer groups **45**A are arranged in the Y direction (the scanning direction), and is capable of controlling the transmission direction of the ultrasonic wave along the scan plane Sc parallel to the Y-Z plane and perpendicular to the operating surface **41**B in accordance with the drive timings of the ultrasonic transducer groups **45**A. In such an ultrasonic device **22**, it is not achievable to change the transmission direction of the ultrasonic wave in the X direction. Therefore, in the ultrasonic device **22** having the one-dimensional array structure, in the case in which the transmission direction of the ultrasonic wave, namely the scan plane Sc, and the transmission target of the ultrasonic wave in the object are shifted from each other along the X direction, it becomes difficult to correct the shift. In contrast, according to the present embodiment, it is possible to relatively move the probe-side magnet **23** and the ultrasonic device **22** along the X direction using the displacement mechanism **24** to thereby move the scan plane Sc along the X direction. Therefore, as described above, even in the case in which the transmission direction of the ultrasonic wave and the transmission target of the ultrasonic wave in the object are shifted from each other along the X direction, the shift can easily be corrected by the displacement mechanism **24**.

[0136] The ultrasonic probe **2** has the contact surface **211**B parallel to the operating surface **41**B. Further, the fixation section **3** has the flat probe-opposed surface **33**. Thus, it is possible to move the probe-side magnet **23** relatively to the ultrasonic device **22** along the X direction to smoothly move the ultrasonic probe **2** relatively to the fixation section **3** while being guided by the probe-opposed surface **33** with respect to the fixation section **3**.

[0137] Here, as the displacement mechanism **24**, it is possible to adopt a configuration of moving the ultrasonic device **22** relatively to the probe-side magnet **23**. However, there is a possibility that the transmission characteristic and the reception characteristic of the ultrasonic wave vary due to, for example, the stress applied to the ultrasonic device **22** during the movement. In contrast, in the present embodiment, since the displacement mechanism **24** moves the probe-side magnet relatively to the ultrasonic device **22**, the problem described above can be prevented.

[0138] The ultrasonic device **22** is provided with the acoustic lens **44**. Therefore, it is possible to converge the ultrasonic transmitted from the ultrasonic device **22** at a predetermined position in the measurement object, and further, it is possible to uniformly spread the ultrasonic wave reflected at the predetermined position to the entire area of the ultrasonic device. Therefore, it is possible to improve the efficiency of the transmission and reception process of the ultrasonic wave.

[0139] The fixation section **3** has the fixation section-side magnet **31** having the frame-like shape, and is capable of housing the acoustic lens **44**. As described above, by housing the acoustic lens **44** in the fixation section **3** having the frame-like shape, the acoustic lens **44** does not hinder the adjustment of the relative position between the ultrasonic device **22** and the probe-side magnet **23**, and the adjustment operation can be performed smoothly. Further, since the frame can be filled with the acoustic matching material **35** such as gel, a drop in output of the ultrasonic wave between the object and the ultrasonic probe **2** can be suppressed.

[0140] Further, in the ultrasonic probe unit **10**, due to the magnetic force generated between the probe-side magnet **23** and the fixation section-side magnet **31**, the ultrasonic probe **2** is fixed to the fixation section **3**. As described above, the ultrasonic probe **2** can be fixed with the simple configuration. Further, it is easy to perform the positioning of the ultrasonic probe **2** compared to the configuration of, for example, making a click part engage with an engaging part. Specifically, in the configuration of making the click part engage with the engaging part, there occurs the work of fitting the click part into the engaging part by an operator. However, in the present embodiment, since the relative position between the fixation section-side magnet **31** and the probe-side magnet **23** is automatically determined by the attractive force due to the magnetic force, the fitting work described above becomes unnecessary.

Second Embodiment

[0141] Then, a second embodiment will be described.

[0142] In the first embodiment described above, the ultrasonic probe **2** is configured so that the scan plane to the body surface can be displaced along the X direction by displacing the probe-side magnet **23** along the X direction relatively to the housing **21**. In contrast, in the second embodiment, there is adopted a configuration in which the angle of the scan plane to the body surface can be changed by rotating the probe-side magnet **23** with respect to the housing **21**. The second embodiment is different in this point from the first embodiment described above.

[0143] Hereinafter, an ultrasonic device according to the present embodiment will be described. It should be noted that in the following explanation, the constituents substantially the same as those of the first embodiment are denoted by the same reference symbols, and the explanation thereof will be omitted or simplified.

Configuration of Ultrasonic Probe 2A

[0144] FIG. **8** is a schematic cross-sectional view of the ultrasonic probe **2**A according to the second embodiment and the fixation section **3** in the case of fixing the ultrasonic probe **2**A to the body surface of the living body. FIG. **9** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe **2**A along the X-Y plane.

[0145] The ultrasonic probe **2**A is provided with a housing **21**A, the ultrasonic device **22** fixed to the inside of the housing **21**A, a probe-side magnet **23** rotatably disposed inside the housing **21**A, a rotary mechanism **26** for rotating the probe-side magnet **23** with respect to the housing **21**A, and a wiring board provided with a driver circuit for controlling the ultrasonic device **22**, and so on.

