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

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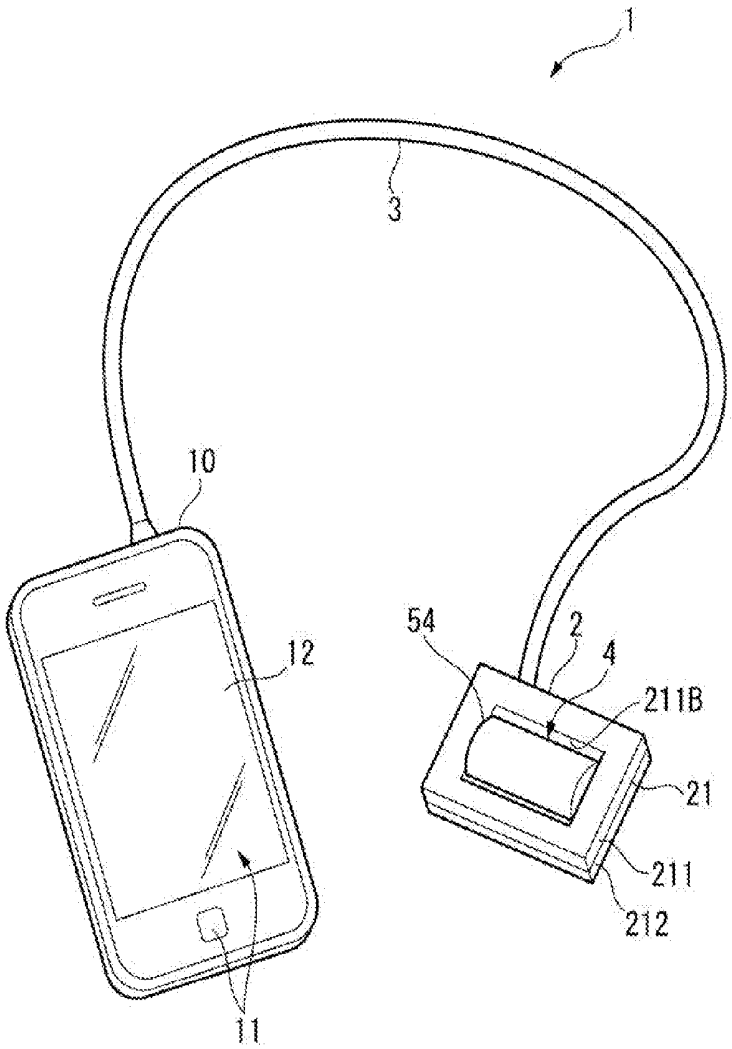
(57) **ABSTRACT**

An ultrasonic device unit includes an ultrasonic device having a device-side terminal, a reinforcing plate having a support surface adapted to support the ultrasonic device, and a flexible printed wiring board to be connected to the ultrasonic device, the flexible printed wiring board includes a connection to be connected to the device-side terminal, a bend continuous with the connection, and extending away from the ultrasonic device, and an outer edge disposed in an end in the extending direction of the bend, and the reinforcing plate is provided with a first side parallel to a first direction crossing the extending direction, and opposed to the bend, and a projection on a reverse surface opposite the support surface, and with which the outer edge has contact when the flexible printed wiring board is curved along the first side in the bend.



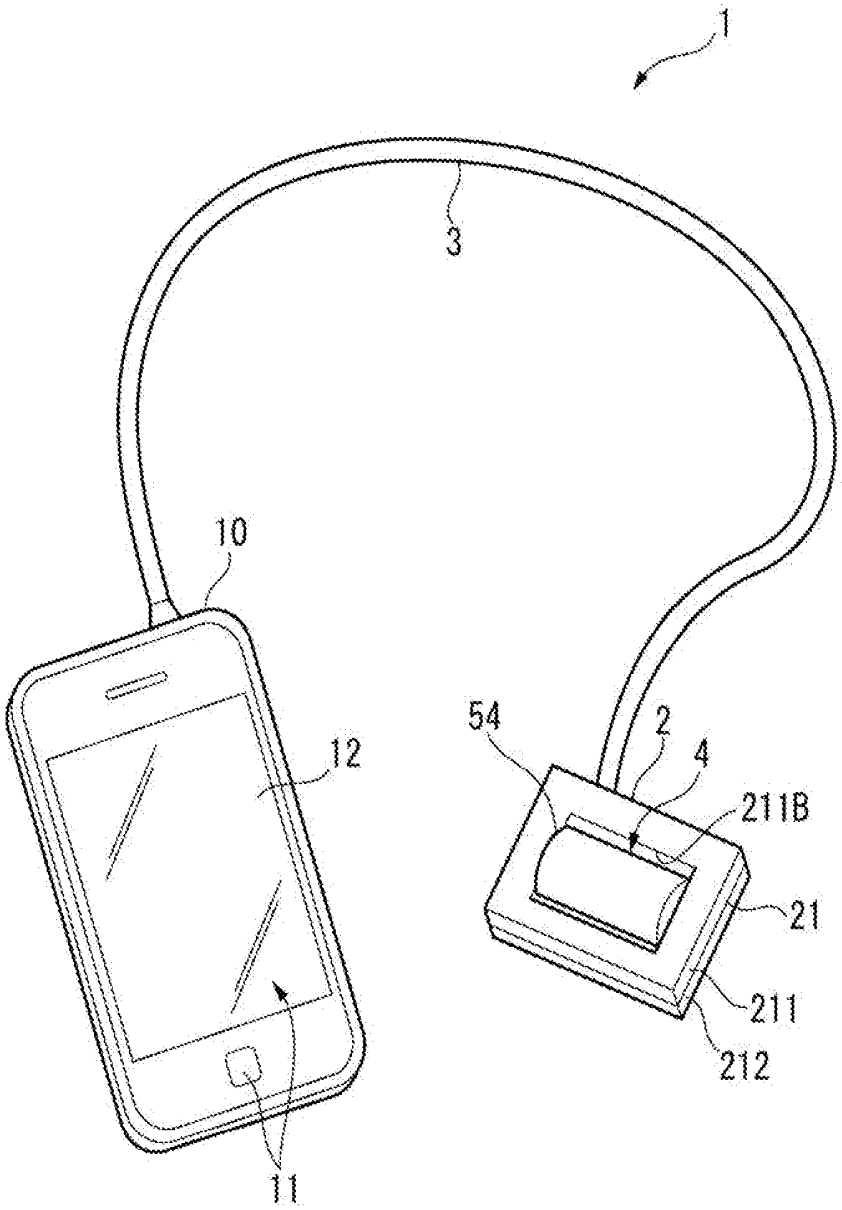


FIG. 1

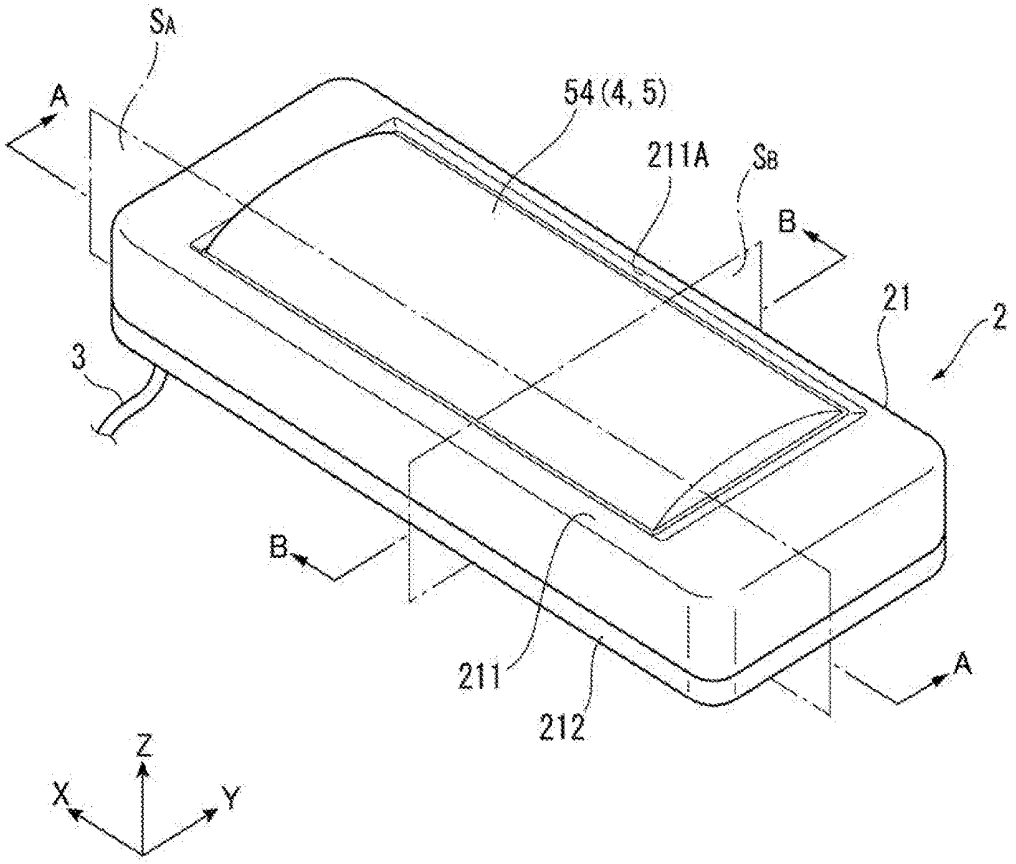
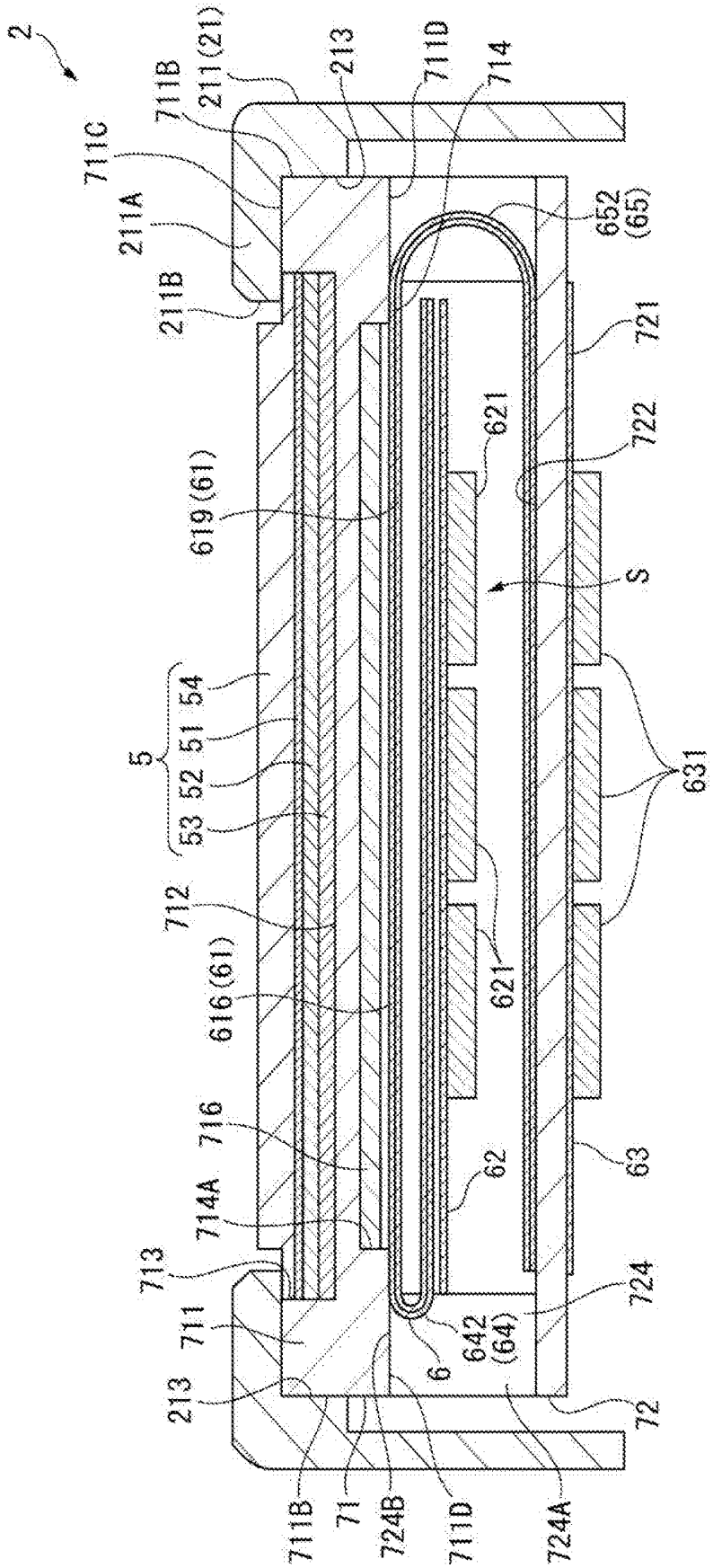


FIG. 2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711B
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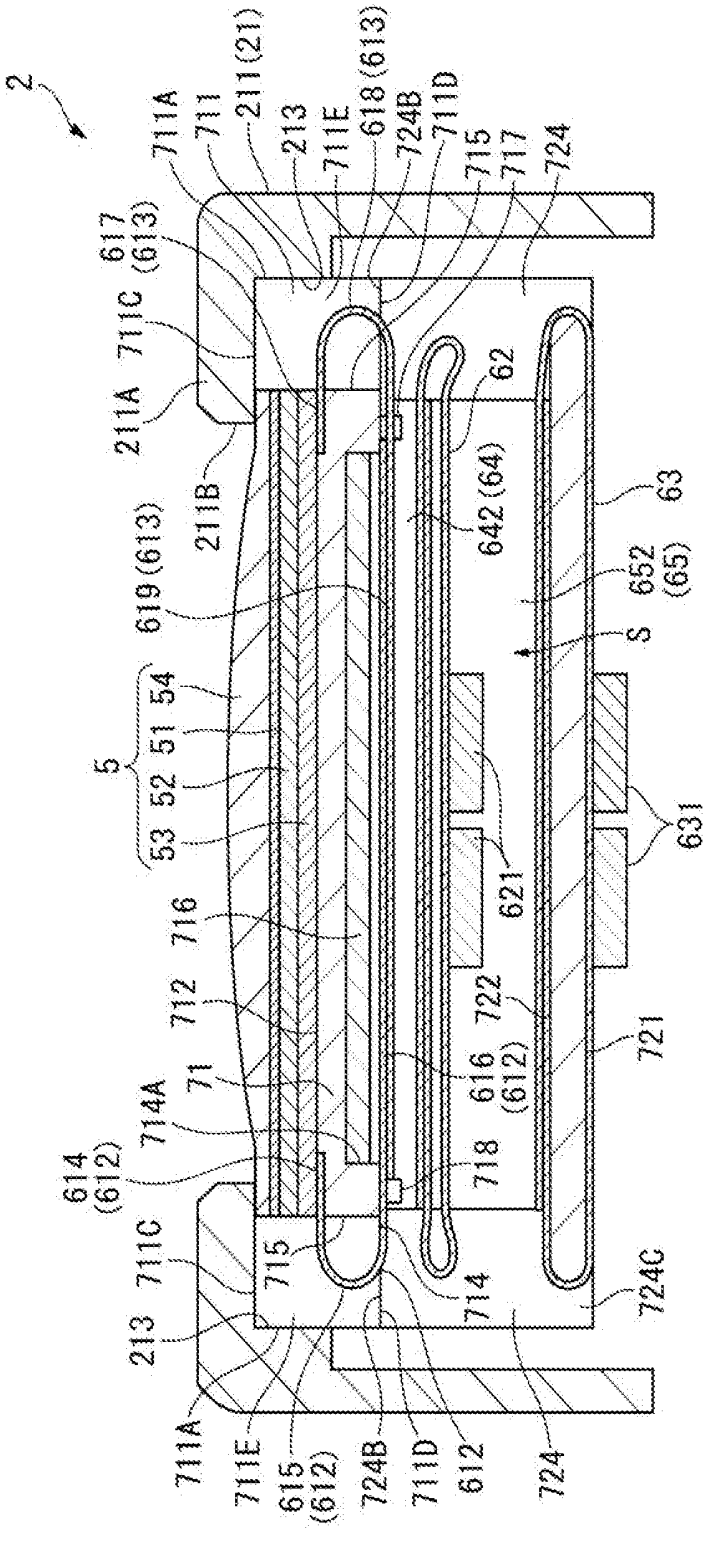
213
711D
714
711C
652
(65)
211A
211B
721
621
722
619(61)
S
5
54
51
52
53
631
712
616(61)
621
716
62
63
714A
713
724
711
642
(64)
6
213
72
711B
71
724B
711D
724A
X
Z
Y

FIG. 3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711C
211A
62
211B
642(64)
63
619(613)
652
(65)
S
5
54
51
52
53
631
621
716
712
722
721
71
616
(612)
714A
614
(612)
718
715
714
724C
213
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711A
711E
615
(612)
724B
711D
612
724
Y
Z
X

