(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 216 104 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
01.02.2017 Bulletin 2017/05

(51) Int Cl.:
B06B 1/06 *(2006.01)* *A61B 8/00* *(2006.01)*

(21) Application number: **10151791.0**

(22) Date of filing: **27.01.2010**

(54) Ultrasonic probe, ultrasonic imaging apparatus and fabricating method thereof

Ultraschallsonde, Ultraschallbildgebungsvorrichtung und Herstellungsverfahren dafür

Sonde ultrasonique, appareil d'imagerie par ultrasons et son procédé de fabrication

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **10.02.2009 KR 20090010661**

(43) Date of publication of application:
11.08.2010 Bulletin 2010/32

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Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to the field of ultrasonics. and is defined in the claims.Other embodiments are merely exemplary.

[0002] Embodiments relate to an ultrasonic probe, an ultrasonic imaging apparatus and a fabricating method thereof, and more particularly, to an ultrasonic probe, an ultrasonic imaging apparatus and a fabricating method thereof for enhancing vibration property and improving focusing of ultrasonic images to obtain clear images.

[0003] Ultrasound is a method of examining tissues of the human body using ultrasonic waves, which irradiates ultrasonic waves to an affected area of the human body and detects an abnormal tissue through an image generated from a reflected signal. The ultrasound is used to diagnose lesions such as a tumor or test embryos.

[0004] Ultrasonic waves are defined as sound having a frequency higher than a frequency range that people can hear, generally, 20,000Hz to 30MHz. Ultrasonic waves for diagnosis of the human body are in the range of 1 MHz to 20MHz.

[0005] An ultrasonic imaging apparatus used for ultrasound may be divided into three parts, that is, an ultrasonic probe, a signal processor and a display. The ultrasonic probe converts electric and ultrasonic signals and the signal processor processes receiving signals and transmitting signals. The display generates images using signals obtained from the ultrasonic probe and the signal processor. Particularly, the ultrasonic probe is an important part that determines the quality of an ultrasonic image.

[0006] The ultrasonic probe includes a piezoelectric wafer, an electrode, an acoustic matching layer, a printed circuit board and an acoustic lens, in general. The size of the ultrasonic probe is decreasing, which requires a method of arranging wiring patterns for processing ultrasonic and electric signals in the ultrasonic probe and a technique for improving vibration property and focusing to obtain clear ultrasonic images and widen a signal bandwidth.

[0007] Embodiments of the present invention provide an ultrasonic probe, an ultrasonic imaging apparatus and a fabricating method thereof for enhancing the vibration property of the ultrasonic imaging apparatus an improving focusing of ultrasonic images to obtain clear images.

[0008] In one aspect, there is provided an ultrasonic probe including a rear block having a predetermined thickness, a flexible printed circuit board stacked on the rear block to surround the top face and side of the rear block and having wiring patterns formed thereon, a piezoelectric wafer stacked on the top face of the flexible printed circuit board and having upper and lower electrodes respectively formed on both sides thereof and a plurality of second holes formed therein, a ground electrode plate stacked on the top face of the piezoelectric wafer, bonded to the upper electrode and connected to a ground layer of the flexible printed circuit board, an acoustic matching layer stacked on the top face of the ground electrode plate, an acoustic lens bonded onto the acoustic matching layer, and a plurality of slots formed in the direction perpendicular to the second holes and ranging from in the acoustic matching layer to the top of the rear block.

[0009] In an embodiment, the flexible printed circuit board includes a base film formed of an insulating material and having a bottom face bonded onto the rear block and a top face opposite to the bottom face, and wiring patterns formed on both sides of the base film. The wiring patterns includes a central wiring pattern that is formed on the top face of the base film, has a central pad formed between neighboring second holes, is connected to the central pad through a via and is extended to the outside of the rear block through the bottom face of the base film, a first wiring pattern that has a first pad formed at one side of the central pad, is connected to the first pad and is arranged at one side of the top face of the base film, a second wiring pattern that has second pad formed on the other side of the central pad, is connected to the second pad and is arranged at the other side of the top face of the base film, a protective layer formed on the bottom face of the central wiring pattern and the top faces of the first and second wiring patterns to protect the central wiring pattern, the first and second wiring patterns, and a ground layer formed on the protective layer formed on the top faces of the first and second wiring patterns and connected to the ground electrode plate.

[0010] In another aspect, there is provided an ultrasonic imaging apparatus includes the ultrasonic probe and a main body having a connector connected to the ultrasonic probe.

[0011] In yet another aspect, there is provided a method of fabricating an ultrasonic probe, which includes a first stacking step of sequentially stacking a piezoelectric wafer, a ground electrode plate and an acoustic matching layer, a second hole forming step of forming a plurality of second holes in the piezoelectric wafer, a second stacking step of sequentially stacking a rear block and a flexible printed circuit board, a third stacking step of stacking the piezoelectric wafer on the flexible printed circuit board, a slot forming step of forming a plurality of slots perpendicular to the second holes such that the slots range from the acoustic matching layer to the top of the rear block, and a bonding step of bonding an acoustic lens onto the acoustic matching layer.

[0012] Holes may be formed in at least one of the rear block, the piezoelectric wafer and the acoustic matching layer and a plurality of slots are formed through a one-time dicing process such that the slots range from the acoustic matching layer to the top of the rear block to form a wiring patterns in the form of a matrix array. Accordingly, the vibration property and focusing can be improved to obtain clear images.

[0013] Furthermore, the present invention reduces ultrasonic signal interference and provides a wide bandwidth and high sensitivity.

[0014] Moreover, a wiring pattern is arranged in the form of a matrix array to control ultrasonic signals or power used for ultrasound, and thus it is possible to adjust a focusing depth, extend an ultrasound area and obtain clear images.

[0015] In addition, the connector that connects the ultrasonic probe to the main body of the ultrasonic imaging apparatus is located on the top of the main body, and thus users can use the ultrasonic imaging apparatus conveniently.

[0016] The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

FIG. 1 illustrates an ultrasonic imaging apparatus according to a first embodiment of the present invention;
FIG. 2A is a cross-sectional view of an ultrasonic probe according to the first embodiment of the present invention;
FIG. 2B is a perspective view of the ultrasonic probe according to the first embodiment of the present invention;
FIG. 3 is a perspective view of a flexible printed circuit board according to an embodiment of the present invention;
FIG. 4A is a cross-sectional view taken along line A-A of FIG. 3;
FIG. 4B is a cross-sectional view taken along line B-B of FIG. 3;
FIG. 5 is a flowchart showing a method of fabricating the ultrasonic probe according to the first embodiment;
FIG. 6 illustrates a method of forming slots of the ultrasonic probe according to the first embodiment;
FIG. 7 is a cross-sectional view of an ultrasonic probe according to a second embodiment;
FIG. 8 is a flowchart showing a method of fabricating the ultrasonic probe according to the second embodiment;
FIG. 9 is a cross-sectional view of an ultrasonic probe according to a third embodiment;
FIG. 10 is a flowchart showing a method of fabricating the ultrasonic probe according to the third embodiment;
FIG. 11A is a cross-sectional view of an ultrasonic probe according to a fourth embodiment;
FIG. 11B is a perspective view of the ultrasonic probe according to the fourth embodiment; and
FIG. 12 is a flowchart showing a method of fabricating the ultrasonic probe according to the fourth embodiment.

[0017] The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. Throughout the drawings, like reference numerals refer to like elements.

[0018] Referring to FIG. 1, the ultrasonic imaging apparatus 1 includes a main body 11, an ultrasonic probe 100, a display 13 and an input unit 14.