[0146] The probe-side magnet **23** is supported by the housing **21** with rotary shafts **237**A, **237**B (see FIG. **9**) so as to be rotatable around the center axis (a shaft center Ax**1**) parallel to the Y direction. Specifically, as shown in FIG. **9**, the rotary shaft **237**A is pivoted by the first side surface part **213** of the housing **21**, and the rotary shaft **237**B is concentric with the rotary shaft **237**A, and is pivoted by the second side surface part **214**. It should be noted that although in the present embodiment, there is shown an example in which the probe-side magnet **23** is supported by the rotary shafts **237**A, **237**B, but the invention is not limited to this example. For example, in the case in which the ultrasonic device **22** is not located at the rotational center (the shaft center Ax**1**), it is also possible to adopt a configuration in which the probe-side magnet **23** is supported by a single rotary shaft penetrating the probe-side magnet **23** in the Y direction.

[0147] The rotary mechanism **26** is connected to the rotary shaft **237**A, and rotates the rotary shaft **237**A to thereby rotate the probe-side magnet **23** relatively to the housing **21**. As the rotary mechanism **26**, there can be used a stepping motor, the rotational amount of which can be controlled based on the control by the control device **5**. It should be noted that as the rotary mechanism **26**, besides the use of the stepping motor, it is also possible to adopt a configuration in which an operating section is disposed at an end part on the −Y side of the rotary shaft **237**A, and the operating section is manually rotated to thereby rotate the probe-side magnet **23**.

[0148] As shown in FIG. **8**, in the present embodiment, the distance dimension between the inner bottom surface **211**C and the top surface **212**A of the housing **21** is larger than the thickness dimension in the Z direction of the probe-side magnet **23**. Thus, there are formed gaps, which enable the rotation of the probe-side magnet **23** around the shaft center Ax**1** of the rotary shafts **237**A, **237**B, between the lower surface **231** of the probe-side magnet **23** and the inner bottom surface **211**C, and between the upper surface **232** of the probe-side magnet **23** and the top surface **212**A.

[0149] Further, in the bottom surface part **211** of the housing **21**, a predetermined area centered on the part where the acoustic lens **44** of the ultrasonic device **22** is exposed forms a contact surface **211**D curved convexly in a direction from the device surface of the ultrasonic device **22** toward the fixation section **3**, namely toward the −Z direction. The contact surface **211**D is formed to have a cylindrical shape, which forms a circular arc with the shaft center Ax**1** of the rotary shafts **237**A, **237**B as the central axis in the Z-X plane shown in FIG. **8**. Here, the center of the circular arc of the contact surface **211**D coincides with the shaft center Ax**1**.

Angle Adjustment of Scan Plane of Ultrasonic Probe **2**A

[0150] FIG. **10** is a diagram schematically showing the condition in which the angle of the scan plane of the ultrasonic probe **2**A has been changed.

[0151] In the ultrasonic device according to the present embodiment, after fixing the ultrasonic probe **2**A to the fixation section **3**, the angle of the scan plane can be changed in the X-Z plane. Specifically, it is possible to drive the rotary mechanism **26** based on the control by the control device **5** to rotate the probe-side magnet **23** around the shaft center Ax**1** relatively to the housing **21** (the ultrasonic device **22**). For example, as shown in FIG. **10**, when rotating the probe-side magnet **23** counterclockwise relatively to the housing **21**, since the probe-side magnet **23** and the fixation section-side magnet attract each other, the housing **21** rotates clockwise relatively to the fixation section **3** while the curved contact surface **211**D and a part of the probe-opposed surface **33** of the fixation section **3** keep having contact with each other. Therefore, the scan plane Sc is tilted relatively to the scan plane Sc**0** corresponding to the probe-side magnet **23**, which has not yet rotated.

[0152] Thus, it is possible to adjust the angle of the scan plane Sc so that the measurement object A**1** is located on the scan plane Sc.

Functions and Advantages of Second Embodiment

[0153] In the present embodiment, in addition to the functions and advantages in the first embodiment described above, the following functions and advantages can be obtained. Specifically, by rotating the probe-side magnet **23** using the rotary mechanism **26**, it is possible to rotate the ultrasonic device **22** in the opposite direction to the rotational direction of the probe-side magnet **23**. Therefore, the transmission direction of the ultrasonic wave of the ultrasonic device **22** and the reception direction of the ultrasonic wave, in which the ultrasonic wave can be received with high sensitivity, can be rotated around the rotational axis. Therefore, even in the case in which the transmission direction (or the reception direction of the ultrasonic wave) of the ultrasonic wave is shifted from the transmission target (or the transmission (reflection) position of the ultrasonic wave to be received) of the ultrasonic wave in the object, it is possible to easily adjust the angle of the ultrasonic device **22** with respect to the object using the rotary mechanism **26**.