FIG. 4

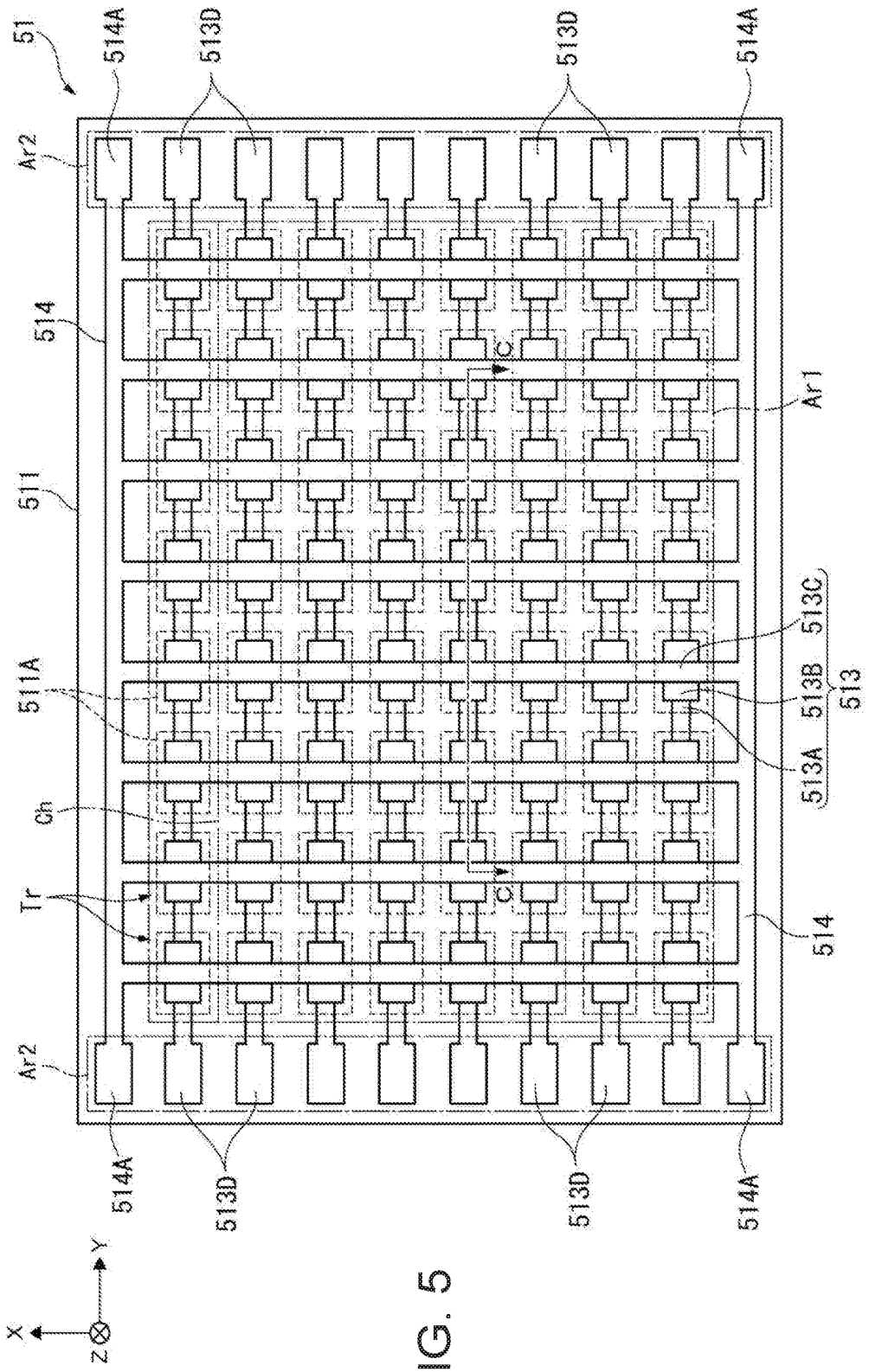

51
514A
513D
513D
514A
Ar2
514
C
Ar1
511
513C
513B
513
511A
513A
Ch
Tr
C'
514
Ar2
514A
513D
513D
514A
Y
X
Z

FIG. 5

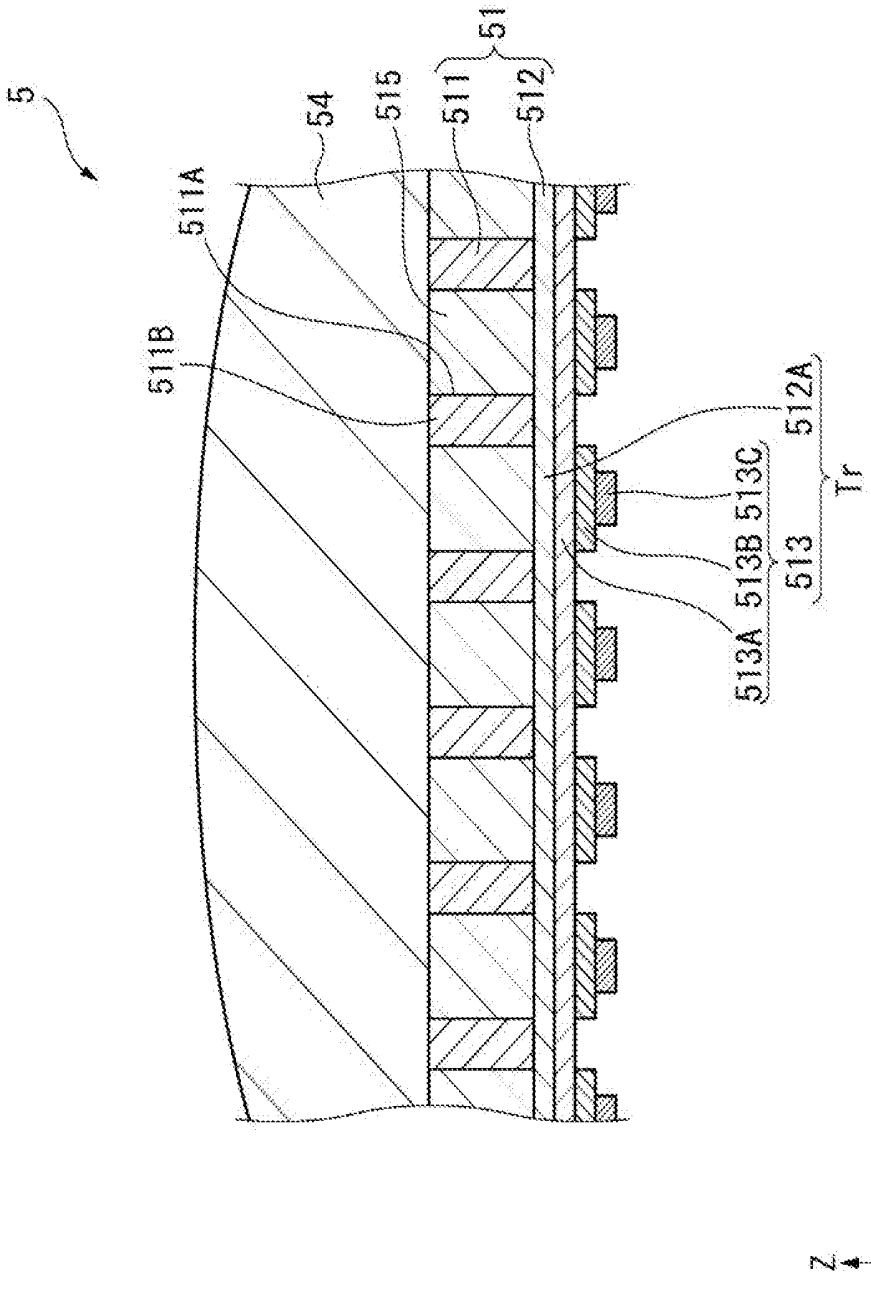


FIG. 6

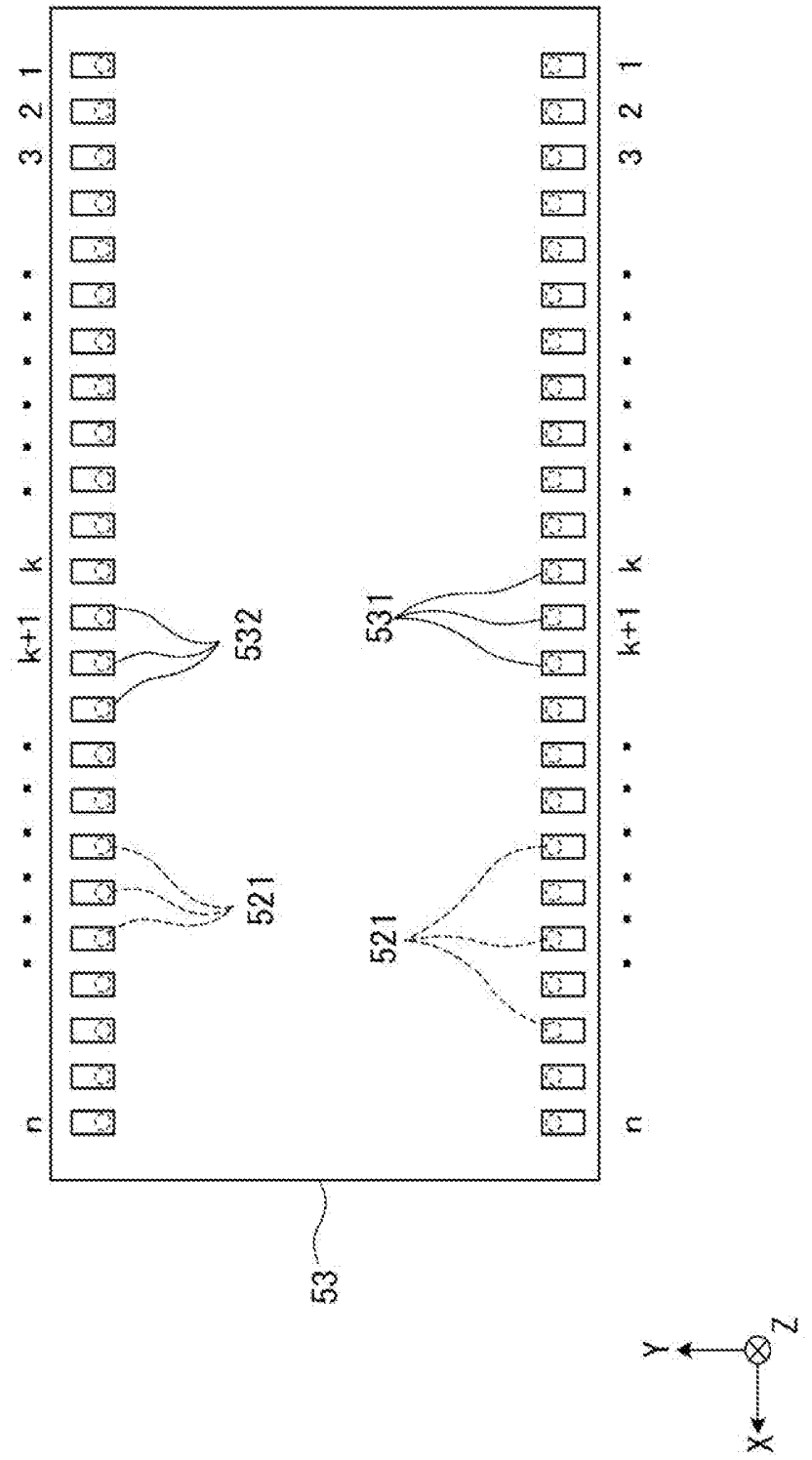
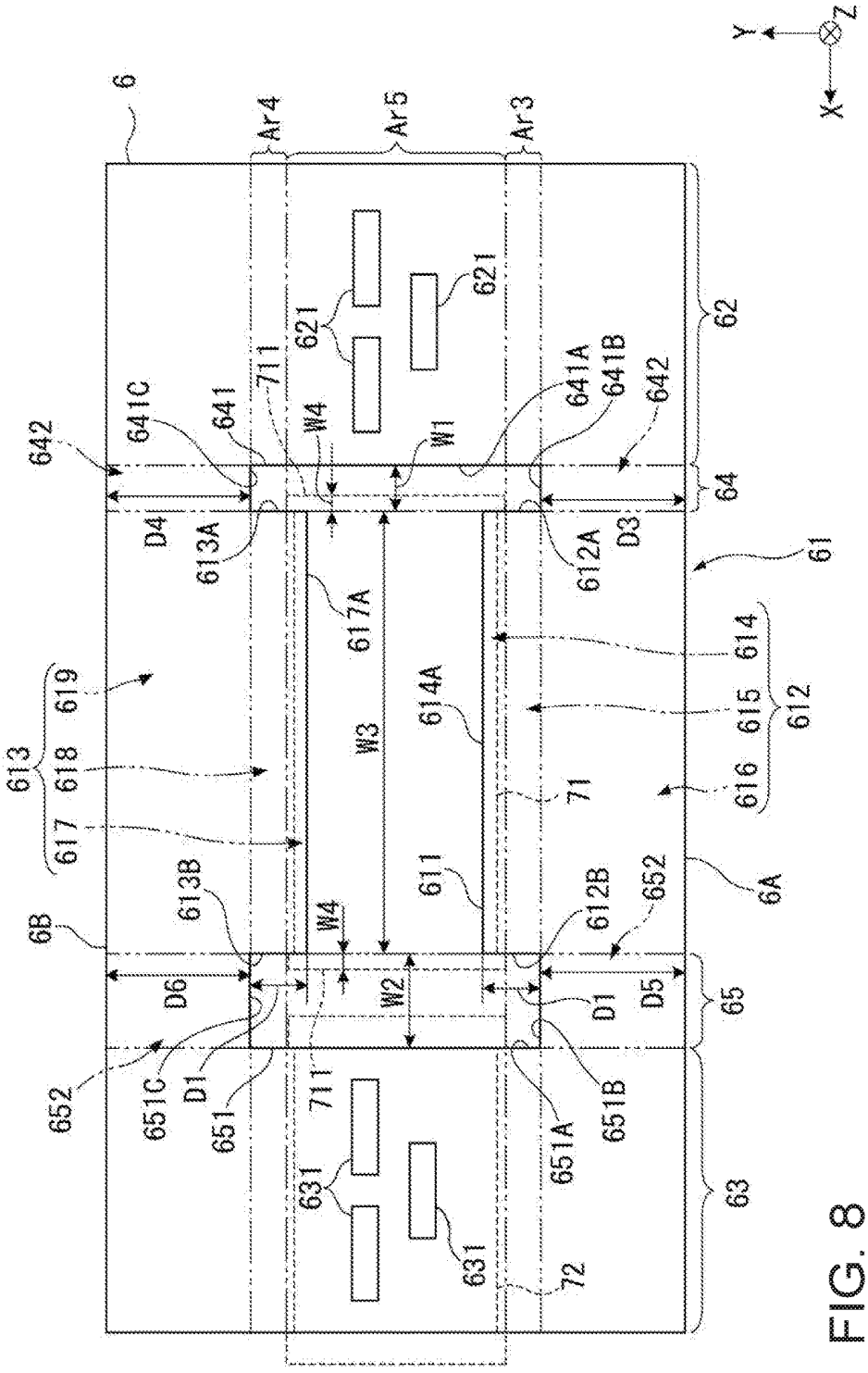


FIG. 7


Y
Z
X
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Ar4
Ar5
Ar3
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642
641C
641
711
W4
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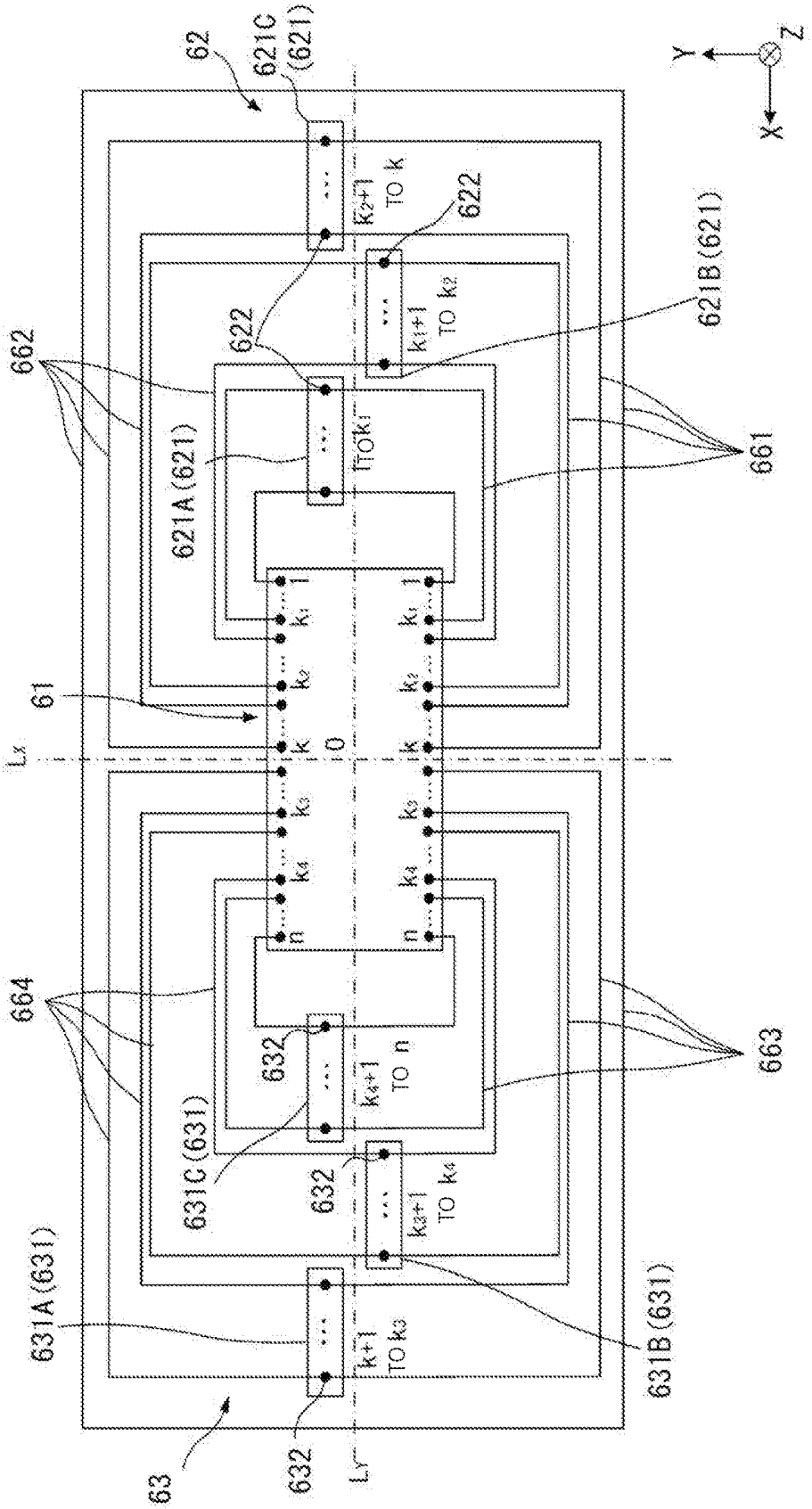
D4
613A
612A
D3
61
617A
614
619
613
618
617
W3
614A
615
612
616
71
611
613B
612B
652
6A
6B
D6
W2
D1
D5
65
651C
651
651A
651B
631
72
63