[0019] The main body 11 includes a signal processor that transmits and receives electric and ultrasonic signals and a storage unit that stores application programs and data required for ultrasound. Further, a connector 15 for connecting the ultrasonic probe 100 to the main body 11 is provided outside the main body 11. The connector 15 is placed on the top of the main body 11 such that a user can easily connect the ultrasonic probe 100 to the main body 11.

[0020] The ultrasonic probe 100 includes an acoustic lens 80 coming into contact with an affected area of a patient and a case 90 covering the other components of the ultrasonic probe 100. The acoustic lens 80 is used for focusing an ultrasonic image and arranged to cover an acoustic matching layer placed under the acoustic lens 80. The acoustic lens 80 may be made of silicon. The other components of the ultrasonic probe 100, covered with the case 90, will be explained in detail later.

[0021] The display 13 displays ultrasonic images obtained through application programs executed for ultrasound and examination.

[0022] The input unit 14 is used to execute the application programs or input data required for examination and includes a plurality of keys.

[0023] The ultrasonic probe 100 according to the first embodiment of the present invention will now be explained with reference to FIGS. 2A and 2B. FIG. 2A is a cross-sectional view of the ultrasonic probe 100 according to the first embodiment of the present invention and FIG. 2B is a perspective view of the ultrasonic probe 100 according to the first embodiment of the present invention.

[0024] The ultrasonic probe 100 according to the first embodiment of the present invention includes a rear block 10, a flexible printed circuit board 20, a piezoelectric wafer 50, a ground electrode plate 60 and an acoustic matching layer 70, which are sequentially stacked. While the ultrasonic probe 100 according to the first embodiment of the present invention includes the acoustic lens 80 (shown in FIG. 1) placed on the acoustic matching layer 70, the acoustic lens is not shown in FIGS. 2A and 2B.

[0025] The rear block 10 is located at the bottom of the ultrasonic probe 100 and absorbs unnecessary ultrasonic signals traveling to the rear block 10 from the piezoelectric wafer 50.

[0026] The flexible printed circuit board 20 is located on the top face of the rear block 10 and has wiring patterns formed on both sides thereof. The flexible printed circuit board 20 will be explained in more detail later.

[0027] The piezoelectric wafer 50 is arranged on the top face of the flexible printed circuit board 20. The piezoelectric wafer 50 has upper and lower electrodes 55 and 57 which are respectively formed on top and bottom surfaces thereof and a plurality of second holes 53.

[0028] While two second holes 53 are formed in the piezoelectric wafer 50 in the first embodiment of the present invention, the number of second holes 53 is not limited thereto. The piezoelectric wafer 50 may be formed of PZT or PMN-PT. The upper and lower electrodes 55 and 57 are formed through sputtering, electron beam, thermal evaporation or electroplating. The upper electrode 55 is connected to the ground electrode plate 60 and the lower electrode 57 is connected to the flexible printed circuit board 20.

[0029] The ground electrode plate 60 has a metal layer formed on the top face thereof and an insulating layer formed on the bottom face thereof and surrounds the top face and the side of the piezoelectric wafer 50. The flexible printed circuit board 20 includes a ground layer. The bottom end of the ground electrode plate 60 is connected to the ground layer of the flexible printed circuit board 20.

[0030] The acoustic matching layer 70 is made of metal powder or ceramic powder and formed on the top face of the ground electrode plate 60.

[0031] A plurality of slots 83 are formed such that the plurality of slots 83 range from the acoustic matching layer 70 to the top of the rear block 10 in the direction perpendicular to the second holes 53. While the ultrasonic probe 100 according to the first embodiment of the present invention has five slots 83, the number of slots 83 is not limited thereto.

[0032] The acoustic lens (not shown) is used for focusing ultrasonic images and located on the top face of the acoustic matching layer 70.

[0033] The flexible printed circuit board 20 and the wiring patterns according to the first embodiment of the present invention will now be explained with reference to FIGS. 2A, 2B, 3, 4A and 4B. FIG. 3 is a perspective view of the flexible printed circuit 20, FIG. 4A is a cross-sectional view taken along line A-A of FIG. 3 and FIG. 4B is a cross-sectional view taken along line B-B of FIG. 3.

[0034] FIG. 3 shows the flexible printed circuit board 20 before the slots 83 are formed therein. Positions of the slots 83 are indicated by dotted lines in FIG. 3.

[0035] Referring to FIGS. 2A, 2B, 3, 4A and 4B, the flexible printed circuit board 20 includes a base film 31 and wiring patterns. The base film 31 is made of an insulating material. The bottom face of the base film 31 is bonded to the top face of the rear block 10 and the top face thereof is opposite to the bottom face. The wiring patterns are divided into a central wiring pattern 33, a first wiring pattern 35 and a second wiring pattern 37 and formed on both sides of the base film 31.

[0036] The central wiring pattern 33 is formed on the top face of the base film 31 and includes a central pad 43 formed in the region between neighboring second holes 53. The central wiring pattern 33 is connected to the central pad 43 through a via 39 and extended to the outside of the rear block 10 through the bottom face of the base film 31. Here, the central wiring pattern 33 is alternately arranged on one side and the other side of the central pad 43. Accordingly, the central wiring pattern 33 shown in FIG. 4A is located at the right side of the central pad 43 while the central wiring pattern 33 shown in FIG. 4B is formed at the left side of the central pad 43.

[0037] The first wiring pattern 35 includes a first pad 45 formed at one side of the central pad 43, is connected to the first pad 45 and arranged at one side of the top face of the base film 31. The second wiring pattern 37 includes a second pad 47 formed at the other side of the central pad 43, is connected to the second pad 47 and arranged at the other side of the top face of the base film 31.

[0038] A protective layer 41 for protecting the wiring patterns is formed on the bottom face of the central wiring pattern 33 and the top faces of the first and second wiring patterns 35 and 37. Here, the central pad 43, the first pad 45 and the second pad 47 are not protected by the protective layer 41 and they are exposed to be connected to the lower electrode 57 of the piezoelectric wafer 50.

[0039] A ground layer 49 is formed on the protective layer 41 formed on the first and second wiring patterns 35 and 37 and connected to the ground electrode plate 60.

[0040] While the central pad 43, the first pad 45 and the second pad 47 form a 3X6 matrix array in the flexible printed circuit board 20 according to the first embodiment of the present invention, they can form 3X64 through 3X192 matrix arrays.

[0041] Furthermore, while the flexible printed circuit board 20 according to the first embodiment of the present invention has the three wiring patterns including the central wiring pattern 33, the first wiring pattern 35 and the second wiring pattern 37, the number of wiring patterns is not limited thereto. If five wiring patterns are formed, the central wiring pattern is alternately formed on one side and the other side of the bottom face of the base film, two wiring patterns are formed on one side of the central wiring pattern and the other two wiring patterns are formed on the other side of the central wiring pattern. The two wiring patterns are respectively arranged at both ends of the flexible printed circuit board.

[0042] In general, circuit connection is achieved at a contact portion of the piezoelectric wafer 50 and the flexible printed circuit board 20. A 1.5D (Dimension) ultrasonic probe has a multi-level circuit structure in order to connect circuits on both ends of the ultrasonic probe. However, the vibration and acoustic properties of the ultrasonic probe 100 increases as the thicknesses of the rear block 10, the piezoelectric wafer 50 and the acoustic matching layer 70, the flexible printed circuit 20 and the ground electrode plate 60 decreases. Accordingly, circuits on both sides of the flexible printed circuit board 20 according to the present invention are not connected at the contact portion of the flexible printed circuit board 20 and the piezoelectric wafer 50 and both ends of the flexible printed circuit board 20 are bonded to each other, as shown in FIG. 2B, and thus the thickness of the flexible printed circuit board 20 coming into contact with the piezoelectric wafer 50 decreases to improve the acoustic property of the ultrasonic probe 100.