[0154] Further, in the present embodiment, the ultrasonic device **22** has the one-dimensional array structure in which the ultrasonic transducer groups **45**A are arranged in the Y direction (the scanning direction), and is capable of controlling the transmission direction of the ultrasonic wave along the scan plane Sc parallel to the Y-Z plane and perpendicular to the operating surface **41**B. Further, it is possible for the rotary mechanism **26** to rotate the probe-side magnet **23** around the rotational axis parallel to the Y direction to thereby rotate (tilt) the scan plane Sc. Therefore, even in the case in which the transmission direction of the ultrasonic wave and the transmission target of the ultrasonic wave in the object are shifted from each other along the second direction, the shift can easily be corrected by the rotary mechanism.

[0155] Further, since the rotary mechanism **26** rotates the probe-side magnet **23**, it is possible to suppress the stress applied from the rotary mechanism to the ultrasonic device compared to the case of rotating the ultrasonic device **22** using the rotary mechanism **26**, and thus, the degradation of the transmission characteristics and the reception characteristics of the ultrasonic wave can be suppressed.

[0156] Further, in the present embodiment, the contact surface **211**D of the ultrasonic probe **2** is curved convexly toward the −Z side. Therefore, in the case in which the ultrasonic device **22** is fixed to the housing **21** of the ultrasonic probe **2** provided with the contact surface **211**D, and it is arranged that the probe-side magnet **23** is rotatable with respect to the housing **21**, when rotating the probe-side magnet **23** relatively to the ultrasonic device **22**, the ultrasonic device **22** and the housing **21** rotate around the rotational axis. On this occasion, in the present embodiment, since the contact surface **211**D is curved convexly, it is possible to smoothly rotate the housing **21** in the state in which a part of the housing **21** keeps having contact with the fixation section **3** during the rotation of the housing **21**, and thus, the smooth angle adjustment can be achieved.

Modified Example of Second Embodiment

[0157] It should be noted that in the second embodiment described above, the contact surface **211**D of the ultrasonic probe **2** has contact with straight line parts extending along the inner ends (opening ends) of the frame in the probe-opposed surface **33** of the fixation section **3** having the rectangular frame shape as shown in FIG. **8** and FIG. **10**. In contrast, it is also possible to adopt a configuration in which the probe-opposed surface **33** of the fixation section **3**A has surface contact with the contact surface **211**D as shown in FIG. **11**.

[0158] FIG. **11** is a schematic cross-sectional view of the ultrasonic probe **2**A according to the modified example of the second embodiment and the fixation section **3**A in the case of fixing the ultrasonic probe **2**A to the body surface of the living body.

[0159] In the present embodiment, similarly to the first and second embodiments described above, the fixation section **3**A is provided with the fixation section-side magnet **31** formed to have a rectangular frame shape in the planar view viewed from the Z direction, and a fixation tape **32**.

[0160] Here, the fixation section-side magnet **31** is provided with curved surfaces forming circular arcs on the inner side (opening part side) of the surface opposed to the ultrasonic probe **2**A in the Z-X plane as shown in FIG. **11**. Thus, probe-contact surfaces **33**A each having the same curvature as that of the curved surface described above are also formed in the probe-opposed surface **33** of the fixation section **3**A. The probe-contact surfaces **33**A have the same curvature radius as that of the contact surface **211**D of the ultrasonic probe **2**A. Therefore, when fixing the ultrasonic probe **2**A to the fixation section **3**A, the contact surface **211**D of the ultrasonic probe **2**A has contact with the probe-contact surface **33**A of the fixation section **3**A.

[0161] Therefore, in the present embodiment, when rotating the probe-side magnet **23** to rotate the housing **21** around the shaft center Ax1 after fixing the ultrasonic probe **2**A to the fixation section **3**A, the contact surface **211**D has sliding contact with the probe-contact surface **33**A of the fixation section **3**A.

[0162] In such a configuration, the contact area in the case of fixing the fixation section **3**A and the ultrasonic probe **2**A to each other can be made larger compared to the second embodiment, and thus, stronger fixation force can be obtained. Further, the leakage of the acoustic matching material **35**, with which the space between the opening part (the space in the frame) of the fixation section **3**A, the living body A, and the ultrasonic probe **2**A is filled, can be suppressed.

Third Embodiment

[0163] Then, a third embodiment will be described.

[0164] In the first embodiment described above, the ultrasonic probe **2** is configured so that the scan plane to the body surface can be displaced along the X direction by displacing the probe-side magnet **23** along the X direction relatively to the housing **21**. Further, in the second embodiment described above, there is adopted a configuration in which the angle of the scan plane to the body surface can be changed by rotating the probe-side magnet **23** with respect to the housing **21**. In contrast, in the present embodiment, similarly to the first embodiment described above, the probe-side magnet **23** is disposed so as to be movable relatively to the housing, and at the same time, the ultrasonic device **22** is configured so as to be rotatable with respect to the housing, and thus, there is adopted a configuration in which the relative position along the X direction and the angle of the ultrasonic device **22** and the probe-side magnet **23** can be changed. In this point, the present embodiment is different from the first and second embodiments described above.

[0165] FIG. **12** is a schematic cross-sectional view of the ultrasonic probe **2**B according to the third embodiment and the fixation section **3** in the case of fixing the ultrasonic probe **2**B to the body surface. FIG. **13** is a schematic cross-sectional view showing a cross-section of the ultrasonic probe **2**B along the X-Y plane.