FIG. 8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621B (621)
662
661
621A (621)
61
664
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631A (631)
631B (631)
63
632
Lx
Ly
O
Y
Z
X

FIG. 9

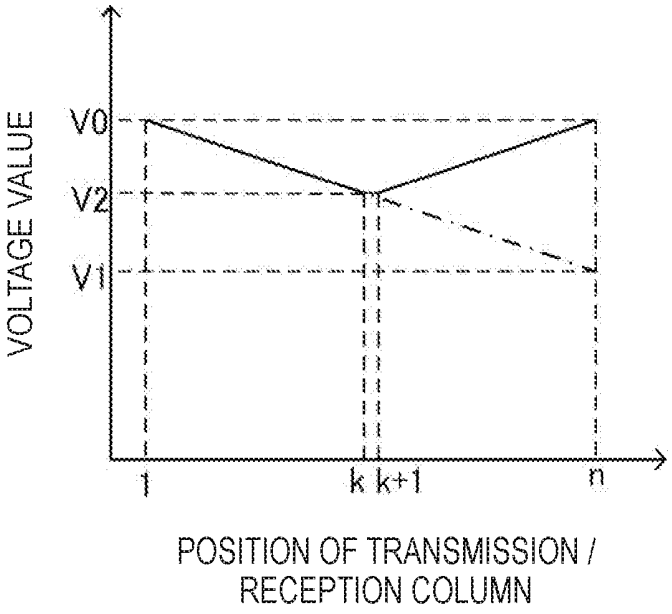
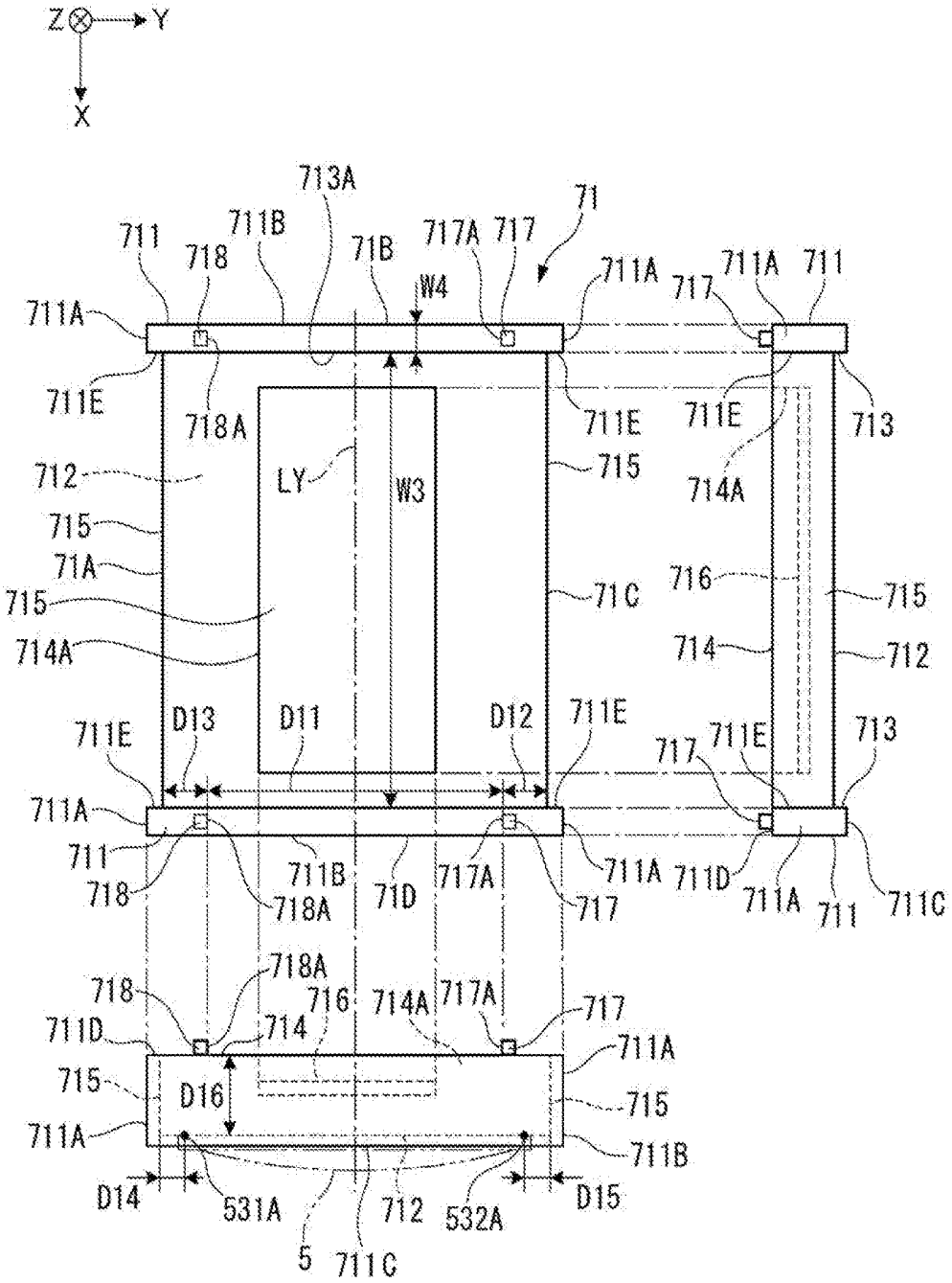

VOLTAGE VALUE
V0
V2
V1
1
k
k+1
n
POSITION OF TRANSMISSION / RECEPTION COLUMN

FIG.10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711B
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71B
717A
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711A
711
W4
711A
711E
718A
711E
711E
713
712
LY
W3
715
714A
715
71A
716
715
715
71C
714A
714
712
711E
D13
D11
D12
711E
711E
711E
713
717
711A
711
711B
718
718A
71D
717A
717
711A
711D
711A
711
711C
718A
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714A
717A
717
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711A
711B
D14
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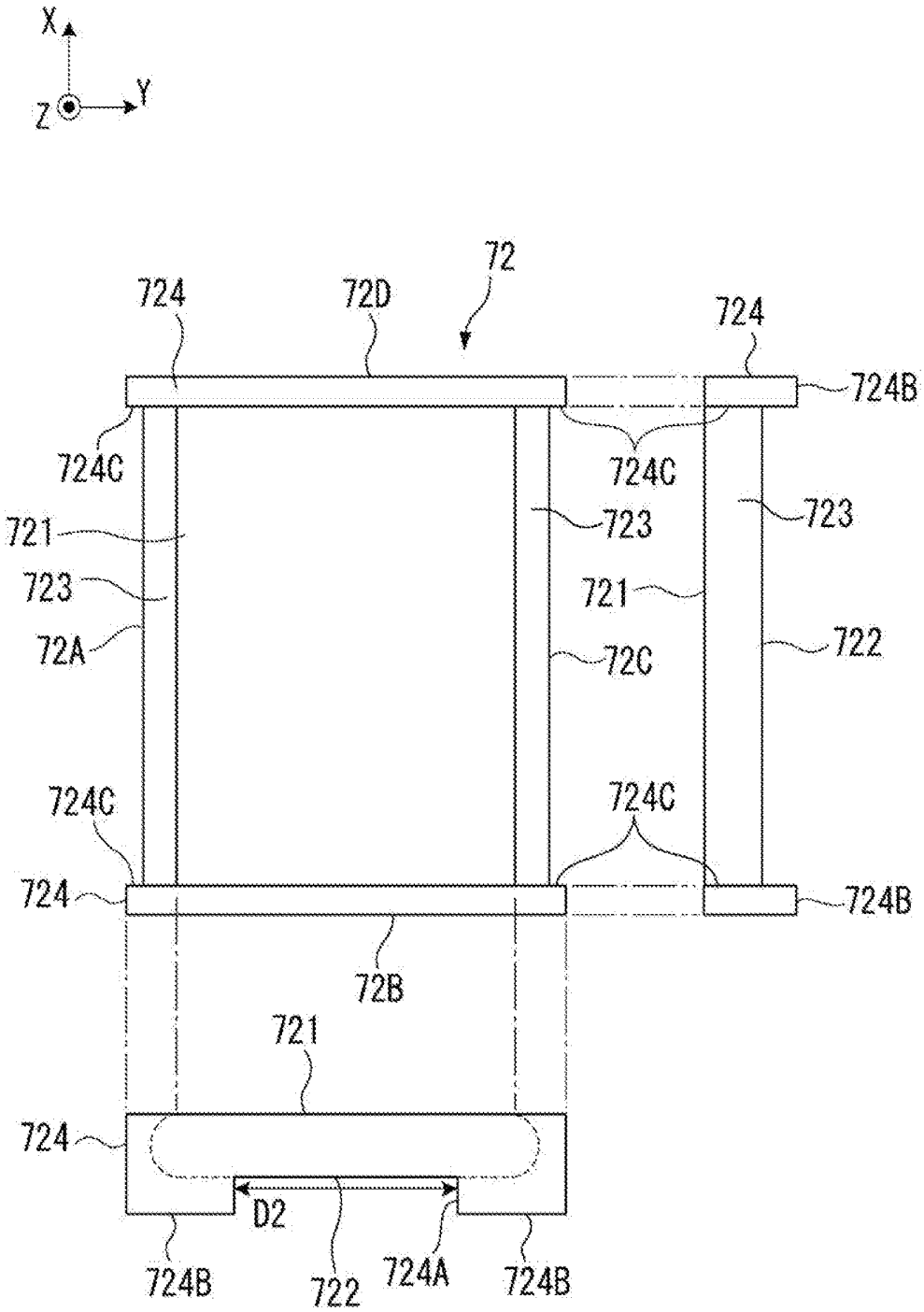
712
532A
D15
5
711C

FIG.11


X
Y
Z
72
724
72D
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724B
724C
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721
723
723
723
721
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72C
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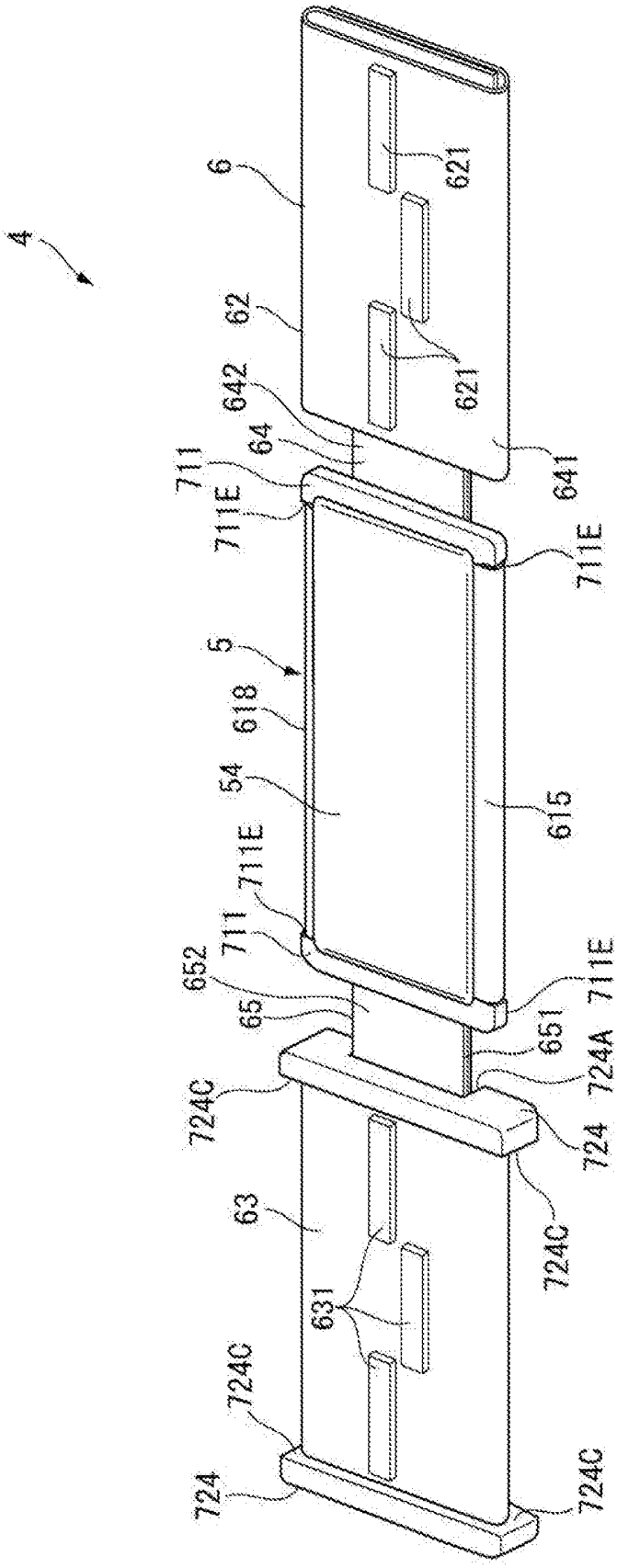
724B
72B
721
724
D2
724B
722
724A
724B

FIG.12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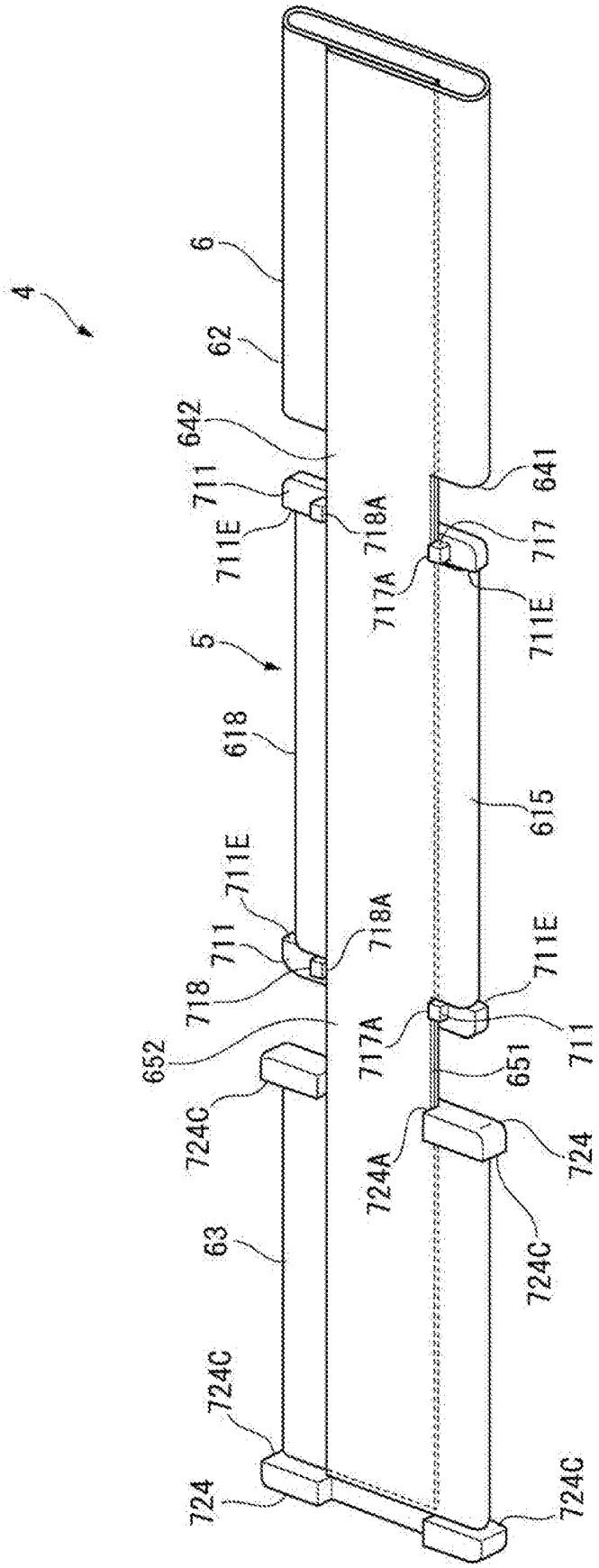
621
62
621
642
64
711
711E
641
711E
5
618
54
615
711E
711
652
65
711E
651
724A
724C
724
724C
63
631
724C
724
724C

FIG. 13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6
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717A
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718A
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724C
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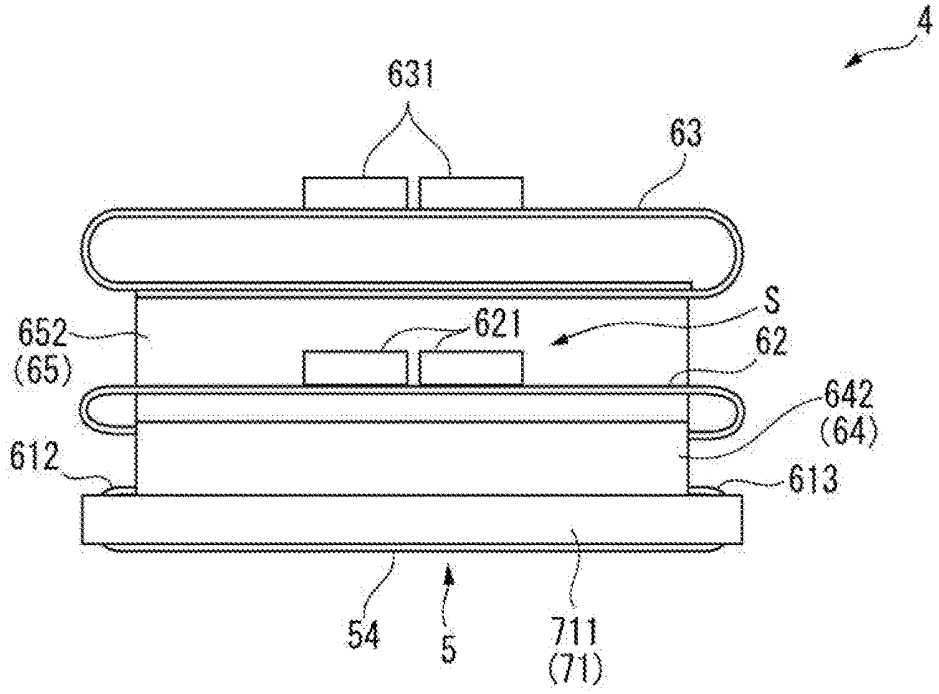
63
724C
724C
724
724C