[0043] A method of fabricating the ultrasonic probe according to the first embodiment will now be explained with reference to FIGS. 2 through 6. FIG. 5 is a flowchart showing the method of fabricating the ultrasonic probe according to the first embodiment and FIG. 6 illustrates a method of forming the slots of the ultrasonic probe according to the first embodiment.

[0044] Referring to FIG. 5, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked in step S711.

[0045] The plurality of second holes 53 are formed in the piezoelectric wafer 50 in step S713.

[0046] The rear block 10 and the flexible printed circuit board 20 are sequentially stacked in step S715.

[0047] The piezoelectric wafer 50, stacked in step S711, is located on the top face of the flexible printed circuit board 20, stacked in step S715, in step S721.

[0048] When the rear block 10, the flexible printed circuit board 20, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked, the plurality of slots 83 are formed such that the plurality of slots 83 range from the acoustic matching layer 70 to the top of the rear block 10 in the direction perpendicular to the second holes 53 in step S723.

[0049] The acoustic lens (not shown) is bonded onto the acoustic matching layer 70 having the slots 83 formed therein to cover the overall surface of the acoustic matching layer 70 in step S725. The acoustic lens is formed of a material such as silicon and bonded onto the acoustic matching layer 70 using a silicon primer.

[0050] The ground electrode plate 60 is connected to the ground layer 59 of the flexible printed circuit board 20 and both ends of the flexible printed circuit board 20 are bonded to each other to connect the first and second wiring patterns 45 and 55 to construct a circuit in step S727.

[0051] The method of forming the slots 83 in step S723 will now be explained with reference to FIG. 6.

[0052] Referring to FIG. 6, the slots 83 are formed in the rear block 10, the flexible printed circuit board 20, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70, stacked in step S723, using a dicing machine 500. FIG. 6 shows that four of five slots 83 are formed.

[0053] The dicing machine 500 used in step S723 can be used to form the second holes 53 in the piezoelectric wafer 50.

[0054] The ultrasonic probe is bonded using general epoxy in the stacking and bonding steps because electrical bonding can be achieved by coating the general epoxy thin by 1 to 2μm. While the general epoxy substitutes for a conductive epoxy having relatively weak adhesiveness, the adhesive used to bond the ultrasonic probe is not limited to the general epoxy.

[0055] An ultrasonic probe 200 according to a second embodiment will now be explained with reference to FIGS. 7 and 8. FIG. 7 is a cross-sectional view of the ultrasonic probe 200 according to the second embodiment of the present invention and FIG. 8 is a flowchart showing a method of fabricating the ultrasonic probe 200 according to the second embodiment.

[0056] The ultrasonic probe 200 according to the second embodiment includes a plurality of downwardly extended spaces 113 formed in the rear block 10 and extended downwardly from the respective second holes 53 formed in the piezoelectric wafer 50. The number of first holes 113 equals the number of second holes 53. The ultrasonic probe 200 according to the second embodiment can reduce ultrasonic interference and improve vibration property according to the downwardly extended spaces 113 formed in the rear block 10.

[0057] Referring to FIGS. 7 and 8, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked in step S611. The plurality of second holes 53 are formed in the piezoelectric wafer 50 in step S613 and the first holes 113 corresponding to the second holes 53 are formed in the rear block 10 in step S617.

[0058] The rear block 10 having the first holes 113 formed therein and the flexible printed circuit board 20 are sequentially stacked in step S619. Here, it is more desirable to form the first holes 113 in the rear block 10 and then stack the flexible printed circuit board 20 on the rear block 10.

[0059] The piezoelectric wafer 50, arranged in step S611, is stacked on the flexible printed circuit board 20, placed on the rear block 10 in step S619, in step S621.

[0060] The slots (83 in FIG. 2B) perpendicular to the second holes 53 are formed such that the slots range from the acoustic matching layer 70 to the top of the rear block 10 in step S623.

[0061] The acoustic lens (not shown) is bonded onto the acoustic matching layer 70 having the slots formed therein to cover the overall surface of the acoustic matching layer 70 in step S625.

[0062] The ground electrode plate 60 is connected to a ground layer (not shown) of the flexible printed circuit board 20 and both ends of the flexible printed circuit board 20 are bonded to each other to connect first and second wiring patterns (not shown) to thereby construct a circuit in step S627.

[0063] An ultrasonic probe 300 according to a third embodiment will now be explained with reference to FIGS. 9 and 10. FIG. 9 is a cross-sectional view of the ultrasonic probe 300 according to the third embodiment and FIG. 10 is a flowchart showing a method of fabricating the ultrasonic probe 300 according to the third embodiment.

[0064] The ultrasonic probe 300 according to the third embodiment includes the second holes 53 formed in the piezoelectric wafer 50 and a plurality of third holes 273 formed in the acoustic matching layer 70 and extended upwardly from the second holes 53. Here, the number of second holes 53 equals the number of third holes 273. The ultrasonic probe 300 according to the third embodiment of the present invention reduces ultrasonic interference according to the second holes 273 formed in the acoustic matching layer 70 to improve vibration property.

[0065] Referring to FIGS. 9 and 10, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked in step S511. The plurality of second holes 53 are formed in the piezoelectric wafer 50 in step S513 and the third holes 273 corresponding to the second holes 53 are formed in the acoustic matching layer 70 in step S515.

[0066] The rear block 10 and the flexible printed circuit board 20 are sequentially stacked in step S519.

[0067] The piezoelectric wafer 50, arranged in step S511, is stacked on the flexible printed circuit board 20, placed on the rear block 10 in step S519, in step S521.

[0068] The slots (83 in FIG. 2B) perpendicular to the second holes 53 are formed such that the slots range from the acoustic matching layer 70 to the top of the rear block 10 in step S523.

[0069] The acoustic lens (not shown) is bonded onto the acoustic matching layer 70 having the slots formed therein to cover the overall surface of the acoustic matching layer 70 in step S525.

[0070] The ground electrode plate 60 is connected to a ground layer (not shown) of the flexible printed circuit board 20 and both ends of the flexible printed circuit board 20 are bonded to each other to connect first and second wiring patterns (not shown) to thereby construct a circuit in step S527.

[0071] An ultrasonic probe 400 according to a fourth embodiment will now be explained with reference to FIGS. 11A, 11B and 12. FIG. 11A is a cross-sectional view of the ultrasonic probe 400 according to the fourth embodiment FIG. 11B is a perspective view of the ultrasonic probe 400 according to the fourth embodiment and FIG. 12 is a flowchart showing a method of fabricating the ultrasonic probe 400 according to the fourth embodiment.

[0072] The ultrasonic probe 400 according to the fourth embodiment includes the downwardly extended spaces 113 formed in the rear block 10, the second holes 53 formed in the piezoelectric wafer 50 and the third holes 273 formed in the acoustic matching layer 70. The number of first holes 113, the number of second holes 53 and the number of third holes 273 are identical. The ultrasonic probe 400 according to the fourth embodiment can minimize inter-layer interference according to the second holes 53 formed in the piezoelectric wafer 50 and their extended holes 113 and 273 respectively formed in the rear block 10 and the acoustic matching layer 70 to improve vibration property.