[0166] Similarly to the first embodiment, the ultrasonic probe **2**B is provided with the displacement mechanism **24**, and is configured so that the probe-side magnet **23** can be displaced along the X direction.

[0167] Here, in the ultrasonic probe **2**B according to the present embodiment, the ultrasonic device **22** is rotatably supported with respect to the housing **21**B via the wiring board **25**. Specifically, the wiring board **25** is supported by the housing **21**B with rotary shafts **251**A, **251**B shown in FIG. **12** so as to be rotatable around the center axis (a shaft center Ax2) parallel to the Y direction as shown in FIG. **12**. In other words, in the present embodiment, the adjustment section according to the invention is configured including the displacement mechanism **24** and the rotary mechanism **26**.

[0168] The rotary mechanism **26** is connected to the rotary shaft **251**A, and rotates the rotary shaft **251**A to thereby rotate the wiring board **25** relatively to the housing **21**B. Since the ultrasonic device **22** is fixed to the wiring board **25**, the ultrasonic device **22** is also rotated in accordance with the rotation of the wiring board **25**. It should be noted that although in the present embodiment, there is shown an example in which the wiring board **25** is rotatably supported by the rotary shafts **251**A, **251**B, but the invention is not limited to this example. It is also possible for the ultrasonic device **22** to rotatably be held directly by the rotary shafts **251**A, **251**B. In this case, by connecting the rotary shafts **251**A, **251**B to the sealing plate **42** for reinforcing the element substrate **41**, stress transmission to the element substrate **41** can be suppressed. Further, although there is shown an example in which the wiring board **25** is held by the rotary shafts **251**A, **251**B, the invention is not limited to this example, but it is also possible to adopt a configuration in which, for example, the wiring board **25** is rotatably supported by a single rotary shaft.

[0169] In the bottom surface part **211** of the housing **21**B, there is formed a sensor window **211**E. In the present embodiment, the sensor window **211**E is a through hole penetrating the bottom surface part **211** along the Z direction, and wall parts on the ±X side are curved along the rotational range of the ultrasonic device **22** and the wiring board **25**. Specifically, the inner surfaces of the sensor window **211**E are formed to be curved surfaces each having a circular arc shape centered on the shaft center Ax**2** of the rotary shafts **251**A, **251**B in the Z-X plane.

[0170] Further, in the present embodiment, the ultrasonic device **22** and the wiring board **25** are held by a holding frame **27**. As shown in FIG. **12**, the holding frame **27** has outer peripheral surfaces along the inner surfaces (the curved surfaces each having the circular arc shape centered on the shaft center Ax**2** in the Z-X plane) of the sensor window **211**E, and becomes rotatable around the shaft center Ax**2** together with the ultrasonic device **22** and the wiring board **25**. Further, on the inner bottom surface **211**C of the bottom surface section **211**, there are disposed flexible waterproof sheets **271** covering the boundaries between the inner bottom surface **211**C and the holding frame **27**. Thus, there is reduced the possibility that the acoustic matching material **35** such as gel enter the inside of the housing **21**B.

[0171] In such a configuration, it is possible to rotate the ultrasonic device **22** and the wiring board **25** without interfering with the housing **21**B. It should be noted that the housing **21**B is configured similarly to the first embodiment except the point that the wall parts of the sensor window **211**A are curved.

[0172] In the ultrasonic apparatus **1** according to the third embodiment having such a configuration as described above, similarly to the first embodiment, by displacing the probe-side magnet **23** along the X direction, it is possible to move the scan plane by the ultrasonic device **22** along the X direction relatively to the body surface. Further, in the ultrasonic apparatus **1**, by rotating the wiring board **25** to which the ultrasonic device **22** is fixed, the angle of the scan plane can be changed.

Functions and Advantages of Third Embodiment

[0173] In the ultrasonic probe **2**B according to the present embodiment, the ultrasonic device **22** becomes rotatable around the rotary shafts **251**A, **251**B, which are parallel to the Y direction, and at the same time, the probe-side magnet **23** becomes movable along the X direction relatively to the housing **21**B. Therefore, similarly to the first and second embodiments described above, even after fixing the ultrasonic probe **2**B to the fixation section **3**, it is possible to adjust the transmission/reception direction of the ultrasonic wave so that the measurement object A**1** is located on the scan plane Sc.

[0174] On this occasion, in the present embodiment, the positioning of the scan plane Sc can be performed using both of the translation of the scan plane Sc toward the X direction and rotation of the scan plane Sc centered on the shaft center Ax**2**.

[0175] In this case, compared to the case in which the positioning of the scan plane Sc is performed using, for example, only the displacement of the probe-side magnet **23** toward the X direction, or only the rotation of the ultrasonic device **22**, the adjustment amount of each of the displacement and the rotation can be made smaller, and further, finer positioning control of the scan plane Sc can be achieved. Further, even in the case in which the measurement object is located on the −Z side of a part as a non-measurement object, by setting the angle of the scan surface Sc so as to cross the Z axis, and performing the positioning, it is possible to perform transmission and reception of the ultrasonic wave around the non-measurement object.