FIG. 14


4
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(64)
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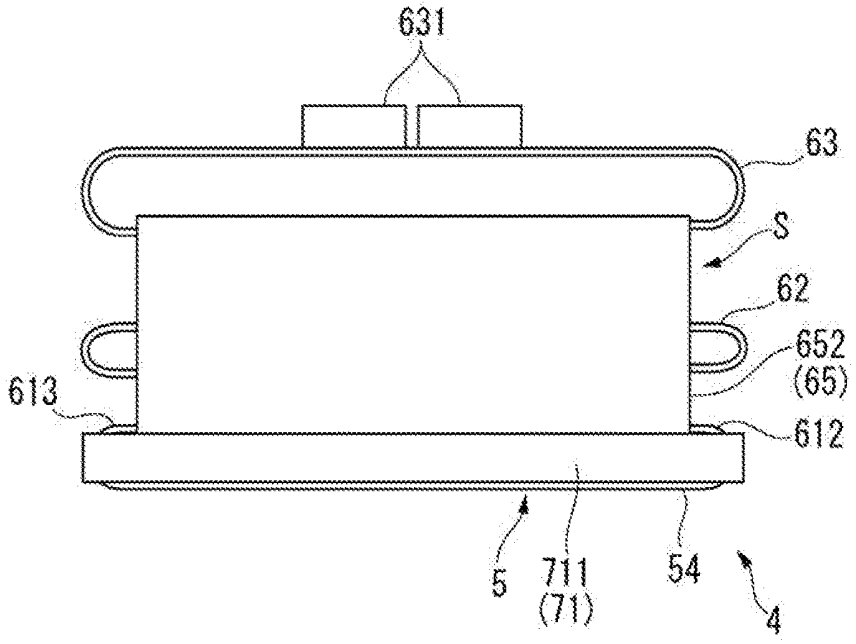
711
(71)

FIG.15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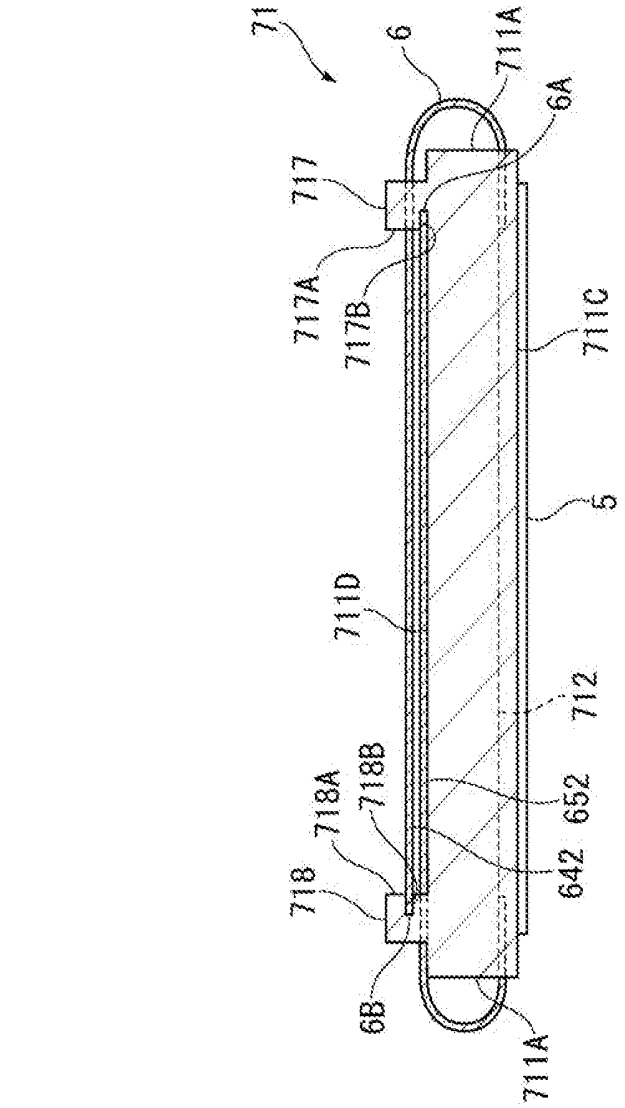
(71)
54
4

FIG.16


71
6
711A
6A
717
717A
717B
711C
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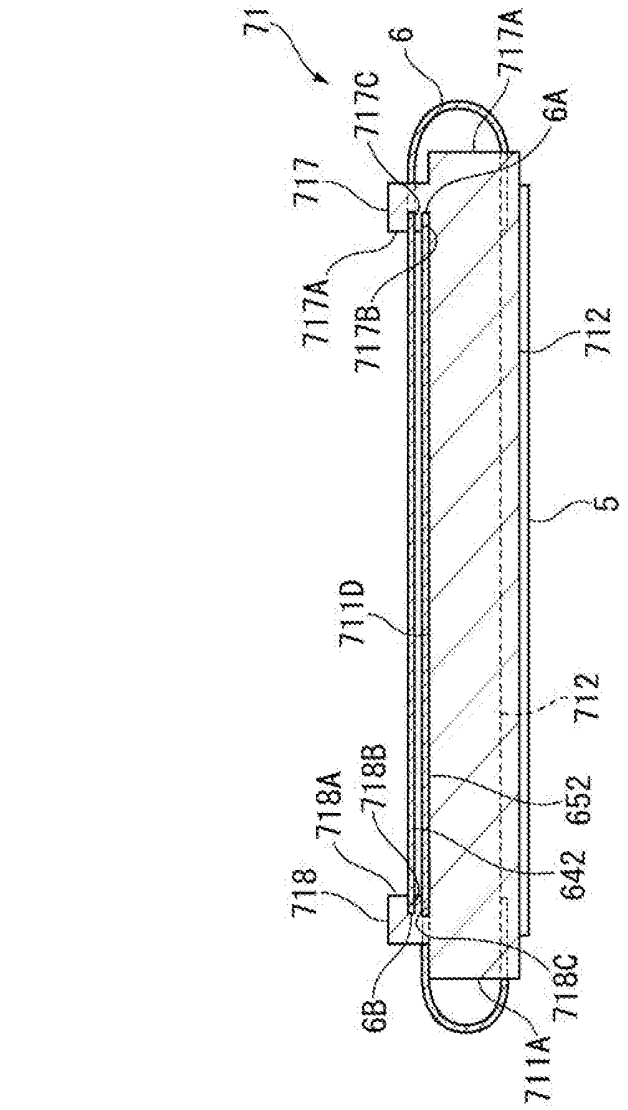
711D
712
652
642
718A
718B
718
6B
711A
Y
X
Z

FIG.17


71
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717A
717C
6A
717
717A
717B
712
5
711D
712
718B
718A
652
642
718
6B
718C
711A
Y
X
Z

FIG. 18

ULTRASONIC DEVICE UNIT, ULTRASONIC PROBE, AND ULTRASONIC APPARATUS

BACKGROUND

1. Technical Field

[0001] The present invention relates to an ultrasonic device unit, an ultrasonic probe, and an ultrasonic apparatus.

2. Related Art

[0002] In the past, there has been known an ultrasonic device unit having an ultrasonic element array in which ultrasonic elements for performing transmission and reception of ultrasonic waves are arranged (see, e.g., JP-A-2016-92592 (Document 1)).

[0003] The ultrasonic device unit of Document 1 is provided with the ultrasonic device having terminals corresponding respectively to the ultrasonic elements, and the ultrasonic device is connected to a device terminal via a flexible printed wiring board (a flexible board).

[0004] The flexible board is provided with a first flat-plate part disposed on one end side with respect to the center line, and the ultrasonic device is fixed to the first flat-plate part. Further, the flexible board is provided with a second flat-plate part disposed on the other end side with respect to the center line, and connecters to which the terminals of the ultrasonic device are connected are disposed in the second flat-plate part.

[0005] Incidentally, in such an ultrasonic device unit as described in Document 1 above, in order to house an ultrasonic device to which a flexible board is connected in a housing, the flexible board is folded into the housing (curved) so as to overlap the ultrasonic device. On this occasion, if the bending position of the flexible board is different, there is a problem that the flexible board becomes larger than the size of the ultrasonic device.

SUMMARY

[0006] An advantage of some aspects of the invention is to provide an ultrasonic device unit, an ultrasonic probe, and an ultrasonic apparatus which can be miniaturized with a simple configuration.

[0007] An ultrasonic device unit of an application example according to the invention includes an ultrasonic device having a device-side terminal, a reinforcing plate having a support surface adapted to support the ultrasonic device, and a flexible printed wiring board to be connected to the ultrasonic device, the flexible printed wiring board is provided with a connection part to be connected to the device-side terminal, a bending part continuous with the connection part, and extending in a direction of getting away from the ultrasonic device, and an outer edge part disposed in and end part in the extending direction of the bending part, and the reinforcing plate is provided with a first side parallel to a first direction crossing the extending direction, and opposed to the bending part, and a projecting part which is disposed on a reverse surface on an opposite side to the support surface, and with which the outer edge part has contact when the flexible printed wiring board is curved to be bent along the first side in the bending part.

[0008] In this application example, the connection part of the flexible printed wiring board is connected to the device-side terminal of the ultrasonic device, and the bending part continuous with the connection part is curved. On this occasion, the outer edge part of the flexible printed wiring board is made to have contact with the projecting part on the reverse surface of the reinforcing plate. Thus, the flexible printed wiring board is curved so that the outer edge part is appropriately located.

[0009] In other words, in the case in which the projecting part is not provided, it becomes difficult to curve the flexible printed wiring board along the first side in the bending part so as not to beak the interconnections. For example, if the bending part is folded on the first side with an angle with strong force, there is a possibility that breaking occurs in the interconnection connected to the device-side terminal. Further, if the bending part is folded with a curve in order to prevent breaking of the interconnection, the bending part is folded with a tilt to the first side in some cases. In this case, the size of the ultrasonic device unit when bending the flexible printed wiring board increases in such a manner that a part of the outer edge part of the flexible printed wiring board projects outside the outer edge of the reinforcing plate.

[0010] In contrast, in this application example, since the outer edge part has contact with, and is thus positioned by, the projecting part, the bending part can be curved along the first side. Therefore, breaking of the interconnection can be prevented. Further, the flexible printed wiring board is positioned by the projecting part, and is thus curved at an appropriate position. Therefore, there is no chance that a part of the flexible printed wiring board projects outside the outer edge of the reinforcing plate, and the miniaturization of the ultrasonic device unit can also be achieved.

[0011] In the ultrasonic device unit according to the application example, it is preferable that a plurality of the projecting parts is provided, and the outer edge part has contact with the plurality of the projecting parts when the flexible printed wiring board is curved to be bent along the first side in the bending part.

[0012] In the application example with this configuration, when bending the flexible printed wiring board along the first side, the outer edge part is positioned by a plurality of projecting parts. Therefore, it is possible to more appropriately bend the flexible printed wiring board without tilting the flexible printed wiring board with respect to the first side.

[0013] In the ultrasonic device unit according to the application example, it is preferable that the reinforcing plate has a rectangular shape having a third side parallel to the first direction, and a second side and a fourth side both crossing the first side and the third side, the device-side terminal is located each of a first position having a first distance from the first side and a second position having a second distance from the third side in a case of making the support surface support the ultrasonic device, the flexible printed wiring board includes a first connection part to be connected to the device-side terminal located at the first position, and a second connection part located at the second position as the connection part, a first bending part continuous with the first connection part and extending in a first extending direction of getting away from the ultrasonic device, and a second bending part continuous with the second connection part and extending in a second extending direction of getting away from the ultrasonic device as the bending part, and a first outer edge part disposed in the first extending direction from the first connection part toward the first bending part, and a second outer edge part disposed in the second extending direction from the second connection part toward the second

bending part as the outer edge part, and the reinforcing plate is provided with a first projecting part with which the first outer edge part has contact when the flexible printed wiring board is curved to be bent along the first side in the first bending part, and a second projecting part with which the second outer edge part has contact when the flexible printed wiring board is curved to be bent along the third side in the second bending part as the projecting part.

[0014] In the application example with this configuration, the flexible printed wiring board is bent along the first side and the third side opposed to each other of the reinforcing plate having a rectangular shape. On this occasion, since there is provided the second projecting part with which the second outer edge part has contact when bending the flexible printed wiring board along the third side, it is possible to bend the flexible printed wiring board along the third side without a tilt similarly to the application example described above.

[0015] In the ultrasonic device unit according to the application example, it is preferable that the flexible printed wiring board has a slit having an opening edge including a first end edge as an end edge extending along the first extending direction of the first connection part and the first bending part, a second end edge as an end edge extending along the second extending direction of the second connection part and the second bending part, and an opposed edge opposed to the first end edge and the second end edge, a width dimension from the first end edge to the opposed edge of the slit is larger than a width dimension in the first direction of the second projecting part, and a width dimension from the second end edge to the opposed edge of the slit is larger than a width dimension in the first direction of the first projecting part.

[0016] As described above, in the case of bending the flexible printed wiring board along the first side and the third side opposed to each other of the reinforcing plate, the flexible printed wiring board bent from the first side covers the second projecting part, and the flexible printed wiring board bent from the third side overlaps the first projecting part. In contrast, in the application example with the configuration described above, there is provided the slit in which the distance from the first end edge to the opposed edge is larger than the width dimension in the first direction of the second projecting part, and the distance from the second end edge to the opposed edge is larger than the width dimension in the first direction of the first projecting part. Therefore, it is possible to prevent the disadvantage that when bending the flexible printed wiring board along the first side and the third side, the first projecting part and the second projecting part are inserted into the slit, and the flexible printed wiring board covers the first projecting part and the second projecting part.

[0017] In the ultrasonic device unit according to the application example, it is preferable that in the opening edge of the slit, an opening end in the first extending direction and an opening end in the second extending direction are located between the first projecting part and the second projecting part when the flexible printed wiring board is curved to be bent along the first side in the first bending part.

[0018] In the application example with this configuration, when bending the flexible printed wiring board along the first side and the third side, the opening end of the slit moves beyond the first projecting part and the second projecting part, and is located between the first projecting part and the second projecting part. In other words, the first projecting part and the second projecting part are inserted through the slit after all. Therefore, the disadvantage that the flexible printed wiring board covers the first projecting part and the second projecting part can more surely be prevented.

[0019] An ultrasonic probe according to another application example according to the invention preferably includes the ultrasonic device unit according to any one of the application examples described above, and a housing adapted to store the ultrasonic device unit.

[0020] In the ultrasonic probe according to this application example, such an ultrasonic device unit as described above is housed in the housing, and by making the ultrasonic probe have contact with the test object, the ultrasonic measurement on the test object can be performed. Further, as described above, in the ultrasonic device unit, the flexible printed wiring board can be bent along the first side of the ultrasonic device while preventing the breaking of the interconnections, and therefore easily deformed into a shape suitable for space-saving. Therefore, it is possible to appropriately arrange the ultrasonic device unit within the limited space of the ultrasonic probe, and further, the miniaturization of the ultrasonic probe can also be achieved.

[0021] An ultrasonic apparatus according to another application example according to the invention includes the ultrasonic device unit according to any one of the application examples described above, and a control section adapted to control the ultrasonic device unit.

[0022] In this application example, by controlling such an ultrasonic device unit as described above, it is possible to perform a variety of types of ultrasonic processing (e.g., ultrasonic measurement on the test object, and ultrasonic therapy on the test object) in accordance with the measurement result of the ultrasonic measurement. Further, since the ultrasonic device unit can be miniaturized as describe above, the miniaturization of the ultrasonic apparatus can also be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0024] FIG. **1** is a perspective view showing a schematic configuration of an ultrasonic measurement apparatus according to an embodiment of the invention.

[0025] FIG. **2** is a perspective view showing an appearance of an ultrasonic probe according to the embodiment.

[0026] FIG. **3** is a cross-sectional view of the ultrasonic probe cut along the line A-A shown in FIG. **2**.

[0027] FIG. **4** is a cross-sectional view of the ultrasonic probe cut along the line B-B shown in FIG. **2**.

[0028] FIG. **5** is a plan view showing a schematic configuration of an ultrasonic substrate of the embodiment.

[0029] FIG. **6** is a cross-sectional view of the ultrasonic substrate cut along the line C-C shown in FIG. **5**.

[0030] FIG. **7** is a plan view showing a schematic configuration of a wiring board of the embodiment.

[0031] FIG. **8** is a plan view showing a schematic configuration of a surface of a flexible board of the embodiment.

[0032] FIG. **9** is a diagram showing a wiring structure of the flexible board of the embodiment.

[0033] FIG. **10** is a diagram showing a voltage value of a drive voltage to be applied to each of transmission/reception columns of an ultrasonic device.

[0034] FIG. **11** is a plan view, a front view, and a side view of a first reinforcing plate of the embodiment.

[0035] FIG. **12** is a plan view, a front view, and a side view of a second reinforcing plate of the embodiment.

[0036] FIG. **13** is a perspective view of the case in which the flexible board is curved along an X direction in the embodiment.

[0037] FIG. **14** is a perspective view of the flexible board viewed from a reverse surface side in FIG. **13**.

[0038] FIG. **15** is a side view of an ultrasonic device unit according to the embodiment viewed from a first inflective part side.

[0039] FIG. **16** is a side view of the ultrasonic device unit according to the embodiment viewed from a second inflective part side.