[0073] Referring to FIGS. 11A, 11B and 12, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked in step S411. The plurality of second holes 53 are formed in the piezoelectric wafer 50 in step S413 and the third holes 273 corresponding to the second holes 53 are formed in the acoustic matching layer 70 in step S415. The first holes 113 corresponding to the second holes 53 are formed in the upper part of the rear block 10 in step S417.

[0074] The rear block 10 having the first holes 113 formed therein and the flexible printed circuit board 20 are sequentially stacked in step S419.

[0075] The piezoelectric wafer 50, arranged in step S411, is stacked on the flexible printed circuit board 20, placed on the rear block 10 in step S419, in step S421.

[0076] When the rear block 10, the flexible printed circuit board 20, the piezoelectric wafer 50, the ground electrode plate 60 and the acoustic matching layer 70 are sequentially stacked in step S421, the slots 83 perpendicular to the second holes 53 are formed such that the slots 83 range from the acoustic matching layer 70 to the top of the rear block 10 in step S423.

[0077] The acoustic lens (not shown) is bonded onto the acoustic matching layer 70 having the slots 83 formed therein to cover the overall surface of the acoustic matching layer 70 in step S425.

[0078] The ground electrode plate 60 is connected to the ground layer of the flexible printed circuit board 20 and both ends of the flexible printed circuit board 20 are bonded to each other to connect first and second wiring patterns (not shown) to thereby construct a circuit in step S427.

[0079] The ultrasonic probe, the ultrasonic imaging apparatus and the fabricating method thereof have been described through embodiments

Claims

1. An ultrasonic probe comprising:

   a rear block (10) having a predetermined thickness;
   a flexible printed circuit board (20) stacked on the rear block (10) to surround the top face and side of the rear block (10) and having wiring patterns formed thereon;
   a piezoelectric wafer (50) stacked on the top face of the flexible printed circuit board (20) and having upper and lower electrodes (55, 57) respectively formed on top and bottom faces thereof whereby the lower electrodes (57) are arranged on and connected to the top face of the flexible printed circuit board (20);
   a ground electrode plate (60) stacked on the top face of the piezoelectric wafer (50), bonded to the upper electrodes (55) and connected to a ground layer of the flexible printed circuit board (20);
   an acoustic matching layer (70) stacked on the top face of the ground electrode plate (60); and

an acoustic lens bonded onto the acoustic matching layer (70),

> wherein the piezoelectric wafer (50) has a plurality of second holes (53) formed therein, and a plurality of slots (83) are formed in the direction perpendicular to the second holes (53) while ranging from the acoustic matching layer (70) to the top of the rear block (10), whereby the piezoelectric wafer (50) is arranged in the form of a matrix array on the top face of the flexible printed circuit board (20),

wherein the flexible printed circuit board (20) comprises:

> a base film (31) formed of an insulating material and having a bottom face bonded onto the rear block (10) and a top face opposite to the bottom face; and
> wiring patterns formed on both sides of the base film,

wherein the wiring patterns comprises:

> a central wiring pattern (33) that is formed on the top face of the base film (31), has a central pad (43) formed between neighboring **second holes** is connected to the central pad (43) through a via (39) and is extended to the outside of the rear block (10) through the bottom face of the base film (31);
> a first wiring pattern (35) that has a first pad (45) formed at one side of the central pad (43), is connected to the first pad (45) and is arranged at one side of the top face of the base film (31);
> a second wiring pattern (37) that has a second pad (47) formed on the other side of the central pad (43), is connected to the second pad (47) and is arranged at the other side of the top face of the base film (31);
> a protective layer (41) formed on the bottom face of the central wiring pattern (33) and the top faces of the first and second wiring patterns (35, 37) to protect the central wiring pattern (33), the first and second wiring patterns (35, 37); and
> a ground layer (49) formed on the protective layer (41) formed on the top faces of the first and second wiring patterns (35, 37) and connected to the ground electrode plate (60),
> wherein the central pad (43), the first pad (45) and the second pad (47) form a matrix array in the flexible printed circuit board (20) such that the lower electrodes (57) of the piezoelectric wafer (50) are connected to and arranged in the matrix array on the central pad (43), the first pad (45) and the second pad (47) of the flexible printed circuit board (20),

wherein the central wiring pattern (33) is alternately arranged on one side and the other side of the base film (31), and
wherein both ends of the flexible printed circuit board (20) are bonded to each other such that the first and second wiring patterns (35, 37) are connected to each other.

2. The ultrasonic probe of claim 1, wherein the rear block has first holes formed therein, which correspond to the second holes.

3. The ultrasonic probe of claim 1, wherein the acoustic matching layer has third holes formed therein, which correspond to the second holes.

4. The ultrasonic probe of claim 1, wherein the rear block has first holes formed therein, which correspond to the second holes, and the acoustic matching layer has third holes formed therein, which correspond to the second holes.

5. The ultrasonic probe of claim 1, wherein the central pad (43), the first pad and the second pad (45, 47) form a 3X96 matrix array.

6. The ultrasonic probe of claim 5, wherein the number of the slots (83) is 95.

7. An ultrasonic imaging apparatus comprising:

> the ultrasonic probe (100, 200, 300, 400) according to one of claims 1 to 6; and
> a main body (11) having a connector (15) connected to the ultrasonic probe.

8. The ultrasonic imaging apparatus of claim 7, wherein the connector (15) is located on the top of the main body (11).

Patentansprüche

1. Ultraschallsonde, aufweisend:

> einen hinteren Block (10) mit einer vorgegebenen Dicke;
> eine flexible Leiterplatte (20), welche auf dem hinteren Block (10) liegt, um die Oberseite und die Seite des hinteren Blocks (10) zu umschließen, und welche darauf gebildete Verdrah-

tungsmuster aufweist;
einen piezoelektrischen Wafer (50), welcher auf der Oberseite der flexiblen Leiterplatte (20) liegt und obere und untere Elektroden (55, 57), welche jeweils auf den Ober- und Unterseiten davon gebildet sind, aufweist, wobei die unteren Elektroden (57) auf der Oberseite der flexiblen Leiterplatte (20) angeordnet und damit verbunden sind;
eine Elektrodenerdungsplatte (60), welche auf der Oberseite des piezoelektrischen Wafers (50) liegt, an die oberen Elektroden (55) angefügt ist und mit einer Erdungsschicht der flexiblen Leiterplatte (20) verbunden ist;
eine akustische Anpassungsschicht (70), welche auf der Oberseite der Elektrodenerdungsplatte (60) liegt; und
eine akustische Linse, welche an die akustische Anpassungsschicht (70) angefügt ist,
wobei der piezoelektrische Wafer (50) mehrere darin gebildete zweite Löcher (53) aufweist und mehrere Schlitze (83) in senkrechter Richtung zu den zweiten Löchern (53) gebildet sind, welche sich von der akustischen Anpassungsschicht (70) bis zum Oberteil des hinteren Blocks (10) erstrecken, wobei der piezoelektrische Wafer (50) in der Form einer matrixförmigen Anordnung auf der Oberseite der flexiblen Leiterplatte (20) angeordnet ist,

wobei die flexible Leiterplatte (20) Folgendes aufweist:

eine Basisfolie (31), welche aus einem Isoliermaterial gebildet ist und eine Unterseite, welche an den hinteren Block (10) angefügt ist, und eine der Unterseite gegenüberliegende Oberseite, aufweist; und
Verdrahtungsmuster, welche auf beiden Seiten der Basisfolie gebildet sind,

wobei die Verdrahtungsmuster Folgendes aufweisen:

ein zentrales Verdrahtungsmuster (33), welches auf der Oberseite der Basisfolie (31) gebildet ist, ein zentrales Pad (43) aufweist, welches zwischen benachbarten zweiten Löcher gebildet ist, mit dem zentralen Pad (43) durch ein Durchgangsloch (39) verbunden ist und sich durch die Unterseite der Basisfolie (31) zur Außenseite des hinteren Blocks (10) erstreckt;
ein erstes Verdrahtungsmuster (35), welches ein auf einer Seite des zentralen Pads(43) gebildetes erstes Pad (45) aufweist, mit dem ersten Pad (45) verbunden ist und auf einer Seite der Oberseite der Basisfolie (31) angeordnet ist;
ein zweites Verdrahtungsmuster (37), welches ein zweites Pad (47), welches auf der anderen Seite des zentralen Pads (43) gebildet ist, mit dem zweiten Pad (47) verbunden ist und auf der anderen Seite der Oberseite der Basisfolie (31) angeordnet ist;
eine Schutzschicht (41), welche auf der Oberseite des zentralen Verdrahtungsmusters (33) und auf den Oberseiten des ersten und zweiten Verdrahtungsmusters (35, 37) gebildet ist, um das zentrale Verdrahtungsmuster (33) und das erste und zweite Verdrahtungsmuster (35, 37) zu schützen; und
eine Erdungsschicht (49), welche auf der Schutzschicht (41) gebildet ist, welche auf den Oberseiten des ersten und zweiten Verdrahtungsmusters (35, 37) gebildet ist, und mit der Elektrodenerdungsplatte (60) verbunden ist,
wobei das zentrale Pad (43), das erste Pad (45) und das zweite Pad (47) eine matrixförmige Anordnung in der flexiblen Leiterplatte (20) bilden, so dass die unteren Elektroden (57) des piezoelektrischen Wafers (50) mit der matrixförmigen Anordnung mit dem zentralen Pad (43), dem ersten Pad (45) und dem zweiten Pad (47) der flexiblen Leiterplatte (20) verbunden und darin angeordnet sind,
wobei das zentrale Verdrahtungsmuster (33) abwechselnd auf einer Seite und der anderen Seite der Basisfolie (31) angeordnet ist, und
wobei beide Enden der flexiblen Leiterplatte (20) so aneinander gefügt sind, dass das erste und zweite Verdrahtungsmuster (35, 37) miteinander verbunden sind.

2. Ultraschallsonde nach Anspruch 1, wobei der hintere Block darin gebildete erste Löcher aufweist, welche den zweiten Löchern entsprechen.

3. Ultraschallsonde nach Anspruch 1, wobei die akustische Anpassungsschicht darin gebildete dritte Löcher aufweist, welche den zweiten Löchern entsprechen.

4. Ultraschallsonde nach Anspruch 1, wobei der hintere Block darin gebildete erste Löcher aufweist, welche den zweiten Löchern entsprechen, und die akustische Anpassungsschicht darin gebildete dritte Löcher aufweist, welche den zweiten Löchern entsprechen.

5. Ultraschallsonde nach Anspruch 1, wobei das zentrale Pad (43), das erste Pad und das zweite Pad (45, 47) eine 3X96-matrixförmige Anordnung bilden.

6. Ultraschallsonde nach Anspruch 5, wobei die Anzahl der Schlitze (83) 95 ist.

7. Ultraschall-Bilderzeugungsvorrichtung, aufweisend:

die Ultraschallsonde (100, 200, 300, 400) nach einem von Anspruch 1 bis 6; und einen Hauptkörper (11), welcher einen Verbinder (15) aufweist, welcher mit der Ultraschallsonde verbunden ist.

8. Ultraschall-Bilderzeugungsvorrichtung nach Anspruch 7, wobei der Verbinder (15) auf dem oberen Hauptkörper (11) angeordnet ist.

Revendications

1. Sonde ultrasonique, comprenant :

un bloc arrière(10) présentant une épaisseur prédéterminée ;
une carte de circuit imprimé flexible (20) empilée sur le bloc arrière (10) pour entourer la face de dessus et le côté du bloc arrière (10) et présentant des schémas de câblage formés dessus ;
une tranche piézoélectrique (50) empilée sur la face de dessus de la carte de circuit imprimé flexible (20) et présentant des électrodes supérieures et inférieures (55, 57) respectivement formées sur les faces de dessus et de dessous de celle-ci, les électrodes inférieures (57) étant agencées sur la face de dessus de la carte de circuit imprimé flexible (20) et reliées à celle-ci ;
une plaque d'électrode de masse (60) empilée sur la face de dessus de la tranche piézoélectrique (50), collée aux électrodes supérieures (55) et reliée à une couche de fond de la carte de circuit imprimé flexible (20) ;
une couche d'adaptation acoustique (70) empilée sur la face de dessus de la plaque d'électrode de masse (60) ; et
une lentille acoustique collée sur la couche d'adaptation acoustique (70),
dans laquelle la tranche piézoélectrique (50) présente une pluralité de deuxièmes trous (53) formés dans celle-ci, et une pluralité de fentes (83) sont formées dans la direction perpendiculaire aux deuxièmes trous (53) tout en allant de la couche d'adaptation acoustique (70) vers le dessus du bloc arrière (10), la tranche piézoélectrique (50) étant agencée sous la forme d'une matrice d'éléments sur la face de dessus de la carte de circuit imprimé flexible (20),

dans laquelle la carte de circuit imprimé flexible (20) comprend :

un film de base (31) formé d'un matériau isolant et présentant une face de dessous collée sur le bloc arrière (10) et une face de dessus opposée à la face de dessous ; et
des schémas de câblage formés sur les deux côtés du film de base,
dans laquelle les schémas de câblage comprennent :
un schéma de câblage central (33) qui est formé sur la face de dessus du film de base (31), présente une plage d'accueil centrale (43) formée entre des deuxièmes trous adjacents, est relié à la plage d'accueil centrale (43) à travers un trou d'interconnexion (39) et s'étend jusqu'à l'extérieur du bloc arrière (10) à travers la face de dessous du film de base (31) ;
un premier schéma de câblage (35) qui présente une première plage d'accueil (45) formée au niveau d'un côté de la plage d'accueil centrale (43), est relié à la première plage d'accueil (45) et est agencé au niveau d'un côté de la face de dessus du film de base (31) ;
un second schéma de câblage (37) qui présente une seconde plage d'accueil (47) formée sur l'autre côté de la plage d'accueil centrale (43), est relié à la seconde plage d'accueil (47) et est agencé de l'autre côté de la face de dessus du film de base (31) ;
un couche de protection (41) formée sur la face de dessous du schéma de câblage central (33) et la face de dessus des premier et second schémas de câblage (35, 37) afin de protéger le schéma de câblage central (33), les premier et second schémas de câblage (35, 37) ; et
une couche de fond (49) formé sur la couche de protection (41) formée sur la face de dessus des premier et second schémas de câblage (35, 37) et reliée à la plaque d'électrode de masse (60),
dans laquelle la plage d'accueil centrale (43), la première plage d'accueil (45) et la seconde plage d'accueil (47) forment une matrice d'éléments dans la carte de circuit imprimé flexible (20) de telle sorte que les électrodes inférieures (57) de la tranche piézoélectrique (50) sont reliées à la matrice d'éléments sur la plage d'accueil centrale (43), la première plage d'accueil (45) et la seconde plage d'accueil (47) de la carte de circuit imprimé flexible (20) et agencées dans celle-ci,
dans laquelle le schéma de câblage central (33) est agencé en variante d'un côté et de l'autre côté du film de base (31), et
dans laquelle les deux extrémités de la carte de circuit imprimé flexible (20) sont collées l'une à l'autre de telle sorte que les premier et second schémas de câblage (35, 37) sont reliés l'un à l'autre

2. Sonde ultrasonique selon la revendication 1, dans laquelle le bloc arrière présente des premiers trous formés dans celui-ci, lesquels correspondent aux deuxièmes trous.