Modified Examples

[0176] It should be noted that the invention is not limited to each of the embodiments described above, but includes modifications and improvements within a range where the advantages of the invention can be achieved, and configurations, which can be obtained by, for example, arbitrarily combining the embodiments.

[0177] For example, in the first and third embodiments described above, there is shown the example in which the two biasing sections **241** are disposed as the displacement mechanism **24**, but the invention is not limited to this example. For example, three or more biasing sections can also be disposed, or there can also adopted a configuration of disposing a single biasing section at the central part in the Y direction.

[0178] Further, as the biasing section **241**, it is also possible to use an extension coil spring, which is disposed on the −X side of the probe-side magnet **23** and pulls the probe-side magnet **23** toward the −X side, and so on. Further, it is also possible to adopt a configuration in which a pressing member such as a compression spring for pressing the probe-side magnet **23** toward the −X side is disposed on the +X side of the probe-side magnet **23**, and the tensile member for pulling the probe-side magnet **23** toward the −X side is disposed on the −X side of the probe-side magnet **23**.

[0179] Further, although there is illustrated the configuration of moving the spindle forward and backward using the advancing/retreating mechanism of the micrometer head as the pressing part **242**A and the drive section **242**B of the pressing section **242**, it is also possible to adopt a configuration of moving a pin forward and backward using an actuator such as a solenoid.

[0180] Further, although there is shown the example of pressing the probe-side magnet **23** with the pressing section **242**, it is also possible to adopt a configuration of fixing the probe-side magnet **23** to the tip of a shaft which can be driven forward and backward by a configuration such as a solenoid, and so on. In this case, the configuration of the biasing section **241** can be made unnecessary.

[0181] Further, as the displacement mechanism **24**, there can be used a variety of types of actuators as described above. It is possible to illustrate a configuration of using, for example, a piezoelectric actuator, which causes an elliptic motion in the tip part to thereby move a surface having contact with the tip part along the X direction, on at least either one of the first outer side surface **233**A, the second outer side surface **233**B, the first inner side surface **234**A, and the second inner side surface **234**B of the probe-side magnet **23**. Further, instead of the piezoelectric actuator, it is also possible to use a surface-wave type ultrasonic motor, which propagates the surface wave along the X direction to move the probe-side magnet **23**, or the like on at least either one of the first outer side surface **233**A, the second outer side surface **233**B, the first inner side surface **234**A, and the second inner side surface **234**B of the probe-side magnet **23**. Further, it is also possible to adopt a configuration of rotating a screw shaft extending along the X direction by an electric motor, and engaging a part of the probe-side magnet **23** with the screw shaft.

[0182] Further, in the first and third embodiments described above, there is illustrated the configuration guiding the displacement of the probe-side magnet **23** by making the probe-side magnet **23** have sliding contact with the wall surfaces (the first side surface part **213** and the second side surface part **214**) of the housing **21**, **21**B, and at the same time, inserting the protrusions (the first protruding parts **235** and the second protruding parts **236**) of the probe-side magnet **23** into the groove parts (the first groove part **213**B and the second groove part **214**B) provided to the wall surfaces, but the invention is not limited to this configuration. For example, it is also possible to adopt a configuration of making a shaft disposed along the X direction hold the probe-side magnet **23**. Further, it is also possible to adopt a configuration of providing the probe-side magnet **23** with a through hole extending along the X direction, and inserting a shaft fixed to the housing into the through hole, or the like. In this case, it is also possible to make the shaft hold the coil spring constituting the biasing section **241**.

[0183] Further, as the rotary mechanism **26** in the second and third embodiments, there is illustrated a stepping motor, but the invention is not limited to this example. It is also possible to adopt a configuration of, for example, making a piezoelectric actuator with the tip part performing an elliptic motion have contact with a rotor disposed at the tip of each of the rotary shafts **237**A, **237**B, **251**A, **251**B to thereby rotate the rotary shafts **237**A, **237**B, **251**A, **251**B.

[0184] Further, in the second embodiment, there is illustrated the configuration of rotating the probe-side magnet **23** around the rotary shafts **237**A, **237**B as the rotary mechanism **26**, but the invention is not limited to this configuration.

[0185] It is also possible to adopt a configuration of, for example, swinging the probe-side magnet **23** along a circular arc groove as shown in FIG. **14** and FIG. **15**.

[0186] FIG. **14** is a schematic cross-sectional view of an ultrasonic probe **2**C according to the present modified example and a fixation section **3** in the case of fixing the ultrasonic probe **2**C to the body surface.

[0187] FIG. **15** is a diagram for explaining an outline of a swing mechanism (an adjustment section) of the probe-side magnet **23** in the present modified example.

[0188] As shown in FIG. **15**, in this ultrasonic probe **2**C, there is provided the swing mechanism **218** constituting the adjustment section according to the invention. The swing mechanism **218** is constituted by guide grooves **218**A, belt guides **218**B, pulleys **218**C, belts **218**D, and pinion gears **238**. It should be noted that in FIG. **14**, illustration of the guide groove **218**A, the belt guide **218**B, the pulleys **218**C, the belt **218**D, and the pinion gears **238** on the second side surface part **214** side is omitted.