[0040] FIG. **17** is a cross-sectional view of a positioning block of a first reinforcing plate related to a modified example cut along the Y-Z plane at a position at which projection parts are disposed.

[0041] FIG. **18** is a cross-sectional view of a positioning block of a first reinforcing plate related to another modified example cut along the Y-Z plane at a position at which projection parts are disposed.

DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[0042] An embodiment according to the invention will hereinafter be described.

[0043] FIG. **1** is a perspective view showing a schematic configuration of the ultrasonic measurement apparatus **1**.

[0044] As shown in FIG. **1**, the ultrasonic measurement apparatus **1** corresponds to an ultrasonic apparatus, and is provided with an ultrasonic probe **2**, and a control device **10** electrically connected to the ultrasonic probe **2** via a cable **3**.

[0045] The ultrasonic measurement apparatus **1** transmits an ultrasonic wave from the ultrasonic probe **2** to the inside of a living body (e.g., a human body) in the state in which the ultrasonic probe **2** has contact with a surface of the living body. Further, the ultrasonic measurement apparatus **1** receives the ultrasonic wave reflected by an organ in the living body using the ultrasonic probe **2**, and then, for example, obtains an internal tomographic image of the inside of the living body to measure the state (e.g., blood flow) of the organ in the living body based on the received signal.

1. Configuration of Control Device

[0046] As shown in FIG. **1**, for example, the control device **10** corresponds to a control section, and is provided with an operating section **11** including buttons or a touch panel, and a display section **12**. Further, although not shown in the drawings, the control device **10** 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. The control device **10** makes the arithmetic section execute a variety of programs stored in the storage section to thereby control the ultrasonic measurement apparatus **1**. For example, the control device **10** outputs a command for controlling the drive of the ultrasonic probe **2**, forms an image of the internal structure of the living body and then makes the display section **12** display the image, and measures the living body information such as the blood flow to make the display section **12** display the living body information based on the received signal input from the ultrasonic probe **2**. As such a control device **10**, 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.

2. Configuration of Ultrasonic Probe

[0047] FIG. **2** is a perspective view showing an appearance of the ultrasonic probe **2**. FIG. **3** is a cross-sectional view of the ultrasonic probe **2** cut along the line A-A (a plane S_A) shown in FIG. **2**, and FIG. **4** is a cross-sectional view of the ultrasonic probe **2** cut along the line B-B (a plane S_B) shown in FIG. **2**.

[0048] The ultrasonic probe **2** corresponds to an ultrasonic probe, and is provided with a housing **21**, and an ultrasonic device unit **4** stored inside the housing **21** as shown in FIG. **1** through FIG. **4**. Further, the ultrasonic device unit **4** is configured including an ultrasonic device **5**, a flexible printed wiring board (a flexible board **6**), a first reinforcing plate **71**, and a second reinforcing plate **72**.

[0049] Hereinafter, each of the constituents will be described in detail.

2-1. Configuration of Ultrasonic Device **5**

[0050] As shown in FIG. **3** and FIG. **4**, the ultrasonic device constituting the ultrasonic device unit **4** includes an ultrasonic substrate **51**, a sealing plate **52**, a wiring board **53**, and an acoustic lens **54**, and is formed by stacking the wiring board **53**, the sealing plate **52**, the ultrasonic substrate **51**, and the acoustic lens **54** in this order. In the present embodiment, the ultrasonic device **5** is formed to have, for example, a rectangular shape in a planar view viewed from the stacking direction (a Z direction) of the wiring board **53**, the sealing plate **52**, the ultrasonic substrate **51**, and the acoustic lens **54**.

2-1-1. Configuration of Ultrasonic Substrate **51**

[0051] FIG. **5** is a plan view showing a schematic configuration of the ultrasonic substrate **51** of the present embodiment.

[0052] As shown in FIG. **5**, the ultrasonic substrate **51** is provided with a plurality of ultrasonic transducers Tr arranged in a two-dimensional array along the X direction (a second direction, a scanning direction) and the Y direction (a first direction, a slicing direction). In the present embodiment, 1-CH (channel) transmission/reception column Ch (vibrator element) is constituted by a plurality of ultrasonic transducers Tr (ultrasonic elements) arranged in the Y direction. Further, a plurality of the 1-CH transmission/reception columns Ch arranged side by side along the X direction constitutes the ultrasonic substrate **51** having a two-dimensional array structure. Here, in the ultrasonic substrate **51**, an area where the ultrasonic transducers Tr are arranged is defined as an array area Ar**1**.

[0053] It should be noted that in FIG. **5**, the number of the ultrasonic transducers Tr arranged is reduced for the sake of convenience of explanation, but in reality, there are arranged a larger number of ultrasonic transducers Tr.

[0054] FIG. **6** is a schematic cross-sectional view of the ultrasonic substrate **51** cut along the line C-C shown in FIG. **5**.

[0055] As shown in FIG. **6**, the ultrasonic substrate **51** is configured including an element substrate **511**, a support

film **512** disposed on the element substrate **511**, and piezoelectric elements **513** disposed on the support film **512**.

[0056] The element substrate **511** is formed of a semiconductor substrate made of, for example, Si. The element substrate **511** is provided with substrate opening parts **511**A corresponding to the respective ultrasonic transducers Tr. In the present embodiment, each of the substrate opening parts **511**A is a through hole penetrating the element substrate **511** in the thickness direction thereof, and the support film **512** is disposed on one end side (the sealing plate **52** side) of the through hole.

[0057] Further, the side of the substrate opening part **511**A where the support film **512** is not provided is filled with an acoustic layer **515** having acoustic impedance approximate to that of the living body.

[0058] Further, on a surface of the element substrate **511** located on the opposite side to the support film **512**, there is disposed the acoustic lens **54** having contact with the element substrate **511** and the acoustic layer **515**. The acoustic lens **54** is a part which is exposed from the sensor window **211**B (see FIG. **1** and so on) provided to the housing **21** when the ultrasonic device unit **4** is stored in the housing **21**, and forms a part to have contact with the test object when performing the ultrasonic measurement. Similarly to the acoustic layer **515**, the acoustic lens **54** is formed of, for example, silicone having acoustic impedance approximate to that of the living body, and is formed to have a cylindrical shape with an axis parallel to the X direction.

[0059] The support film **512** is formed of, for example, a stacked body of SiO_2 and ZrO_2, and is disposed so as to cover the entire area on the sealing plate **52** side of the element substrate **511**. Specifically, the support film **512** is supported by partition walls **511**B constituting the substrate opening parts **511**A, and closes the sealing plate **52** side of the substrate opening parts **511**A. The thickness dimension of the support film **512** is made sufficiently small with respect to that of the element substrate **511**.

[0060] It should be noted that in the present embodiment, the support film **512** is formed by performing a thermal oxidation treatment on one surface of the element substrate **511** formed of Si to form SiO_2, and then stacking ZrO_2 thereon. On this occasion, by performing etching on the element substrate **511** using the support film **512** including SiO_2 as an etching stopper, it becomes possible to easily form the substrate opening parts **511**A and the partition walls **511**B.

[0061] The piezoelectric elements **513** are disposed on respective parts of the support film **512** closing the respective substrate opening parts **511**A. The piezoelectric elements **513** are each formed of, for example, a stacked body obtained by stacking a lower-part electrode **513**A, a piezoelectric film **513**B, and an upper-part electrode **513**C from the support film **512** side.

[0062] Here, the part of the support film **512** closing the substrate opening part **511**A constitutes a vibrating part **512**A, and the vibrating part **512**A and the piezoelectric element **513** constitute one ultrasonic transducer Tr.

[0063] In such an ultrasonic transducer Tr, by applying a rectangular-wave voltage (a drive voltage) having a predetermined frequency between the lower-part electrode **513**A and the upper-part electrode **513**C, the piezoelectric film **513**B is deflected to vibrate the vibrating part **512**A to transmit the ultrasonic wave. Further, when the vibrating part **512**A is vibrated by the ultrasonic wave (a reflected wave) reflected by the living body, an electrical potential difference occurs between an upper part and a lower part of the piezoelectric film **513**B. Thus, by detecting the electrical potential difference occurring between the lower-part electrode **513**A and the upper-part electrode **513**C, it becomes possible to detect the ultrasonic wave received.

[0064] As shown in FIG. **5**, in the present embodiment, the lower-part electrode **513**A is formed along the Y direction to have a linear shape, and connects the plurality of ultrasonic transducers Tr constituting the 1-CH transmission/reception column Ch to each other. Drive terminals **513**D therefor are electrically connected to the wiring board **53** via, for example, through electrodes provided to the sealing plate **52**.

[0065] Further, the upper-part electrode **513**C is formed along the X direction to form a linear shape, and connects the ultrasonic transducers Tr arranged in the X direction. Further, the end parts on the ±X sides of the upper-part electrode **513**C are respectively connected to common electrode lines **514**. The common electrode lines **514** each connect the upper-part electrodes **513**C arranged along the Y direction to each other, and are each provided with common terminals **514**A at the end parts thereof, wherein the common terminals **514**A are electrically connected to the wiring board **53**. The common terminals **514**A are electrically connected to the wiring board **53** with, for example, through electrodes provided to the sealing plate **52**.

2-1-2. Configuration of Sealing Plate **52**

[0066] The sealing plate **52** is formed so that the planar shape of the sealing plate **52** viewed from the thickness direction has the same shape as that of, for example, the ultrasonic substrate **51**. Further, the sealing plate **52** is bonded with a fixation member such as resin on the support film **512** side of the ultrasonic substrate **51**, and at the positions overlapping the partition walls **511**B viewed from the substrate thickness direction, to reinforce the ultrasonic substrate **51**.

[0067] The sealing plate **52** is provided with openings not shown at positions opposed to the drive terminals **513**D and the common terminals **514**A of the element substrate **511**, and through electrodes **521** (see FIG. **7**), for example, for connecting the drive terminals **513**D and the common terminals **514**A to the wiring board **53** are inserted through the openings.

2-1-3. Configuration of Wiring Board **53**

[0068] FIG. **7** is a plan view showing a schematic configuration of the wiring board **53**.

[0069] As shown in FIG. **7**, the wiring board **53** is provided with device-side terminals (first device-side terminals **531** and second device-side terminals **532**) at positions opposed to the drive terminals **513**D and the common terminals **514**A. These device-side terminals are connected to the drive terminals **513**D and the common terminals **514**A via the through electrodes **521** provided to the sealing plate **52**, respectively.

[0070] In the present embodiment, the drive terminals **513**D and the common terminals **514**A are disposed in the both end parts in the Y direction. Therefore, also in the wiring board **53**, the device-side terminals corresponding to the drive terminals **513**D and the common terminals **514**A are disposed in the both end parts in the Y direction. Here, the device-side terminals disposed on the −Y side are

referred to as first device-side terminals **531**, and the device-side terminals disposed on the +Y side as the other end side in the Y direction are referred to as second device-side terminals **532**.

[0071] Further, in the present embodiment, the number of each of the first device-side terminals **531** and the second device-side terminals **532** provided to the wiring substrate **53** is n (n is an integer equal to or greater than 2). Here, the first device-side terminal disposed at the −X side end part is defined as a 1-st first device-side terminal **531**, the second device-side terminal disposed at the −X side end part is defined as a 1-st second device-side terminal **532**, the first device-side terminal disposed at the +X side end part is defined as an n-th first device-side terminal **531**, and the second device-side terminal disposed at the +X side end part is defined as an n-th second device-side terminal **532**. The first device-side terminal **531** and the second device-side terminal **532** disposed at "i"-th position from the −X side end part are defined as an i-th first device-side terminal **531** and an i-th second device-side terminal **532**, respectively.

[0072] To each of the first device-side terminals **531** and the second device-side terminals **532**, there is connected the flexible board **6**.

2-2. Configuration of Flexible Printed Wiring Board (Flexible Board **6**)

[0073] FIG. **8** is a plan view showing a schematic configuration of a surface of the flexible board **6** of the present embodiment. FIG. **9** is a diagram showing a wiring structure of the flexible board.

[0074] As shown in FIG. **8**, the flexible board **6** is formed to have, for example, a rectangular planar shape. Here, in the above description, the outer edge (a side extending along the X direction) on the −Y side of the flexible board **6** is defined as a first outer edge part **6**A, and the outer edge (a side extending along the X direction) on the +Y side is referred to as a second outer edge part **6**B.

[0075] The flexible board **6** is divided into five regions along the X direction. Specifically, the flexible board **6** is provided with a device connection section **61** disposed in the central part in the X direction, a first connector section **62** located on the −X side of the device connection section **61**, and a second connector section **63** located on the +X side of the device connection section **61**. Further, the device connection section **61** and the first connector section **62** are linked (connected) to each other via a first inflective part **64**, and the device connection section **61** and the second connector section **63** are linked (connected) to each other via a second inflective part **65**.

2-2-1. Description of Device Connection Section **61**

[0076] The device connection section **61** is a part to which the ultrasonic device **5** is connected, and has an opening part **611** having a roughly rectangular shape corresponding to the acoustic lens **54**. Further, the device connection section **61** is configured including a first wiring part **612** disposed on the −Y side of the opening part **611**, and a second wiring part **613** disposed on the +Y side of the opening part **611**.

[0077] The first wiring part **612** is a part in which interconnections to be connected to the first device-side terminals **531** are disposed, and is provided with a first connection part **614**, a first bending part **615**, and a first device stacking part **616**.

[0078] The first connection part **614** has connection terminals disposed in a connection side **614**A along the X direction facing the opening part **611**, and connected to the respective first device-side terminals **531** along the connection side **614**A.

[0079] The first bending part **615** is a part continuously extending from the first connection part **614** toward the −Y side (in a first extending direction). Although the details will be described later, the first bending part **615** is curved to form an arc-like shape when bending the flexible board **6**, and is opposed to a cross-sectional surface (an opposed end surface **715**) including a first side **71**A (see FIG. **11**) of the first reinforcing plate **71**.

[0080] Further, a first negative-side end edge **612**A (a first end edge) on the −X side of the first connection part **614** and the first bending part **615** constitutes a part of an opening edge of a first slit **641** provided to the first inflective part **64** described later. Further, a first positive-side end edge **612**B (a second end edge) on the +X side of the first connection part **614** and the first bending part **615** constitutes a part of an opening edge of a second slit **651** provided to the second inflective part **65** described later.

[0081] The first device stacking part **616** is a part which overlaps the first reinforcing plate **71** when connecting the flexible board **6** to the ultrasonic device **5** supported by the first reinforcing plate **71**, and bending the flexible board **6** around the first bending part **615** along the first reinforcing plate **71**.

[0082] In the present embodiment, as shown in FIG. **9**, the interconnections (first interconnections **661**) connected to the 1-st through k-th first device-side terminals **531** out of the first device-side terminals **531** are disposed in the first device stacking part **616** so as to extend toward the first connector section **62**. Meanwhile, the interconnections (third interconnections **663**) connected to the (k+1)-th through n-th first device-side terminals **531** out of the first device-side terminals **531** are disposed in the first device stacking part **616** so as to extend toward the second connector section **63**.

[0083] Further, the end edge on the −Y side of the first device stacking part **616** forms the first outer edge part **6**A. In other words, the first outer edge part **6**A is located at an end part in the extending direction (the first extending direction) of the first bending part **615** from the first connection part.

[0084] The second wiring part **613** is a part in which interconnections to be connected to the second device-side terminals **532** are disposed, and has substantially the same configuration as that of the first wiring part **612**. Specifically, the second wiring part **613** is configured line symmetrically with the first wiring part **612** about a Y-central axis line L_Y passing through the central point in the Y direction of the opening part **611** and parallel to the X direction.

[0085] Specifically, the second wiring part **613** is provided with a second connection part **617**, a second bending part **618**, and a second device stacking part **619**.

[0086] The second connection part **617** has connection terminals disposed along a connection side **617**A along the X direction facing the opening part **611**, and connected to the respective second device-side terminals **532** along the connection side **617**A.

[0087] The second bending part **618** is a part extending from the second connection part **617** toward the +Y side (in a second extending direction), and is opposed to an end

surface (the opposed end surface **715**) including third side **71**C of the first reinforcing plate **71** described later when bending the flexible board **6**.

[0088] A second negative-side end edge **613**A (the first end edge) on the −X side of the second connection part **617** and the second bending part **618** constitutes a part of an opening edge of the first slit **641** provided to the first inflective part **64** described later. Further, a second positive-side end edge **613**B (the second end edge) on the +X side of the second connection part **617** and the second bending part **618** constitutes a part of the opening edge of the second slit **651** provided to the second inflective part **65** described later.

[0089] The second device stacking part **619** is a part which overlaps the first reinforcing plate **71** together with the first device stacking part **616** when connecting the flexible board **6** to the ultrasonic device **5** fixed to the first reinforcing plate **71**, and bending the second bending part **618** of the flexible board **6** along the first reinforcing plate **71**.

[0090] Among the interconnections disposed in the second device stacking part **619**, the interconnections (second interconnections **662**) to be connected to the 1-st through k-th second device-side terminals **532** are disposed so as to extend toward the first connector section **62**. Further, the interconnections (fourth interconnections **664**) to be connected to the (k+1)-th through n-th second device-side terminals **532** are disposed so as to extend toward the second connector section **63**.

[0091] Further, the end edge on the +Y side of the second device stacking part **619** forms the second outer edge part **6**B. In other words, the second outer edge part **6**B is located at an end part in the extending direction (the second extending direction) of the second bending part **618** from the second connection part **617**.

2-2-2. Description of First Connector Section **62** and Second Connection Section **63**

[0092] The first connector section **62** and the second connector section **63** are disposed on the ±X sides of the device connection section **61**, respectively, and has a width dimension smaller than the width dimension in the X direction of the device connection section **61**.

[0093] The first connector section **62** is provided with a plurality of connectors **621** each provided with a plurality of external connection terminals **622** (see FIG. **9**), and the second connector section **63** is provided with a plurality of connectors **631** each provided with a plurality of external connection terminals **632** (see FIG. **9**). As shown in FIG. **8** and FIG. **9**, in the present embodiment, the first connector section **62** is provided with the three connectors **621**, and the second connector section **63** is provided with the three connectors **631**. Further, each of the connectors **621** is provided with the external connection terminals **622** to be connected to either of the interconnections **661**, **662**, and each of the connectors **631** is provided with the external connection terminals **632** to be connected to either of the interconnections **663**, **664**.