3. Sonde ultrasonique selon la revendication 1, dans laquelle la couche d'adaptation acoustique présente des troisièmes trous formés dans celle-ci, lesquels correspondent aux deuxièmes trous.

4. Sonde ultrasonique selon la revendication 1, dans laquelle le bloc arrière présente des premiers trous formés dans celui-ci, lesquels correspondent aux deuxièmes trous, et la couche d'adaptation acoustique présente des troisièmes trous formés dans celle-ci, lesquels correspondent aux deuxièmes trous.

5. Sonde ultrasonique selon la revendication 1, dans laquelle la plage d'accueil centrale (43), la première et la seconde plage d'accueil (45, 47) forment une matrice d'éléments 3X96.

6. Sonde ultrasonique selon la revendication 5, dans laquelle le nombre de fentes (83) est de 95.

7. Dispositif d'imagerie par ultrasons, comprenant :

> la sonde ultrasonique (100, 200, 300, 400) selon une des revendications 1 à 6 ; et
> un corps principal (11) présentant un connecteur (15) relié à la sonde ultrasonique.

8. Dispositif d'imagerie par ultrasons selon la revendication 7, dans laquelle le connecteur (1 5) est situé sur le dessus du corps principal (11).

FIG. 1

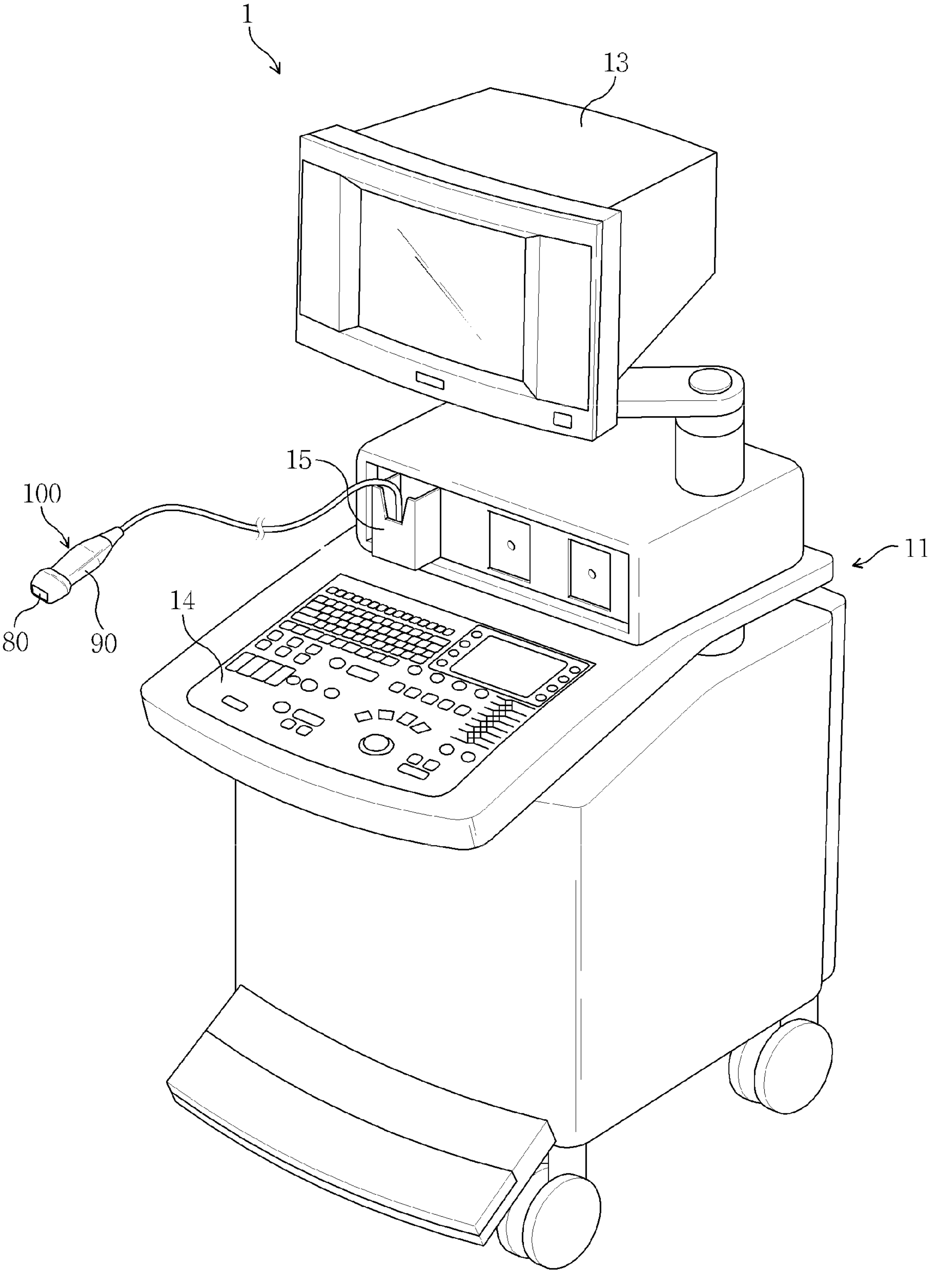

FIG. 2A

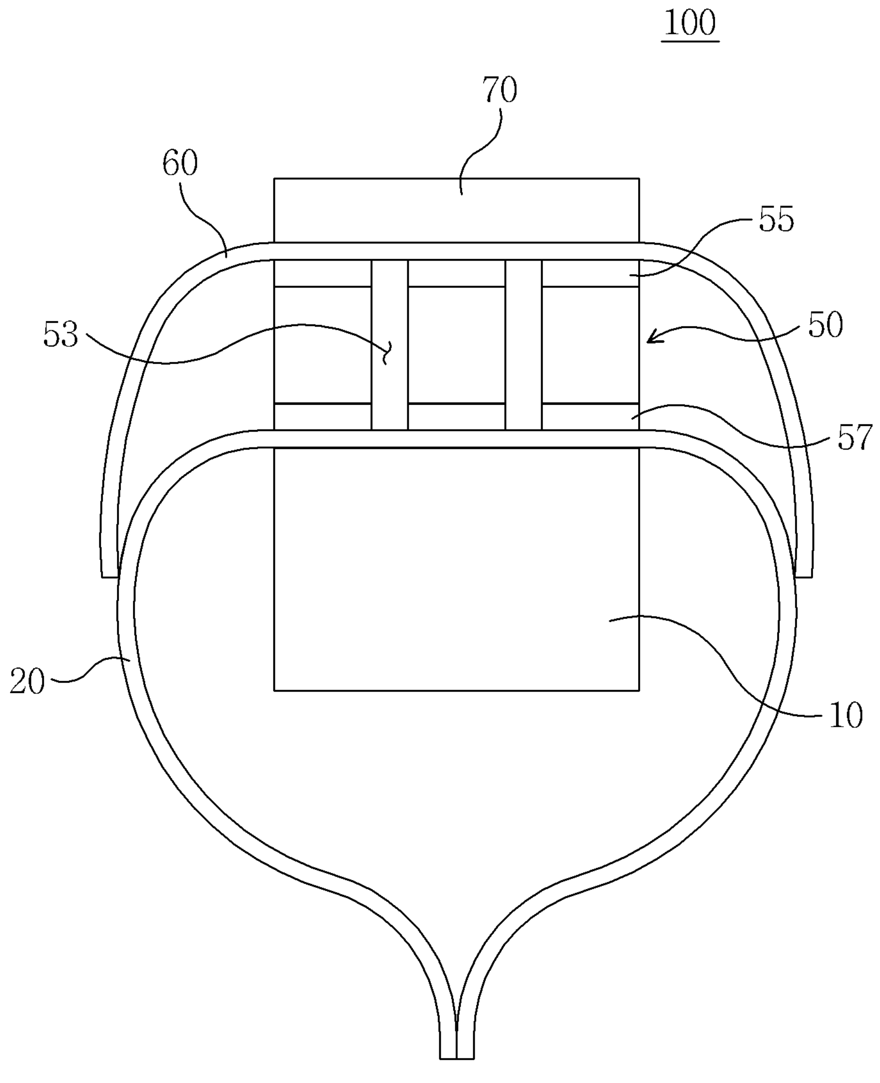

FIG. 2B

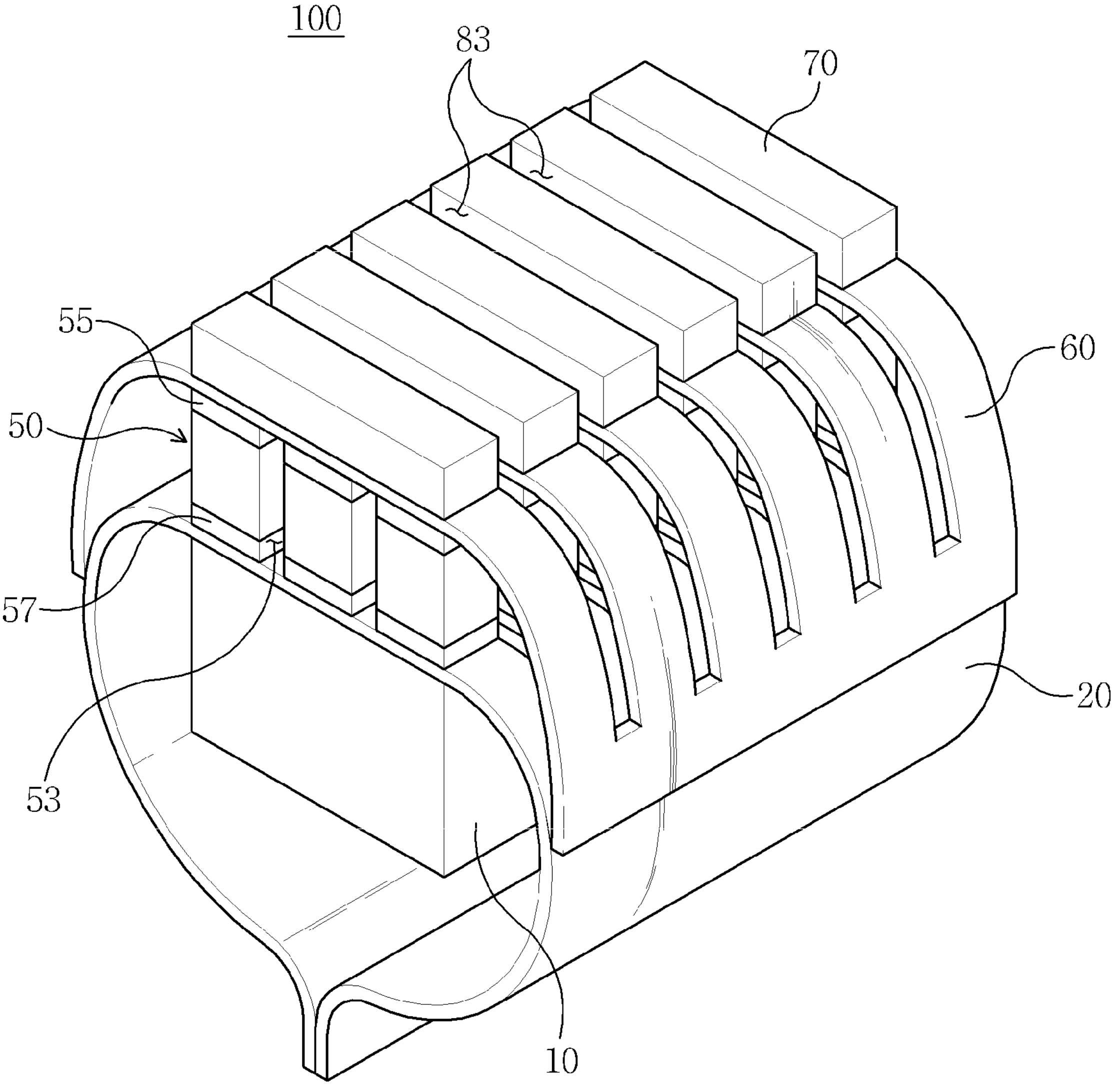

FIG.3

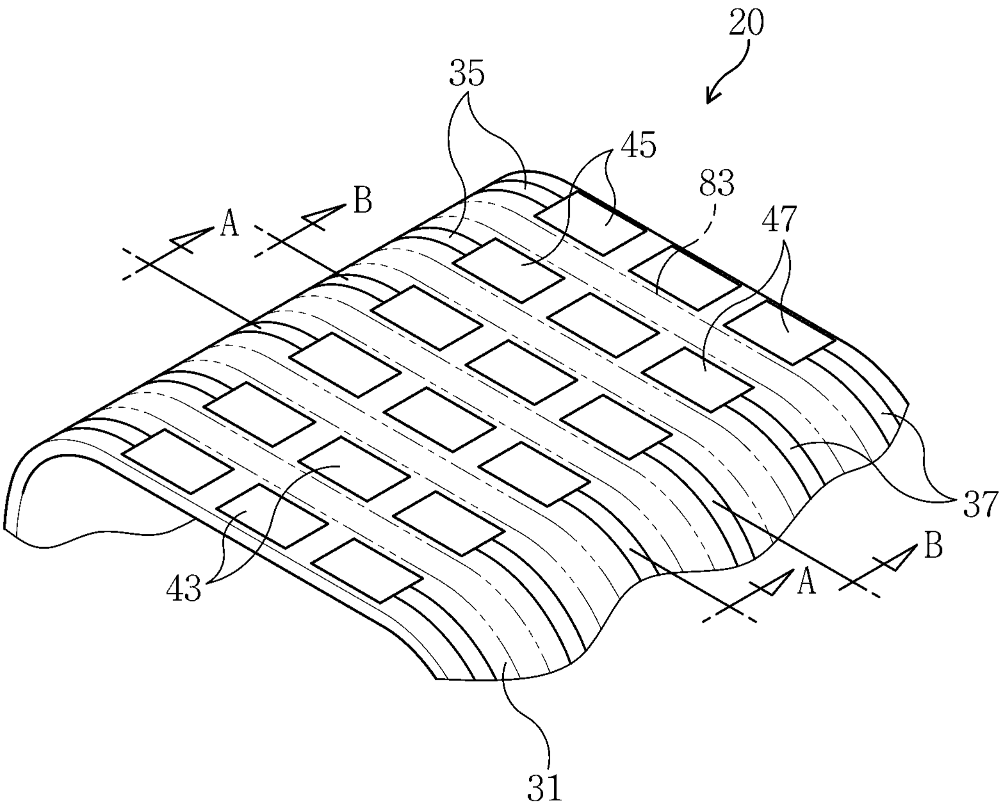

FIG.4A

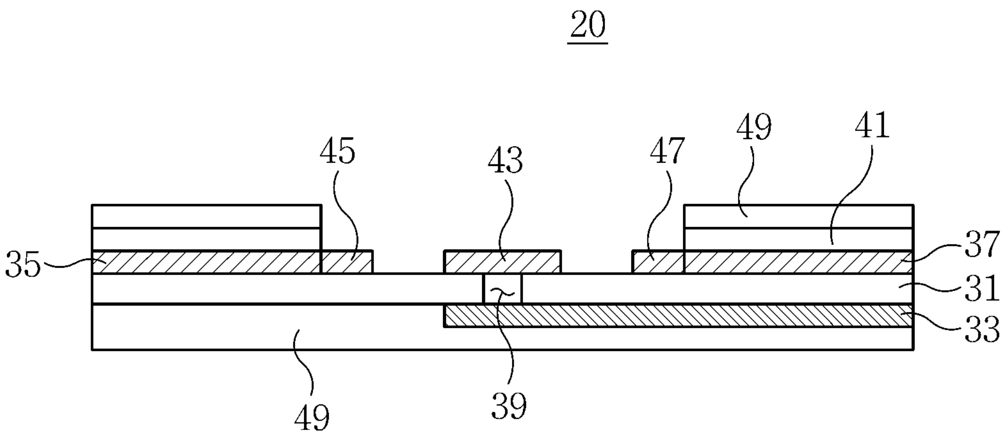

FIG.4B

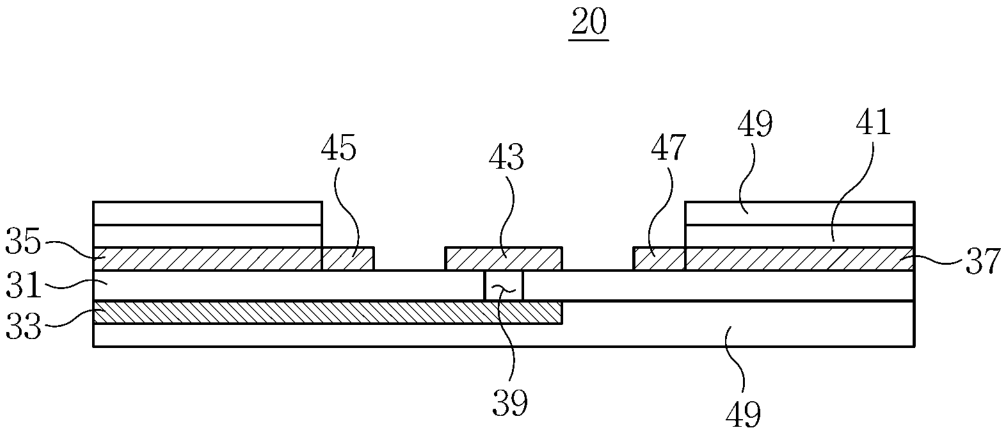