[0189] The guide grooves **218**A are grooves each having a circular arc shape and are provided respectively to the first side surface part **213** and the second side surface part **214** of the housing **21**C. As shown in FIG. **14**, the circular arc center (an imaginary shaft center Ax3) of the guide groove **218**A is disposed outside the ultrasonic probe **2**C.

[0190] The belt guides **218**B are disposed along the circular arc of the guide grooves **218**A on the +Z side (the top surface part **212** side) of the guide grooves **218**A of the first side surface part **213** and the second side surface part **214**, respectively. Further, the pulleys **218**C are disposed on both end sides in the X direction of the belt guides **218**B so as to be able to rotate around the rotary shaft perpendicular to the first side surface part **213** (and the second side surface part **214**).

[0191] Further, the belts **218**D are each wound around the pair of pulleys **218**C, and a part of the belt **218**D located on the −Z side has sliding contact with a surface on the −Z side of the belt guide **218**B. Further, the outer peripheral surface of the belt **218**D is provided with rack grooves as shown in FIG. **15**.

[0192] One of the pair of pulleys **218**C becomes to be able to be rotationally driven by a drive section not shown, and thus, it becomes possible to drive the −Z side of the belt **218**D along the guide groove **218**A.

[0193] Further, the pinion gears **238** protrude from the probe-side magnet **23** toward the first side surface part **213** (and the second side surface part **214**), and are inserted into the guide grooves **218**A. Further, the pinion gears **238** engage with the rack grooves provided to the outer peripheral surface of the belt **218**D, and when the pulleys **218**C are rotationally driven to move the belts **218**D along the guide grooves **218**A, the pinion gears **238** rotate to move along the guide grooves **218**A. Thus, the probe-side magnet **23** becomes possible to swing along the guide grooves **218**A together with the pinion gears **238**.

[0194] In such an ultrasonic probe **2**C according to the modified example as described above, by swinging the probe-side magnet **23** in the state in which the relative position to the fixation section-side magnet **31** is fixed, the housing **21**C is displaced in the direction along the guide grooves **218**A. Thus, the angle and the position in the X direction of the scan plane Sc of the ultrasonic wave transmitted and received by the ultrasonic device **22** are changed. Thus, it becomes possible to adjust the fixation position of the ultrasonic probe **2**C so that the measurement object **A1** is located on the scan plane Sc.

[0195] It should be noted that the swing mechanism is not limited to the example shown in FIG. **15**. It is also possible to adopt a configuration in which, for example, rack grooves are formed on the inner peripheral surface of the guide groove **218**A, the pinion gears **238** are rotationally driven by a stepping motor provided to the probe-side magnet **23** to thereby swing the probe-side magnet **23**.

[0196] Further, although there is illustrated the configuration of swinging the probe-side magnet **23** relatively to the housing **21**C, it is also possible to adopt a configuration of swinging the ultrasonic device **22** relatively to the housing **21**C. The configuration can be realized with substantially the same configuration as the swing mechanism **218** of the probe-side magnet **23**, and it is sufficient to, for example, provide the ultrasonic device **22** with the pinion gears to be inserted into the guide grooves **218**A.

[0197] In the first embodiment, there is shown the example in which the ultrasonic device **22** is fixed to the housing **21**, and by displacing the probe-side magnet **23** relatively to the housing **21**, the housing is displaced in the X direction relatively to the fixation section **3**, but the invention is not limited to this example.

[0198] It is also possible to adopt a configuration in which, for example, the probe-side magnet **21** is fixed to the housing **21**, and the ultrasonic device **22** becomes to be able to be displaced relatively to the housing **21**, and displaced along the X direction by the displacement mechanism.

[0199] Further, the same applies to the second embodiment, it is also possible to adopt a configuration in which, for example, the probe-side magnet **23** is fixed to the housing **21**, and the ultrasonic device **22** becomes rotatable around the rotary shaft extending along the Y direction with respect to the housing **21** as in the third embodiment.

[0200] Further, also in the third embodiment, it is also possible to adopt a configuration in which the probe-side magnet **23** is rotatable around the rotary shaft extending along the Y direction with respect to the housing **21** to thereby make the ultrasonic device **22** movable in the X direction using the displacement mechanism **24**.

[0201] In each of the embodiments described above, the bulk type probe-side magnet **23** is illustrated as the first fixation section according to the invention, but the invention is not limited to this example. It is also possible to use, for example, a coil magnet.

[0202] Further, as the first fixation section and the second fixation section, there is described the example of fixing the ultrasonic probe **2**, 2A, **2**B to the fixation section **3**, **3**A with the magnetic force of the magnet, but the invention is not limited to this configuration.

[0203] It is also possible to adopt a configuration in which, for example, a click part (a male engagement part) is provided to either one of the ultrasonic probe **2** and the fixation section **3**, an engagement part (a female engagement part) is provided to the other thereof, and the click part is made to engage with the engagement part. In this case, by adopting a configuration of, for example, displacing the click part relatively to the housing to which the ultrasonic device is fixed, it is possible to displace the scan plane along the X direction similarly to each of the embodiments described above.