[0094] It should be noted that although in the present embodiment, there is shown an example in which the three connectors **621**, **631** are provided, this is not a limitation, and it is also possible to provide one or two connectors **621**, **631**, or it is also possible to provide four or more connectors **621**, **631**.

[0095] Here, among the three connectors **621** provided to the first connector section **62**, in the connector **621**A located on the +X side, there are disposed the 1-st external connection terminal **622** through the k_1-th ($k_1<k$) external connection terminal **622**. Further, in the connector **621**A, the 1-st external connection terminal **622** is disposed at the +X side end part, and the k_1-th external connection terminal **622** is disposed at the −X side end part.

[0096] Among the three connectors **621** provided to the first connector section **62**, in the connector **621**B located in the central part in the X direction, there are disposed the (k_1+1)-th external connection terminal **622** through the k_2-th ($k_1<k_2<k$) external connection terminal **622**. Further, in the connector **621**B, the (k_1+1)-th external connection terminal **622** is disposed at the +X side end part, and the k_2-th external connection terminal **622** is disposed at the −X side end part.

[0097] Among the three connectors **621** provided to the first connector section **62**, in the connector **621**C located on the −X side, there are disposed the (k_2+1)-th external connection terminal **622** through the k-th external connection terminal **622**. Further, in the connector **621**C, the (k_2+1)-th external connection terminal **622** is disposed at the +X side end part, and the k-th external connection terminal **622** is disposed at the −X side end part.

[0098] Therefore, in the first connector section **62**, the "i ($1\leq i\leq k$)"-th external connection terminal **622** from the +X side corresponds to the i-th external connection terminal.

[0099] Further, to the i-th external connection terminal **622**, there are connected the first interconnection **661** connected to the i-th first device-side terminal **531**, and the second interconnection **662** connected to the i-th second device-side terminal **532**.

[0100] Here, the first interconnection **661** and the second interconnection **662** disposed in the first connector section **62** are made roughly line-symmetric about the Y-central axis line L_Y similarly to the device connection section **61**. In other words, the wiring length from the first device-side terminal **531** to the external connection terminal **622** in the first interconnection **661** and the wiring length from the second device-side terminal **532** to the external connection terminal **622** in the second interconnection **662** are roughly equal to each other.

[0101] On the other hand, among the three connectors **631** provided to the second connector section **63**, in the connector **631**A located on the +X side, there are disposed the (k+1)-th external connection terminal **632** through the k_3-th ($k+1\leq k_3<n$) external connection terminal **632**. Further, in the connector **631**A, the (k+1)-th external connection terminal **632** is disposed at the +X side end part, and the k_3-th external connection terminal **632** is disposed at the −X side end part.

[0102] Among the three connectors **631** provided to the second connector section **63**, in the connector **631**B located in the central part in the X direction, there are disposed the (k_3+1)-th external connection terminal **632** through the k_4-th ($k_3<k_4<n$) external connection terminal **632**. Further, in the connector **631**B, the (k_3+1)-th external connection terminal **632** is disposed at the +X side end part, and the k_4-th external connection terminal **632** is disposed at the −X side end part.

[0103] Among the three connectors **631** provided to the second connector section **63**, in the connector **631**C located on the −X side, there are disposed the (k_4+1)-th external connection terminal **632** through the n-th external connection terminal **632**. Further, in the connector **631**C, the

(k_4+1)-th external connection terminal **632** is disposed at the +X side end part, and the n-th external connection terminal **632** is disposed at the −X side end part.

[0104] Therefore, in the second connector section **63**, the "i (k+1≤i≤n)"-th external connection terminal **632** from the +X side corresponds to the i-th external connection terminal **632**.

[0105] Further, to the i-th external connection terminal **632**, there are connected the third interconnection **663** connected to the i-th first device-side terminal **531**, and the fourth interconnection **664** connected to the i-th second device-side terminal **532**.

[0106] Here, the third interconnection **663** and the fourth interconnection **664** disposed in the second connector section **63** are made roughly line-symmetric about the Y-central axis line L_Y similarly to the device connection section **61**. In other words, the wiring length from the first device-side terminal **531** to the external connection terminal **632** in the third interconnection **663** and the wiring length from the second device-side terminal **532** to the external connection terminal **622** in the fourth interconnection **664** are roughly equal to each other.

[0107] Here, among the first device-side terminals **531**, it is preferable for the number (k) of the first device-side terminals **531** to be connected to the external connection terminals **622** of the first connector section **62**, and the number (n−k) of the first device-side terminals **531** to be connected to the external connection terminals **632** of the second connector section **63** to satisfy the relationship of $|(n-k)-k|/n \leq 0.2$.

[0108] In other words, it is preferable to adopt the wiring configuration in which the difference between the number (k) of the first device-side terminals **531** to be connected to the external connection terminals **622** and the number (n-k) of the first device-side terminals **531** to be connected to the external connection terminals **632** is equal to or lower than 20% of the total number (n) of the first device-side terminals **531**. Further, it is more preferable that n is an even number, and k=n/2 is assumed.

[0109] FIG. **10** is a diagram showing a voltage value of a drive voltage to be applied to each of the transmission/reception columns Ch. In FIG. **10**, the dashed-dotted line represents the voltage value in the case of using the flexible board (related art example) having just one connector section with respect to the device connection section, and the solid line represents the voltage value in the present embodiment.

[0110] As shown in FIG. **10**, in the past, the device-side terminals located close to the connector section are connected to the external connection terminals located on the device connection section side of the connector section, and the device-side terminals located farther from the connector section are connected to the external connection terminals located farther from the device connection section of the connector section. Therefore, as the device-side terminal is located farther from the connector section, the length of the interconnection also increases, and due to the influence of the voltage drop, the voltage value of the drive voltage applied to each of the transmission/reception columns Ch connected to the device-side terminals also drops.

[0111] In contrast, in the present embodiment, there are provided the first connector section **62** and the second connector section **63** as described above, and the interconnections **661**, **662** are provided to the connector section **62**, and the interconnections **663**, **664** are provided to the connector section **63**, wherein the numbers of the interconnections **661**, **662**, **663**, and **664** are the same. Further, in the present embodiment, the first interconnections **661** and the third interconnections **663** are made roughly line-symmetric about an X-central axis line L_X passing through the center of the ultrasonic device **5** and parallel to the Y direction, and the second interconnections **662** and the fourth interconnections **664** are made roughly line-symmetric about the X-central axis line L. Therefore, the first interconnection **661** connected to the i-th first device-side terminal **531**, the second interconnection **662** connected to the i-th second device-side terminal **532**, the third interconnection **663** connected to the (n−i+1)-th first device-side terminal **531**, and the fourth interconnection **664** connected to the (n−i+1)-th second device-side terminal **532** become roughly the same in length, and as shown in FIG. **10**, the influence of the voltage drop is suppressed.

2-2-3. Configuration of First Inflective Part **64** and Second Inflective Part **65**

[0112] As shown in FIG. **8**, the first inflective part **64** is disposed between the device connection section **61** and the first connector section **62**, and links the first connector section **62** to the device connection section **61** in a bendable manner. Similarly, the second inflective part **65** is disposed between the device connection section **61** and the second connector section **63**, and links the second connector section **63** to the device connection section **61** in a bendable manner.

[0113] The first inflective part **64** has the first slit **641** connected to the opening part **611** provided to the device connection section **61**, and first linking parts **642** connected to the device connection section **61** and the first connector section **62** respectively on the ±Y sides of the first slit **641**.

[0114] As shown in FIG. **8**, the first slit **641** is an opening elongated along the Y direction (a direction crossing the direction from the device connection section **61** toward the first connector section **62**), and includes the first negative-side end edge **612**A, which is the end edge on the −X side of the first connection part **614** and the first bending part **615**, and the second negative-side end edge **613**A, which is the end edge on the −X side of the second connection part **617** and the second bending part **618** as a part of the opening edge on the +X side. In the present embodiment, the first negative-side end edge **612**A and the second negative-side end edge **613**A are located on a straight line along the Y direction. The opening edge opposed to the first negative-side end edge **612**A and the second negative-side end edge **613**A of the first slit **641** forms a first opposed edge **641**A shaped like a straight line parallel to the Y direction.

[0115] Further, the opening edge (a first slit end edge **641**B) on the −Y side of the first slit **641** links the −Y side end parts of the first opposed edge **641**A and the first negative-side end edge **612**A to each other, and the opening edge (a first slit end edge **641**C) on the +Y side of the first slit **641** links the +Y side end parts of the first opposed edge **641**A and the second negative-side end edge **613**A to each other. The first slit end edge **641**B is disposed at a position shifted from the first connection part **614** toward the −Y side as much as a dimension D**1**. Further, the first slit end edge **641**C is disposed at a position shifted from the second connection part **617** toward the +Y side as much as the dimension D**1**.

[0116] Here, the dimension D1 is set to a dimension larger than a distance from the wiring board **53** to a first side **71**A (see FIG. **11**) of the first reinforcing plate **71** in the case of connecting the flexible board **6** to the ultrasonic device **5** supported by the first reinforcing plate **71** (see FIG. **11**) described later.

[0117] The first linking parts **642** each link the device connection section **61** and the first connector section **62** to each other. The first linking part **642** on the −Y side is provided with the first interconnections **661**, and the first linking part **642** on the +Y side is provided with the second interconnections **662**.

[0118] The second inflective part **65** has the second slit **651** connected to the opening part **611** provided to the device connection section **61**, and second linking parts **652** connected to the device connection section **61** and the second connector section **63** respectively on the ±Y sides of the second slit **651**.

[0119] The second slit **651** has roughly the same configuration as that of the first slit **641**, and is connected to the opening part **611**, including the first positive-side end edge **612**B and the second positive-side end edge **613**B as a part of the opening edge on the −X side. The opening edge opposed to the first positive-side end edge **612**B and the second positive-side end edge **613**B of the second slit **651** forms a second opposed edge **651**A shaped like a straight line parallel to the Y direction.

[0120] Further, the end edge (a second slit end edge **651**B) on the −Y side of the second slit **651** links the −Y side end parts of the second opposed edge **651**A and the first positive-side end edge **612**B to each other, and the end edge (a second slit end edge **651**C) on the +Y side of the second slit **651** links the +Y side end parts of the second opposed edge **651**A and the second positive-side end edge **613**B to each other. The second slit end edge **651**B is disposed at a position shifted from the first connection part **614** toward the −Y side as much as the dimension D1, and the second slit end edge **651**C is disposed at a position shifted from the second connection part **617** toward the +Y side as much as the dimension D1.

[0121] Incidentally, the first device-side terminals **531** to which the first connection part **614** is connected are disposed on the −Y side end part of the ultrasonic device **5**, and the second device-side terminals **532** to which the second connection part **617** is connected are disposed on the +Y side end edge of the ultrasonic device **5**. The fact that the first slit end edge **641**B and the first connection part **614** are distant from each other as much as the dimension D1, and the first slit end edge **641**C and the second connection part **617** are distant from each other as much as the dimension D1 means that the width dimension in the Y direction of the first slit **641** and the second slit **651** is larger than the width dimension in the Y direction of the ultrasonic device **5**.

[0122] Here, the dimension from the first negative-side end edge **612**A to the first opposed edge **641**A and the dimension from the second negative-side end edge **613**A to the first opposed edge **641**A are the same as each other, and are defined as a width dimension W1 in the X direction in the first slit **641**. Further, the dimension from the first positive-side end edge **612**B to the second opposed edge **651**A and the dimension from the second positive-side end edge **613**B to the second opposed edge **651**A are the same as each other, and are defined as a width dimension W2 in the X direction in the second slit **651**. In the present embodiment, the width dimension W1 of the first slit **641** and the width dimension W2 of the second slit **651** are different from each other, and satisfy W1<W2.

[0123] The second linking parts **652** each link the device connection section **61** and the second connector section **63** to each other. The second linking part **652** on the −Y side is provided with the third interconnections **663**, and the second linking part **652** on the +Y side is provided with the fourth interconnections **664**.

2-3. Configuration of First Reinforcing Plate **71** and Second Reinforcing Plate **72**

2-3-1. Configuration of First Reinforcing Plate **71**

[0124] FIG. **11** is a plan view, a front view, and a side view of a first reinforcing plate **71**.

[0125] The first reinforcing plate **71** supports the ultrasonic device **5**, and is fixed to the housing **21**. Further, the first reinforcing plate **71** is formed of a resin material in order to prevent short circuit of the interconnections of the flexible board **6** when the first reinforcing plate **71** has contact with the flexible board **6** connected to the ultrasonic device **5**.

[0126] As shown in FIG. **11**, the first reinforcing plate **71** has, for example, a roughly rectangular shape in a plan view viewed from the substrate thickness direction, and is provided with a first side **71**A (−Y side) and a third side **71**C (+Y side) parallel to the X direction, and a second side **71**B (−X side) and a fourth side **71**D (+X side) parallel to the Y direction. The second side **71**B and the fourth side **71**D each form a side parallel to the extending direction of the first bending part **615** and the second bending part **618** in the case of fixing the ultrasonic device **5** to the first reinforcing plate **71** and connecting the flexible board **6** to the ultrasonic device **5**. The first side **71**A and the third side **71**C each form a side crossing the extending direction of the first bending part **615** and the second bending part **618** in the case of fixing the ultrasonic device **5** to the first reinforcing plate **71** and connecting the flexible board **6** to the ultrasonic device **5**.

[0127] The first reinforcing plate **71** is provided with positioning blocks **711** along the second side **71**B and the fourth side **71**D, respectively. Specifically, there are disposed the positioning block **711** located in an area from a corner part between the first side **71**A and the second side **71**B through a corner part between the second side **71**B and the third side **71**C, and the positioning block **711** located in an area from a corner part between the third side **71**C and the fourth side **71**D through a corner part between the fourth side **71**D and the first side **71**A. These positioning blocks **711** each correspond to reference corner parts. For example, the positioning block **711** disposed along the second side **71**B includes the reference corner part with respect to the corner part between the first side **71**A and the second side **71**B, and the reference corner part with respect to the corner part between the third side **71**C and the second side **71**B.

[0128] Each of the positioning blocks **711** is provided with first reference surfaces **711**A parallel to the X direction, a second reference surface **711**B parallel to the Y direction, and a third reference surface **711**C and a fourth reference surface **711**D crossing the first reference surfaces **711**A and the second reference surface **711**B.

[0129] Specifically, the first reference surfaces **711**A are ±Y side end surfaces of the positioning block **711**, and are planes parallel to the X-Z plane.

[0130] The second reference surface **711**B is a −X side end surface in the positioning block **711** located on the second side **71**B side, and a +X side end surface in the positioning block **711** located on the fourth side **71**D side, and is a plane parallel to the Y-Z plane.

[0131] The third reference surface **711**C is a +Z side end surface of each of the positioning blocks **711**, and has contact with the housing **21**. The third reference surface **711**C is located on the +Z side with respect to the surface (a fixation surface **712**) on the +Z side of the central part of the first reinforcing plate **71**. Thus, a step **713** is disposed between the third reference surface **711**C and the fixation surface **712**, and due to the step **713**, the ±X side end surfaces of the ultrasonic device **5** are positioned. Here, it is preferable for the height dimension (the dimension in the Z direction) of the step **713** to be equal to or larger than at least the thickness dimension of the flexible board **6**. It should be noted that the fixation surface **712** is a surface for supporting the ultrasonic device **5**, and corresponds to a support part.

[0132] The fourth reference surface **711**D is a surface forming a reverse surface with respect to the third reference surface **711**C, and is opposed to the second reinforcing plate **72** described later when housing the ultrasonic device unit **4** in the housing **21**.

[0133] It should be noted that in the present embodiment, the fourth reference surface **711**D is disposed in the same plane as the reverse surface **714** as shown in FIG. **11**.

[0134] Further, the width dimension W**4** in the X direction of the positioning block **711** is smaller than the width dimension W**1** of the first slit **641** and the width dimension W**2** of the second slit **651** (see FIG. **8**).

[0135] Further, in each of the positioning blocks **711**, a surface (a surface on the opposite side to the second reference surface **711**B) crossing the first side **71**A and the third side **71**C forms a guide surface **711**E. The guide surface **711**E is a surface parallel to the Y-Z plane, and has contact with the end edges **612**A, **612**B, **613**A, and **613**B when curving the first bending part **615** and the second bending part **618** of the flexible board **6** respectively along the opposed end surfaces **715**.

[0136] Here, the distance along the X direction between a pair of guide surfaces **711**E opposed to each other across the first side **71**A is roughly the same as the width dimension W**3** in the X direction of the first connection part **614** and the first bending part **615** of the flexible board **6**.

[0137] Further, on the ±Y sides of the fixation surface of the first reinforcing plate **71**, there are disposed the opposed end surfaces **715** along the first side **71**A and the third side **71**C, respectively. In the present embodiment, as the opposed end surfaces **715**, there are illustrated flat surface shapes crossing the fixation surface **712**. It should be noted that the opposed end surfaces **715** can each be configured to have an arc-like curved surface, the Y-Z cross-sectional surface of which has an arc-like shape convex toward a direction of getting away from the fixation surface **712**, and in this case, it is possible to curve the first bending part **615** and the second bending part **618** along the respective opposed end surfaces **715**.

[0138] Further, on the fourth reference surface **711**D of each of the positioning blocks **711**, there are projected a first projecting part **717** and a second projecting part **718** on the +Z side, wherein the first projecting part **717** and the second projecting part **718** project toward the reverse surface **714** side.

[0139] The first projecting part **717** is disposed on the third side **71**C side of the Y-central axis line L_Y on each of the positioning blocks **711**. In other words, in the present embodiment, there are disposed the two first projecting parts **717**. An end surface on the −Y side of the first projecting part **717** acts as a first positioning surface **717**A with which the first outer edge part **6**A of the flexible board **6** has contact to be positioned when curving the flexible board **6** in the first bending area Ar**3**.