[0204] Besides the above, it is also possible to adopt a configuration in which an adhesive surface is provided to the probe-opposed surface **33** of the fixation section, and the ultrasonic probe **2** is adhesively fixed, and so on. In this case, by, for example, displacing the ultrasonic device **22** relatively to the housing **21**, it is possible to displace the scan plane along the X direction similarly to each of the embodiments described above.

[0205] In each of the embodiments described above, there is illustrate the configuration in which the fixation section **3** has the frame-like shape, but the invention is not limited to this configuration.

[0206] It is also possible to adopt a configuration of, for example, fixing two fixation section-side magnets **31** parallel to each other to the body surface of the living body A with the fixation tape **32**.

[0207] Further, although there is shown the example in which the fixation section **3** is constituted by the fixation section-side magnet **31** and the fixation tape **32**, it is also possible to adopt a configuration in which, for example, the fixation surface **34** of the fixation section-side magnet **31** is an adhesive surface, and can directly fixed adhesively to the living body A.

[0208] In the embodiments described above, there is shown the example in which the ultrasonic device **22** has the one-dimensional structure having the groups of the ultrasonic transducers **45** arranged along the Y direction, but the invention is not limited to this structure. It is also possible to adopt a configuration in which the plurality of ultrasonic transducers **45** is arranged in the X direction and the Y direction to constitute a two-dimensional structure. In this case the acoustic lens **44** is not required to be provided.

[0209] In the second and third embodiments, there is shown the example in which the rotary shafts **237**A, **237**B, **251**A, and **251**B are disposed in parallel to the Y direction, but the invention is not limited to this example. For example, if the rotary shafts **237**A, **237**B cross the X direction, which is an arrangement direction of the ultrasonic transducers in each of the ultrasonic transducer groups **45**A, by rotating either one of the ultrasonic device **22** and the probe-side magnet **23** around the rotary shafts **237**A, **237**B, **251**A, and **251**B, it is possible to swing the scan plane Sc in the X direction.

[0210] In the first embodiment, there is shown the example in which the contact surface **211**B of the ultrasonic probe **2** and the probe-opposed surface **33** of the fixation section **3** are each a roughly flat surface, but the invention is not limited this example. It is also possible to adopt a configuration in which, for example, a groove extending along the X direction is provided to one of the contact surface **211**B and the probe-opposed surface **33**, and a protruding part engaging with the groove is provided to the other. In such a configuration, the displacement of the ultrasonic probe **2** in the direction crossing the X direction can be limited.

[0211] In the first embodiment, there is shown the example of displacing the probe-side magnet **23** along the X direction, but it is also possible to adopt a configuration of displacing the probe-side magnet **23** in a direction tilted (except the right angle) with respect to, for example, the X direction. Further, there is shown the example of displacing the probe-side magnet **23** along the X-Y plane, but it is also possible to adopt a configuration of displacing the probe-side magnet **23** in a direction tilted (except the right angle) with respect to, for example, the X-Y plane. In other words, in the invention, the relative movement direction between the first fixation section and the ultrasonic probe is not limited to the X direction, but it is also possible to perform the relative movement with a tilt toward a direction except the right angle direction with respect to the X direction. Also in this case, the scan plane Sc can be displaced in the X direction with the displacement amount corresponding to the X direction component.

[0212] In each of the embodiments, there is illustrated the configuration in which the lower-part electrode **414**, the piezoelectric film **415**, and the upper-part electrode **416** are stacked on the vibrating film **412** as the ultrasonic transducer **45**, but the invention is not limited to this configuration. It is also possible to adopt a configuration in which, for example, a pair of electrodes are disposed on one surface perpendicular to the thickness direction of the piezoelectric element **413** so as to be opposed to each other as the ultrasonic transducer. Further, it is also possible to dispose the electrodes on the side surfaces along the thickness direction of the piezoelectric film so as to sandwich the piezoelectric film.

[0213] Further, as the ultrasonic transducer, it is also possible to vibrate the vibrating film or detect the vibration of the vibrating film using a drive method other than the piezoelectric method using the piezoelectric film. It is possible to illustrate a configuration in which, for example, the first electrode is disposed on the substrate, the vibrating film is disposed on the first electrode with a predetermined air gap, and the second electrode opposed to the first electrode is disposed on the vibrating film. In this case, by applying the pulse drive voltage between the first electrode and the second electrode, it is possible to drive the vibrating film with the electrostatic force to output the ultrasonic wave, and when the vibrating film vibrates due to the received ultrasonic wave, the capacitance between the first electrode and the second electrode varies, and therefore, the reception of the ultrasonic wave can be detected based on the variation of the capacitance.

[0214] In the first embodiment, there is illustrated the ultrasonic measurement apparatus for transmitting the ultrasonic wave to the living body A, and receiving the ultrasonic wave reflected by the measurement object A1 in the living body A to thereby measure the internal structure of the living body A as the ultrasonic apparatus of the invention, but the invention is not limited to this example.

[0215] For example, the object is not limited to the living body A, but it is also possible to adopt an apparatus for performing the ultrasonic measurement on other objects such as a concrete structure.

[0216] Further, the invention is not limited to the ultrasonic measurement apparatus, but can also be, for example, a transmission-only ultrasonic apparatus for transmitting the ultrasonic wave to the object. As such an ultrasonic apparatus, there can be illustrated, for example, an ultrasonic therapy apparatus for transmitting the ultrasonic wave to an affected part of the living body.

[0217] Besides the above, specific structures to be adopted when implementing the invention can be configured by arbitrarily combining the embodiments and the modified examples described above with each other, or can arbitrarily be replaced with other structures and so on within the range in which the advantages of the invention can be achieved.

[0218] The entire disclosure of Japanese Patent Application No. 2015-235448, filed Dec. 2, 2015 is expressly incorporated by reference herein.

What is claimed is:

1. An ultrasonic probe unit comprising:
an ultrasonic probe; and
a fixation section adapted to fix the ultrasonic probe to an object,
wherein the ultrasonic probe includes
an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave,
a first fixation section, and
an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section, and
the fixation section includes
a fixation surface to be fixed to the object, and
a second fixation section a relative position of which to the first fixation section is fixed to thereby fix the ultrasonic probe to the object.

2. The ultrasonic probe unit according to claim **1**, wherein
the adjustment section has a displacement mechanism adapted to displace the first fixation section relatively to the ultrasonic device.

3. The ultrasonic probe unit according to claim **2**, wherein
the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave, and
the displacement mechanism displaces the first fixation section relatively to the ultrasonic device in a plane parallel to the device surface.

4. The ultrasonic probe unit according to claim **3**, wherein
the ultrasonic device has a one-dimensional array structure in which a plurality of ultrasonic transducers is arranged along a first direction parallel to the device surface, and
the displacement mechanism displaces the first fixation section relatively to the ultrasonic device along a second direction crossing the first direction.

5. The ultrasonic probe unit according to claim **2**, wherein
the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave,
the ultrasonic probe has a contact surface having contact with the fixation section and parallel to the device surface, and
the fixation section has a plane along the contact surface.

6. The ultrasonic probe unit according to claim **2**, wherein
the displacement mechanism displaces the first fixation section.

7. The ultrasonic probe unit according to claim **1**, wherein
the ultrasonic device has a device surface, which is at least one of a surface adapted to transmit the ultrasonic wave and a surface adapted to receive the ultrasonic wave, and
the adjustment section includes a rotary mechanism adapted to rotate at least one of the ultrasonic device and the first fixation section around a rotational axis crossing a normal line of the device surface.

8. The ultrasonic probe unit according to claim **7**, wherein
the ultrasonic device has a one-dimensional array structure in which a plurality of ultrasonic transducers is arranged along a first direction parallel to the device surface, and
the rotational axis is parallel to the first direction.

9. The ultrasonic probe unit according to claim **7**, wherein
the rotary mechanism rotates the ultrasonic device.

10. The ultrasonic probe unit according to claim **7**, wherein
the rotary mechanism rotates the first fixation section.

11. The ultrasonic probe unit according to claim **10**, wherein
the ultrasonic probe has a contact surface having contact with the fixation section, and
the contact surface is curved convexly toward a direction from the device surface toward the fixation section when being cut by a plane perpendicular to the rotational axis.

12. The ultrasonic probe unit according to claim **11**, wherein
the fixation section has a curved surface curved along the contact surface.

13. The ultrasonic probe unit according to claim **1**, wherein
the ultrasonic probe has an acoustic lens protruding from a contact surface having contact with the fixation section toward the object.

14. The ultrasonic probe unit according to claim **13**, wherein
the fixation section has a frame body adapted to house the acoustic lens.

15. The ultrasonic probe unit according to claim **1**, wherein
the first fixation section and the second fixation section are each a magnet.

16. An ultrasonic probe to be fixed to a fixation section fixed to an object, comprising:

an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave;

a first fixation section a relative position of which to a second fixation section provided to the fixation section is fixed to thereby fix the ultrasonic probe to the fixation section; and

an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section.

17. An ultrasonic apparatus comprising:

an ultrasonic probe;

a fixation section adapted to fix the ultrasonic probe to an object; and

a control section adapted to control the ultrasonic probe,

wherein the ultrasonic probe includes

an ultrasonic device adapted to perform at least one of transmission and reception of an ultrasonic wave,

a first fixation section, and

an adjustment section adapted to adjust a relative positional relationship between the ultrasonic device and the first fixation section, and

the fixation section includes

a fixation surface to be fixed to the object, and

a second fixation section a relative position of which to the first fixation section is fixed to thereby fix the ultrasonic probe to the object.

* * * * *

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摘要(译)

超声波探头单元具有超声波探头和适于将超声波探头固定于生物体的固定部，超声波探头包括适于进行超声波的发送和接收的超声波装置，探头侧磁铁，位移机构，其适于调整超声波装置与探头侧磁铁之间的相对位置关系，固定部包括固定于生物体的固定面，固定部侧磁铁的相对位置固定探头侧磁铁，从而将超声波探头固定在生物体上。