[0140] In contrast, the second projecting part **718** is disposed on the first side **71**A side of the Y-central axis line L_Y on each of the positioning blocks **711**. In other words, in the present embodiment, there are disposed the two second projecting parts **718**. An end surface on the +Y side of the second projecting part **718** acts as a second positioning surface **718**A with which the second outer edge part **6**B of the flexible board **6** has contact to be positioned when curving the flexible board **6** in the second bending area Ar**4**.

[0141] The width dimensions in the X direction of the first projecting parts **717** and the second projecting parts **718** are made sufficiently smaller than the width dimensions in the X direction of the first slit **641** and the second slit **651**.

[0142] The dimension D**11** from the first positioning surface **717**A to the second positioning surface **718**A is smaller than the width dimensions D**3**, D**4** in the Y direction of the first linking parts **642**, and the width dimensions D**5**, D**6** in the Y direction of the second linking parts **652**. More preferably, D**11**=D**3**=D**4**=D**5**=D**6** is satisfied. In this case, when curving the flexible board **6** in the first bending area Ar**3** and the second bending area Ar**4**, the ±Y side end edges (the first outer edge part **6**A, the second outer edge part **6**B, the first slit end edges **641**B, **641**C, and the second slit end edges **651**B, **651**C) of the first linking parts **642** and the second linking part **652** have contact with the first positioning surfaces **717**A and the second positioning surfaces **718**A, and are positioned.

[0143] Incidentally, in the first reinforcing plate **71**, the dimension from the third side **71**C to the first positioning surfaces **717**A is D**12**, and the dimension from the first side **71**A to the second positioning surfaces **718**A is D**13**.

[0144] Further, when fixing the ultrasonic device **5** to the fixation surface **712** of the first reinforcing plate **71**, the first device-side terminals **531** are located at a first position **531**A distant from the first side **71**A as much as a dimension D**14** (a first distance), and the second device-side terminals **532** are located at a second position **532**A distant from the third side **71**C as much as a dimension D**15** (a second distance) as shown in FIG. **11**.

[0145] Further, in the present embodiment, defining the thickness dimension (the thickness dimension from the fixation surface **712** to the reverse surface **714**) of the first reinforcing plate **71** as D**16**, the dimension D**1** from the first slit end edge **641**B to the first connection part **614** (from the first slit end edge **641**C to the second connection part **617**, from the second slit end edge **651**B to the first connection part **614**, from the second slit end edge **651**C to the second connection part **617**) satisfies the following expressions (1), (2).

$$D1>D13+D14+D16 \ldots \quad (1)$$

$$D1>D12+D15+D16 \ldots \quad (2)$$

[0146] Further, as described above, in the present embodiment, the first reinforcing plate **71** is formed of the resin material, and is therefore lower in strength compared to the case of being formed of, for example, metal. Therefore, in order to increase the substrate strength, the first reinforcing plate **71** is provided with a recessed part **714**A disposed on the reverse surface **714**, and a metal plate **716** is disposed in the recessed part **714**A. The metal plate **716** is disposed on the bottom surface of the recessed part **714**A, and does not protrude outward (the −Z side) from the reverse surface **714**. Thus, even when bending the flexible board **6** toward the reverse surface **714** side of the first reinforcing plate **71**, the flexible board **6** and the metal plate **716** do not interfere with each other.

2-3-2. Configuration of Second Reinforcing Plate **72**

[0147] As shown in FIG. **3** and FIG. **4**, the second reinforcing plate **72** supports the second connector section **63**.

[0148] FIG. **12** is a plan view, a front view, and a side view of the second reinforcing plate **72**.

[0149] As shown in FIG. **12**, the second reinforcing plate **72** has a roughly rectangular shape having a fifth side **72**A, a sixth side **72**B, a seventh side **72**C, and an eighth side **72**D in a planar view viewed from the plate thickness direction similarly to the first reinforcing plate **71**.

[0150] The second reinforcing plate **72** is provided with a connector support surface **721** with which the central part (an area where the connectors **631** are disposed) of the second connector section **63** has contact, and a reverse surface **722** on the opposite side to the connector support surface **721**. Further, the second reinforcing plate **72** is provided with second bending guide parts **723** each curved to have an arc-like shape disposed respectively in the fifth side **72**A and the seventh side **72**C extending along the X direction similarly to the first reinforcing plate **71**.

[0151] Further, the second reinforcing plate **72** is provided with second positioning blocks **724** respectively disposed along the sixth side **72**B and the eighth side **72**D located on the ±X sides similarly to the first reinforcing plate **71**.

[0152] The second positioning blocks **724** are each provided with a recessed part **724**A on a surface on the opposite side to the connector support surface **721**. The recessed part **724**A forms a configuration space for the first inflective part **64** and the second inflective part **65** of the flexible board **6**. Specifically, the width dimension D**2** in the Y direction of the recessed part **724**A of the second positioning block **724** located on the −X side is equal to or larger than the width dimensions D**3**, D**4** in the Y direction of the first linking parts **642** of the first inflective part **64**, and preferably satisfies D**2**=D**3**=D**4**.

[0153] Further, although not shown in the drawings, the width dimension in the Y direction of the recessed part **724**A of the second positioning block **724** located on the +X side is equal to or larger than the width dimensions D**5**, D**6** in the Y direction of the second linking parts of the second inflective part **65**, and is preferably the same as the dimensions D**5**, D**6**.

[0154] That is, by making the width dimension in the Y direction of the recessed part **724**A equal to the width dimension in the Y direction of the first linking part **642** and the second linking part **652**, it is possible to support the end edges (a first outer edge part **6**A, a second outer edge part **6**B, the first slit end edges **641**B, **641**C, and the second slit end edges **651**B, **651**C) on the ±Y sides of the first linking part **642** and the second linking part **652** with the inner periphery side surfaces of the recessed part **724**A.

[0155] Further, on a surface on the opposite side to the connector support surface **721** of the second positioning block **724**, there are disposed mount surfaces **724**B across the recessed part **724**A from each other. The mount surfaces **724**B are respectively mounted on the first projecting part **717** and the second projecting part **718** when storing the second reinforcing plate **72** in the housing **21**.

[0156] In the present embodiment, the mount surfaces **724**B are located on the −Z side (+Z side when stored in the housing **21**) of the reverse surface **722**. Thus, when mounting the mount surfaces **724**B on the first projecting part **717** and the second projecting part **718**, between the reverse surface **714** of the first reinforcing plate **71** and the reverse surface **722** of the second reinforcing plate **72**, there is formed a space at least equal to or larger than the configuration space S for the flexible board **6** bent multiply and the connectors **621** of the first connector section **62**.

[0157] The surface on the fifth side **72**A side and on the seventh side **72**C side of each of the second positioning blocks **724** forms a second guide surface **724**C for guiding the second opposed edge **651**A of the second slit **651** of the flexible board **6**, and an outer peripheral edge on the −X side of the flexible board **6**.

2-4. Configuration of Housing **21**

[0158] As shown in FIG. **2**, the housing **21** is provided with a storage part **211** and a lid part **212**.

[0159] As shown in FIG. **3** and FIG. **4**, the storage part **211** is a vessel-like member for storing the ultrasonic device unit **4**, and has a sensor window **211**B in a bottom part **211**A, wherein the acoustic lens **54** of the ultrasonic device **5** is exposed to the outside from the sensor window **211**B.

[0160] Further, in the bottom part **211**A of the storage part **211**, there is disposed a device installation part **213** (a unit holding part) so as to surround the sensor window **211**B. The device installation part **213** is formed to have a frame-like shape rising from the bottom part **211**A so that the four corners of the first reinforcing plate **71** are fitted into the device installation part **213**.

2-5. Storage of Ultrasonic Device Unit **4** into Housing **21**

[0161] In such an ultrasonic probe **2** as described above, firstly, the ultrasonic device **5** is fixed to the fixation surface **712** of the first reinforcing plate **71**.

[0162] Then, the first connection part **614** of the flexible board **6** is connected to the −X side of the wiring board **53** of the ultrasonic device **5**. Thus, the connection terminals of the first connection part **614** and the first device-side terminals **531** are electrically connected to each other, respectively. Further, the second connection part **617** is connected to the +X side of the wiring board **53** of the ultrasonic device **5**. Thus, the connection terminals of the second connection part **617** and the second device-side terminals **532** are electrically connected to each other, respectively.

[0163] On this occasion, the first negative-side end edge **612**A of the flexible board **6** is made to have contact with (be guided by) the guide surface **711**E located on the −X side of the first side **71**A, and the first positive-side end edge **612**B is made to have contact with (be guided by) the guide surface **711**E located on the +X side of the first side **71**A. Further, the second negative-side end edge **613**A of the flexible board **6** is made to have contact with (be guided by) the guide surface **711**E located on the −X side of the third

side **71**C, and the second positive-side end edge **613**B is made to have contact with (be guided by) the guide surface **711**E located on the +X side of the third side **71**C.

[0164] FIG. **13** is a perspective view of the case in which the flexible board **6** is curved along the X direction in the present embodiment. Further, FIG. **14** is a perspective view of the flexible board **6** viewed from a reverse surface side in FIG. **13**.

[0165] Subsequently, the flexible board **6** is curved in a first bending area Ar**3** (see FIG. **8**) including the first bending part **615** parallel to the X direction to fold back the end edge on the −Y side of the flexible board **6** toward the +Y side. Further, the flexible board **6** is curved in a second bending area Ar**4** (see FIG. **8**) including the second bending part **618** parallel to the X direction to fold back the end edge on the +Y side of the flexible board **6** toward the −Y side. It should be noted that either one of the first bending area Ar**3** and the second bending area Ar**4** can be folded back first.

[0166] Here, as shown in FIG. **14**, the end edges (the first negative-side end edge **612**A and the first positive-side end edge **612**B) of the ±X sides of the first bending part **615** and the end edges (the second negative-side end edge **613**A and the second positive-side end edge **613**B) on the ±X sides of the second bending part **618** are guided by the guide surfaces **711**E. Thus, the tilt of the flexible board **6** with respect to the first reinforcing plate **71** is suppressed.

[0167] Further, the first outer edge part **6**A of the flexible board **6** is made to have contact with the first positioning surfaces **717**A of the first projecting parts **717**, and the second outer edge part **6**B is made to have contact with the second positioning surfaces **718**A of the second projecting parts **718** on the reverse surface **714** side of the first reinforcing plate **71**. Thus, it results that the first outer edge part **6**A and the second outer edge part **6**B of the flexible board **6** are each positioned by a plurality of (two) projection parts, and thus, it is possible to appropriately bend the flexible board **6** in the first bending area Ar**3** and the second bending area Ar**4**, and the tilt with respect to the X direction is suppressed.

[0168] On this occasion, the flexible board **6** is curved so that the first slit end edges **641**B, **641**C of the first slit **641** and the second slit end edges **651**B, **651**C of the second slit **651** are located between the first positioning surfaces **717**A and the second positioning surfaces **718**A. Thus, the first projecting parts **717** and the second projecting parts **718** are inserted through the first slit **641** and the second slit **651**, and the disadvantage that the flexible board **6** covers the first projecting parts **717** and the second projecting parts **718** is prevented.

[0169] Further, in the case in which the dimension D**11** from the first positioning surface **717**A to the second position surface **718**A is set to satisfy D**11**=D**3**=D**4**=D**5**=D**6**, it is possible to make the ±Y side end edges of the first linking parts **642** and the second linking parts **652** have contact with, and be guided by the first positioning surfaces **717**A and the second positioning surfaces **718**A. On this occasion, the tilt of the flexible board **6** with respect to the first reinforcing plate (the ultrasonic device **5**) is more surely suppressed.

[0170] Further, since the extending dimension (the dimension D**1**) of the first wiring part **612** in the flexible board **6** satisfies the expressions (1), (2) described above, the first bending part **615** is curved to have an arc-like shape at the position opposed to the opposed end surface **715**, and it is possible to prevent breaking of the interconnections caused by bending the flexible board **6** at, for example, right angle in the first side **71**A or the third side **71**C.

[0171] As described above, in the flexible board **6**, by bending the first bending area Ar**3** along (in parallel to the X direction) the first side **71**A of the first reinforcing plate **71**, the first device stacking part **616** is stacked on the reverse surface **714** side of the first reinforcing plate **71** so as to overlap the first reinforcing plate **71**. Further, by bending the second bending area Ar**4** along (in parallel to the X direction) the third side **71**C of the first reinforcing plate **71**, the second device stacking part **619** is stacked on the reverse surface **714** side of the first reinforcing plate **71** so as to overlap the first reinforcing plate **71**.

[0172] Further, in a similar manner, in each of the first connector section **62**, the first inflective part **64** and the second inflective part **65**, an area located on the −Y side of the first bending area Ar**3** is made to overlap a central area Ar**5**. Further, in each of the first connector section **62**, the first inflective part **64** and the second inflective part **65**, an area located on the +Y side of the second bending area Ar**4** is made to overlap the central area Ar**5**.

[0173] Further, the first bending area Ar**3** and the second bending area Ar**4** of the second connector section **63** are guided by the second guide surfaces **724**C to be curved along the second bending guide parts **723** of the second reinforcing plate **72**, and thus, an area located on the −Y side of the first bending area Ar**3** of the second connector section **63** and an area located on the +Y side of the second bending area Ar**4** are made to overlap the reverse surface of the second reinforcing plate **72**.

[0174] As described above, when curving the flexible board **6**, the first slit end edges **641**B, **641**C of the first slit **641** and the second slit end edges **651**B, **651**C of the second slit **651** move to the positions to be overlapped with the central area Ar**5**. Therefore, even in the case in which the flexible board **6** is folded back in the first bending area Ar**3** and the second bending area Ar**4** to be deformed to have a roughly cylindrical shape, in each of the first inflective part **64** and the second inflective part **65**, there is formed a shape in which the two first linking parts **642** (the two second linking parts **652** in the second inflective part **65**) overlap each other only on the reverse surface **714** side of the first reinforcing plate **71**. In other words, the first inflective part **64** and the second inflective part **65** do not form a cylindrical shape, but become to be able to easily be bent toward the reverse surface **714** side of the first reinforcing plate **71**.

[0175] Further, in the present embodiment, the width dimension W**1** in the X direction of the first slit **641** in the first inflective part **64** is smaller than the width dimension W**2** in the X direction of the second slit **651** in the second inflective part **65**. Therefore, when bending the first inflective part **64** and second inflective part **65**, the first inflective part **64** is bent first, and then the first connector section **62** is overlapped with the first reinforcing plate **71**. Here, since the X-width dimension of the first connector section **62** is smaller than the X-width dimension of the first reinforcing plate **71**, the first connector section **62** does not project toward the second inflective part **65**, and does not hinder bending of the second inflective part **65**.

[0176] Further, by bending the first inflective part **64** toward the reverse surface **714** side of the first reinforcing plate **71**, the connectors **621** in the first connector section **62** project toward the −Z side.

[0177] Then, the first reinforcing plate **71** is fixed to the storage part **211** of the housing **21**.

[0178] Specifically, as shown in FIG. **3** and FIG. **4**, the first reference surfaces **711**A and the second reference surfaces **711**B of the positioning blocks **711** provided to the first reinforcing plate **71** are made to have contact with, and then fitted into, the device installation part **213** provided to the housing **21**. Thus, the third reference surfaces **711**C of the first reinforcing plate **71** have contact with the bottom part **211**A of the housing **21**, and the acoustic lens **54** of the ultrasonic device **5** projects from the sensor window **211**B.

[0179] Further, on this occasion, each of the connectors **621** in the first connector section **62** is exposed on the opposite side to the bottom part **211**A of the storage part **211**. Then, the terminals disposed on the tip of the cable **3** are connected to the connectors **621**.

[0180] FIG. **15** is a side view of the ultrasonic device unit **4** housed in the housing **21** viewed from the first inflective part **64** side, and FIG. **16** is a side view viewed from the second inflective part **65** side. It should be noted that the illustration of the second reinforcing plate **72** is omitted in FIG. **15** and FIG. **16**.

[0181] Subsequently, the second inflective part **65** is bent to overlap the second reinforcing plate **72** which supports the second connector section **63** with the first reinforcing plate **71**. Thus, the mount surfaces **724**B of the second positioning blocks **724** of the second reinforcing plate **72** are mounted on the first projecting parts **717** of the positioning blocks **711** of the first reinforcing plate **71** and the second projecting parts **718**.

[0182] On this occasion, since the width dimension W**2** of the second slit **651** in the second inflective part **65** satisfies W**2**>W**1**, the second connector section **63** does not interfere with the first connector section **62**, and the first inflective part **64** and the second inflective part **65** do not project outside as shown in FIG. **15** and FIG. **16**, and therefore, miniaturization of the flexible board **6** can be advanced.

[0183] Further, when mounting the mount surfaces **724**B of the second reinforcing plate **72** on the first projecting parts **717** and the second projecting parts **718** of the first reinforcing plate **71**, the configuration space S for disposing the flexible board **6** and the first connector section **62** is formed between the reverse surface **714** of the first reinforcing plate **71** and the reverse surface **722** of the second reinforcing plate **72**. In the configuration space S, there are disposed the first device stacking part **616**, the second device stacking part **619**, the first connector section **62** bent to be triply overlapped, the second connector section **63** bent toward the reverse surface **722** side of the second reinforcing plate **72** to be doubly overlapped, the connectors in the first connector section **62**, and the terminals of the cable **3** to be connected to the connectors (the illustration of the cable **3** is omitted in FIG. **2** and FIG. **3**).

[0184] Further, since the connectors **631** of the second connector section **63** supported by the second reinforcing plate **72** are exposed on the −Z side, the terminals provided to the tip of the cable **3** are connected to the connectors **631**. Subsequently, the lid part **212** is fixed to the storage part **211**, and the space between the sensor window **211**B and the acoustic lens **54** is sealed with a resin material such as silicone resin, and thus, the ultrasonic probe **2** is assembled.

3. Functions and Advantages of First Embodiment

[0185] The ultrasonic device unit **4** according to the present embodiment is provided with the ultrasonic device **5**, the flexible board **6** connected to the ultrasonic device **5**, and the first reinforcing plate **71** for supporting the ultrasonic device **5**. The flexible board **6** is provided with the first connection part **614** and the second connection part **617** to be connected to the ultrasonic device **5**, and the first bending part **615** and the second bending part **618** extending respectively from the first connection part **614** and the second connection part **617**, and the outer edges (±Y side end edges) in the extending direction of the first bending part **615** and the second bending part **618** of the flexible board **6** are respectively provided with the first outer edge part **6**A and the second outer edge part **6**B. Further, the first reinforcing plate **71** is provided with the first projecting parts **717** and the second projecting parts **718**, wherein the first outer edge part **6**A has contact with the first projecting parts **717** and the second outer edge part **6**B has contact with the second projecting parts **718**, when fixing the ultrasonic device **5** to the fixation surface **712** for fixing the ultrasonic device **5**, then connecting the flexible board **6** to the ultrasonic device **5**, and then curving the flexible board **6** along the first side **71**A and the third side **71**C.

[0186] In such a configuration, since the first outer edge part **6**A and the second outer edge part **6**B of the flexible board **6** are respectively positioned by the first projecting parts **717** and the second projecting parts **718**, it is possible to curve the first bending part **615** and the second bending part **618** without being bent respectively at the first side **71**A and the third side **71**C at, for example, right angle, and thus, breaking of the interconnections can be prevented. Further, since it is possible to curve the flexible board **6** in the first bending area Ar**3** and the second bending area Ar**4** along the arrangement direction (the X direction) of the ultrasonic device **5**, for example, it is possible to prevent a part of the flexible board **6** from projecting outside the sides **71**A, **71**B, **71**C, and **71**D of the first reinforcing plate **71**, to thereby achieve the miniaturization of the ultrasonic device unit.

[0187] Thus, the miniaturization in the ultrasonic probe **2** incorporating the ultrasonic device unit **4** and the ultrasonic measurement apparatus **1** can also be advanced.

[0188] In the present embodiment, the number of the first projecting parts **717** disposed is two, and the number of the second projecting parts **718** disposed is two. Therefore, by making the first outer edge part **6**A have contact with the two first projecting parts **717**, and making the second outer edge part **6**B have contact with the two second projecting parts **718**, it is possible to curve the flexible board **6** without tilting the flexible board **6** with respect to the X direction.

[0189] In the present embodiment, the width dimension in the X direction of the first slit **641** of the flexible board **6** is larger than the width dimensions in the X direction of the second projecting parts **718** and the first projecting parts **717**. Further, the width dimensions (D**3** through D**6**) in the Y direction of the first linking parts **642** and the second linking parts **652** of the flexible board **6** are smaller than the dimension D**11** from the first positioning surface **717**A to the second positioning surface **718**A.

[0190] Therefore, when bending the flexible board **6** along the first side **71**A and the third side **71**C, the first projecting parts **717** and the second projecting parts **718** are inserted through the slits, and thus, interference between the flexible board **6**, and the first projecting parts **717** and the second

projecting parts **718** can be prevented. In other words, the flexible board **6** is prevented from covering the surfaces (on the −Z side) of the first projecting parts **717** and the second projecting parts **718**, and thus, the miniaturization of the ultrasonic device unit **4** can be achieved.

[0191] Further, when overlapping the second reinforcing plate **72** with the first reinforcing plate **71**, the mount surfaces **724**B of the second positioning blocks **724** are mounted on projection tip surfaces of the first projecting parts **717** and the second projecting parts **718**. Thus, there is provided the configuration in which the first linking parts **642** and the second linking parts **652** are sandwiched by the first projecting parts **717** and the second projecting parts **718** on the ±Y sides, and are sandwiched by the first reinforcing plate **71** and the second reinforcing plate **72**, and thus, the displacement of the flexible board **6** can be suppressed.

[0192] In particular, by making the dimension D**11** from the first positioning surface **717**A to the second positioning surface **718**A and the width dimensions (D**3** through D**6**) in the Y direction of the first linking parts **642** and the second linking parts **652** of the flexible board **6** equal to each other, the ±Y side end edges of the first linking parts **642** and the second linking parts **652** are held (guided) by the first positioning surfaces **717**A and the second positioning surfaces **718**A, and thus, it is possible to more surely suppress the displacement of the flexible board **6**.

Modified Examples

[0193] It should be noted that the invention is not limited to the embodiment and the modified examples described above, but includes modifications and improvements within a range in which the advantages of the invention can be achieved, and configurations which can be obtained by arbitrary combinations of the embodiment and modified examples, and so on.

[0194] In the embodiment described above, there is described the example in which the distance from the first connection part **614** to the first slit end edge **641**B in the first slit **641**, the distance from the second connection part **617** to the first slit end edge **641**C in the first slit **641**, the distance from the first connection part **614** to the second slit end edge **651**B in the slit **651**, and the distance from the second connection part **617** to the second slit end edge **651**C in the second slit **651** are the same dimension D**1**, but this example is not a limitation. For example, the distances described above can also be different from each other, and it is sufficient for the flexible board **6** not to overlap the first projecting parts **717** and the second projecting parts **718** in the case of connecting the first connection part **614** and the second connection part **617** to the ultrasonic device **5**, and then curving the flexible board **6** in the first bending area Ar**3** and the second bending area Ar**4**.

[0195] The same applies to the width dimensions in the Y direction (D**3** through D**6**) in the first linking parts **642** and the second linking parts **652**, and any dimensions can be adopted as long as the flexible board **6** do not overlap the first projecting parts **717** and the second projecting parts **718**. For example, it is also possible for the width dimensions of the first linking part **642** and the second linking part **652** on the −Y side to be smaller than the width dimensions of the first linking part **642** and the second linking part **652** on the +Y side. In this case, it is sufficient to dispose the positions of the first projecting parts **717** and the second projecting parts **718** in accordance with the dimensions.

[0196] In the embodiment described above, there is shown the example in which the first slit **641** and the second slit **651** are disposed continuously from the first wiring part **612** to the second wiring part **613**, but the example is not a limitation.

[0197] For example, it is also possible to adopt a configuration in which the slits are disposed respectively on the ±X sides of the first wiring part **612** and the ±X sides of the second wiring part **613** independently of each other.

[0198] In the embodiment described above, there is shown the example in which the first projecting parts **717** have the first positioning surfaces **717**A for positioning the first outer edge part **6**A, and the second projecting parts **718** have the second positioning surfaces **718**A for positioning the second outer edge part **6**B, but the example is not a limitation.

[0199] FIG. **17** and FIG. **18** are each a cross-sectional view of the positioning block **711** of the first reinforcing plate **71** related to a modified example cut along the Y-Z plane at a position at which the projection parts are disposed.

[0200] For example, it is also possible to adopt a configuration in which each of the first positioning surfaces **717**A of the first projecting parts **717** is provided with a cutout groove **717**B having a shape recessed toward the Y side from the first positioning surface **717**A as shown in FIG. **17**. In such a configuration, by tucking the first outer edge part **6**A into the cutout grooves **717**B, it is possible to fix the flexible board **6**.

[0201] The same applies to the second projecting parts **718**, and it is also possible to adopt a configuration of providing the cutout grooves **718**B for tucking the second outer edge part **6**B.

[0202] Further, it is also possible to adopt a configuration in which the first projecting parts **717** are each provided with a cutout groove **717**C for tucking the first slit end edge **641**C (or the second slit end edge **651**C), and the second projecting parts **718** are each provided with a cutout groove **718**C for tucking the first lit end edge **641**B (or the second slit end edge **651**B) as shown in FIG. **18**. In this case, it is possible to fix the first linking parts **642** and the second linking parts **652** between the first projecting parts **717** and the second projecting parts **718**, and thus, the displacement (the tilt with respect to the X direction) of the flexible board **6** can more surely be suppressed.

[0203] Further, in the embodiment described above, there is described the example in which the positioning blocks **711** disposed on the ±X sides of the first reinforcing plate **71** are each provided with the first projecting parts **717** and the second projecting parts **718**, but it is also possible to adopt a configuration in which the first projecting parts **717** and the second projecting parts **718** are provided to, for example, only either one of the positioning blocks **711** on the ±X sides.

[0204] Further, it is also possible to adopt a configuration provide with three or more first projecting parts **717** and three or more second projecting parts **718**. In this case, some of the first projecting parts **717** and the second projecting parts **718** can be disposed between the positioning blocks **711** on the ±X sides. By providing the first wiring part **612** or the second wiring part **613** of the flexible board **6** with insertion holes corresponding to the first projecting part **717** and the second projecting part **718** disposed between the positioning blocks **711**, it is possible to prevent the disadvantage that the flexible board **6** covers the surfaces of the first projecting parts **717** and the second projecting parts

718. Further, by inserting the first projecting parts 717 and the second projecting parts 718 through the insertion holes provided to the flexible board 6, it is possible to improve the positioning accuracy in the case of curving the flexible board 6 to be bent.

[0205] In the embodiment described above, there is illustrated the configuration in which the first reinforcing plate 71 is provided with both of the first projecting parts 717 and the second projecting parts 718, but this is not a limitation. For example, in the case in which the second device-side terminals 532 are not provided in the ultrasonic device 5, and so on, the area on the +Y side of the second bending area Ar4 becomes unnecessary in the flexible board 6, accordingly. In such a case, since it is sufficient to fold the area on the −Y side of the first bending area Ar3 so as to overlap the first reinforcing plate 71, the second projecting parts 718 become unnecessary.

[0206] Although there is described the example in which the second reinforcing plate 72 is provided with the second bending guide parts 723, flat-plate surfaces can also be adopted similarly to the first reinforcing plate 71. As described above, by making the first outer edge part 6A and the second outer edge part 6B have contact with the first projecting parts 717 and the second projecting parts 718 when curving the flexible board 6 along the first side 71A and the third side 71C of the first reinforcing plate 71, it is possible to curve the flexible board 6 without tilting with respect to the X direction.

[0207] In the embodiment described above, there is adopted the configuration in which the recessed part 714A is provided to the reverse surface 714 of the first reinforcing plate 71, and the metal plate 716 is provided to the recessed part 714A, but this is not a limitation.

[0208] For example, it is possible to adopt a configuration in which, for example, the metal plate 716 is embedded inside the first reinforcing plate 71 without providing the recessed part 714A to the first reinforcing plate 71.

[0209] In the embodiment described above, there is shown the configuration in which the first reference surfaces 711A and the second reference surfaces 711B of the positioning blocks 711 are made to have contact with the device installation part 213 of the housing 21 to thereby achieve the positioning, but this is not a limitation. It is also possible to adopt a configuration in which, for example, the positioning blocks 711 are provided with a plurality of hole parts, and the housing 21 is provided with pins which can be fitted into the hole parts described above.

[0210] Further, there is illustrated the configuration in which the mount surfaces 724B of the second reinforcing plate 72 are mounted on the first projecting parts 717 and the second projecting parts 718, but this is not a limitation. For example, it is also possible to adopt a configuration in which the second reinforcing plate 72 is provided with engaging recessed parts to be engaged with the first projecting parts 717 and the second projecting parts 718. In this case, it is possible to surely fix the second reinforcing plate 72 to the first reinforcing plate 71.

[0211] In the embodiment described above, there is shown the example in which the ultrasonic device 5 transmits the ultrasonic wave from the substrate opening part 511A, and receives the ultrasonic wave entering the substrate opening part 511A. In contrast, it is also possible to adopt a configuration in which the sealing plate 52 is disposed on the substrate opening part 511A side, and the ultrasonic wave is output to the opposite side to the substrate opening part 511A.

[0212] Further, the transmission/reception column Ch provided with a plurality of ultrasonic transducers Tr is illustrated as the vibrator element provided to the ultrasonic device 5, but this example is not a limitation. For example, it is also possible that each of the ultrasonic transducers Tr can also be configured as a vibrator element.

[0213] Further, there is shown an example of the ultrasonic transducer Tr in which the ultrasonic wave is transmitted by vibrating the support film 512 with the piezoelectric element 513, and the ultrasonic wave is received by converting the vibration of the support film 512 into an electric signal with the piezoelectric element 513, but this example is not a limitation. For example, it is also possible to adopt a configuration in which the ultrasonic wave is transmitted and received by vibrating a bulk-type piezoelectric body, and further, it is also possible to adopt a configuration in which electrodes opposed to each other are provided to a pair of film members, and a cyclic drive voltage is applied between the electrodes to thereby vibrate the film members using electrostatic force.

[0214] In the embodiment described above, the ultrasonic measurement apparatus 1 taking an organ in a living body as the measurement object is illustrated as the ultrasonic apparatus, but this is not a limitation. For example, the configurations of the embodiment and the modified examples described above can be applied to a measurement apparatus taking a variety of types of structures as the measurement object, and performing detection of defects of the structures and inspections of aging of the structures. Further, the same applies to a measurement apparatus taking, for example, a semiconductor package or a wafer as the measurement object, and detecting the defects of the measurement object.

[0215] Besides the above, specific structures to be adopted when implementing the invention can be configured by arbitrarily combining the embodiment 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.

[0216] The entire disclosure of Japanese Patent Application No. 2017-055813 filed Mar. 22, 2017 is expressly incorporated by reference herein.

What is claimed is:

1. An ultrasonic device unit comprising:

an ultrasonic device having a device-side terminal,

a reinforcing plate having a support surface adapted to support the ultrasonic device; and

a flexible printed wiring board to be connected to the ultrasonic device,

wherein the flexible printed wiring board is provided with

a connection part to be connected to the device-side terminal,

a bending part continuous with the connection part, and extending in a direction of getting away from the ultrasonic device, and

an outer edge part disposed in and end part in the extending direction of the bending part, and

the reinforcing plate is provided with

a first side parallel to a first direction crossing the extending direction, and opposed to the bending part, and

a projecting part which is disposed on a reverse surface on an opposite side to the support surface, and with which the outer edge part has contact when the flexible printed wiring board is curved to be bent along the first side in the bending part.

2. The ultrasonic device unit according to claim **1**, wherein

a plurality of the projecting parts is provided, and the outer edge part has contact with the plurality of the projecting parts when the flexible printed wiring board is curved to be bent along the first side in the bending part.

3. The ultrasonic device unit according to claim **1**, wherein

the reinforcing plate has a rectangular shape having a third side parallel to the first direction, and a second side and a fourth side both crossing the first side and the third side,

the device-side terminal is located each of a first position having a first distance from the first side and a second position having a second distance from the third side in a case of making the support surface support the ultrasonic device,

the flexible printed wiring board includes

a first connection part to be connected to the device-side terminal located at the first position, and a second connection part located at the second position as the connection part,

a first bending part continuous with the first connection part and extending in a first extending direction of getting away from the ultrasonic device, and a second bending part continuous with the second connection part and extending in a second extending direction of getting away from the ultrasonic device as the bending part, and

a first outer edge part disposed in the first extending direction from the first connection part toward the first bending part, and a second outer edge part disposed in the second extending direction from the second connection part toward the second bending part as the outer edge part, and

the reinforcing plate is provided with a first projecting part with which the first outer edge part has contact when the flexible printed wiring board is curved to be bent along the first side in the first bending part, and a second projecting part with which the second outer edge part has contact when the flexible printed wiring board is curved to be bent along the third side in the second bending part as the projecting part.

4. The ultrasonic device unit according to claim **3**, wherein

the flexible printed wiring board has a slit having an opening edge including a first end edge as an end edge extending along the first extending direction of the first connection part and the first bending part, a second end edge as an end edge extending along the second extending direction of the second connection part and the second bending part, and an opposed edge opposed to the first end edge and the second end edge,

a width dimension from the first end edge to the opposed edge of the slit is larger than a width dimension in the first direction of the second projecting part, and

a width dimension from the second end edge to the opposed edge of the slit is larger than a width dimension in the first direction of the first projecting part.

5. The ultrasonic device unit according to claim **4**, wherein

in the opening edge of the slit, an opening end in the first extending direction and an opening end in the second extending direction are located between the first projecting part and the second projecting part when the flexible printed wiring board is curved to be bent along the first side in the first bending part.

6. An ultrasonic probe comprising:

the ultrasonic device unit according to claim **1**; and

a housing adapted to store the ultrasonic device unit.

7. An ultrasonic probe comprising:

the ultrasonic device unit according to claim **2**; and

a housing adapted to store the ultrasonic device unit.

8. An ultrasonic probe comprising:

the ultrasonic device unit according to claim **3**; and

a housing adapted to store the ultrasonic device unit.

9. An ultrasonic probe comprising:

the ultrasonic device unit according to claim **4**; and

a housing adapted to store the ultrasonic device unit.

10. An ultrasonic probe comprising:

the ultrasonic device unit according to claim **5**; and

a housing adapted to store the ultrasonic device unit.

11. An ultrasonic apparatus comprising:

the ultrasonic device unit according to claim **1**; and

a control section adapted to control the ultrasonic device unit.

12. An ultrasonic apparatus comprising:

the ultrasonic device unit according to claim **2**; and

a control section adapted to control the ultrasonic device unit.

13. An ultrasonic apparatus comprising:

the ultrasonic device unit according to claim **3**; and

a control section adapted to control the ultrasonic device unit.

14. An ultrasonic apparatus comprising:

the ultrasonic device unit according to claim **4**; and

a control section adapted to control the ultrasonic device unit.

* * * * *

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摘要(译)

超声波装置单元包括具有装置侧端子的超声波装置，具有适于支撑超声波装置的支撑表面的加强板，以及与超声波装置连接的柔性印刷布线板，该柔性印刷布线板包括：连接到设备侧端子，与连接连续的弯曲，并且远离超声波设备延伸，并且外边缘设置在弯曲的延伸方向的一端，并且加强板设置有第一侧平行于与延伸方向交叉的第一方向，并且与弯曲部分相对，并且在与支撑表面相对的反面上具有突起，并且当柔性印刷线路板沿第一侧弯曲时外边缘与之接触在弯道。