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FIG.5

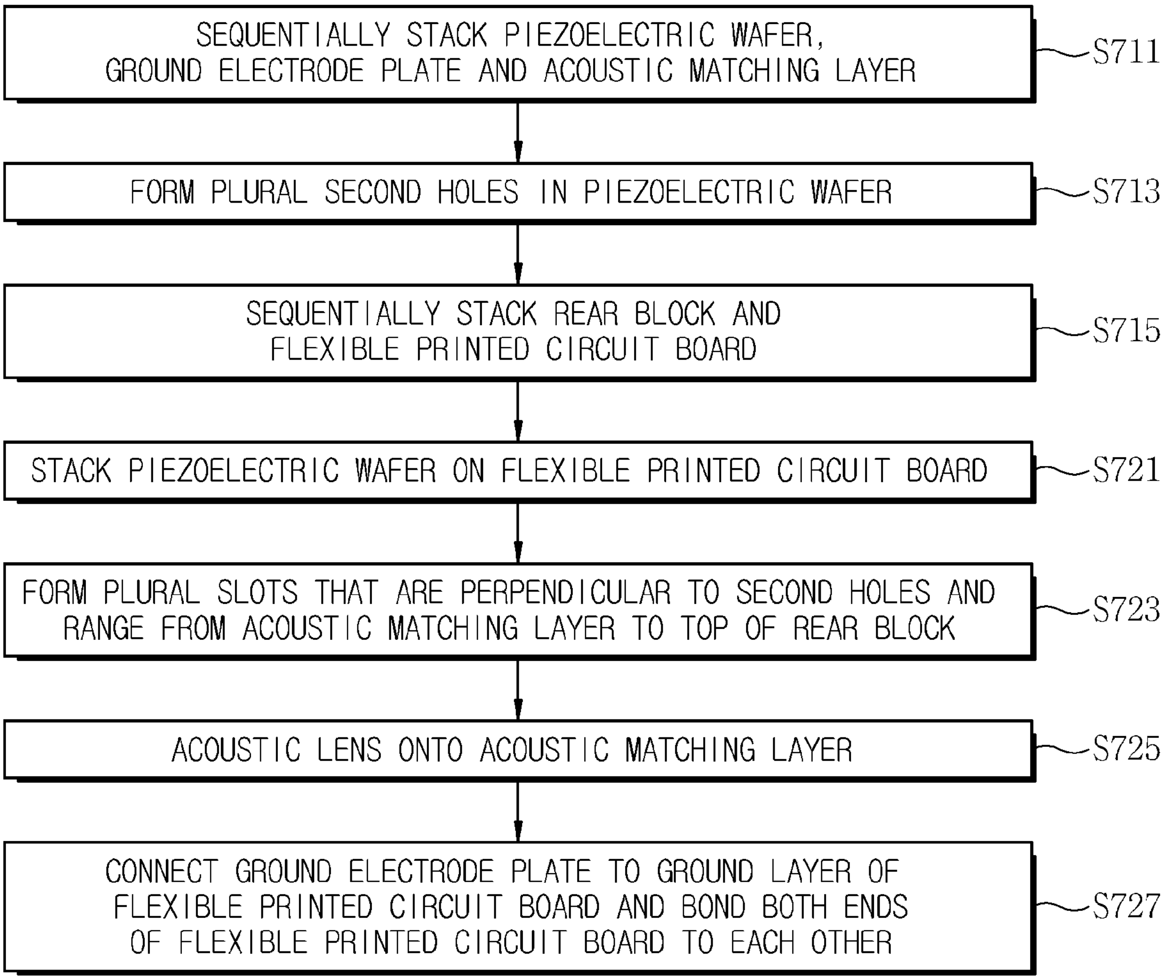

SEQUENTIALLY STACK PIEZOELECTRIC WAFER, GROUND ELECTRODE PLATE AND ACOUSTIC MATCHING LAYER
S711
FORM PLURAL SECOND HOLES IN PIEZOELECTRIC WAFER
S713
SEQUENTIALLY STACK REAR BLOCK AND FLEXIBLE PRINTED CIRCUIT BOARD
S715
STACK PIEZOELECTRIC WAFER ON FLEXIBLE PRINTED CIRCUIT BOARD
S721
FORM PLURAL SLOTS THAT ARE PERPENDICULAR TO SECOND HOLES AND RANGE FROM ACOUSTIC MATCHING LAYER TO TOP OF REAR BLOCK
S723
ACOUSTIC LENS ONTO ACOUSTIC MATCHING LAYER
S725
CONNECT GROUND ELECTRODE PLATE TO GROUND LAYER OF FLEXIBLE PRINTED CIRCUIT BOARD AND BOND BOTH ENDS OF FLEXIBLE PRINTED CIRCUIT BOARD TO EACH OTHER
S727

FIG.6

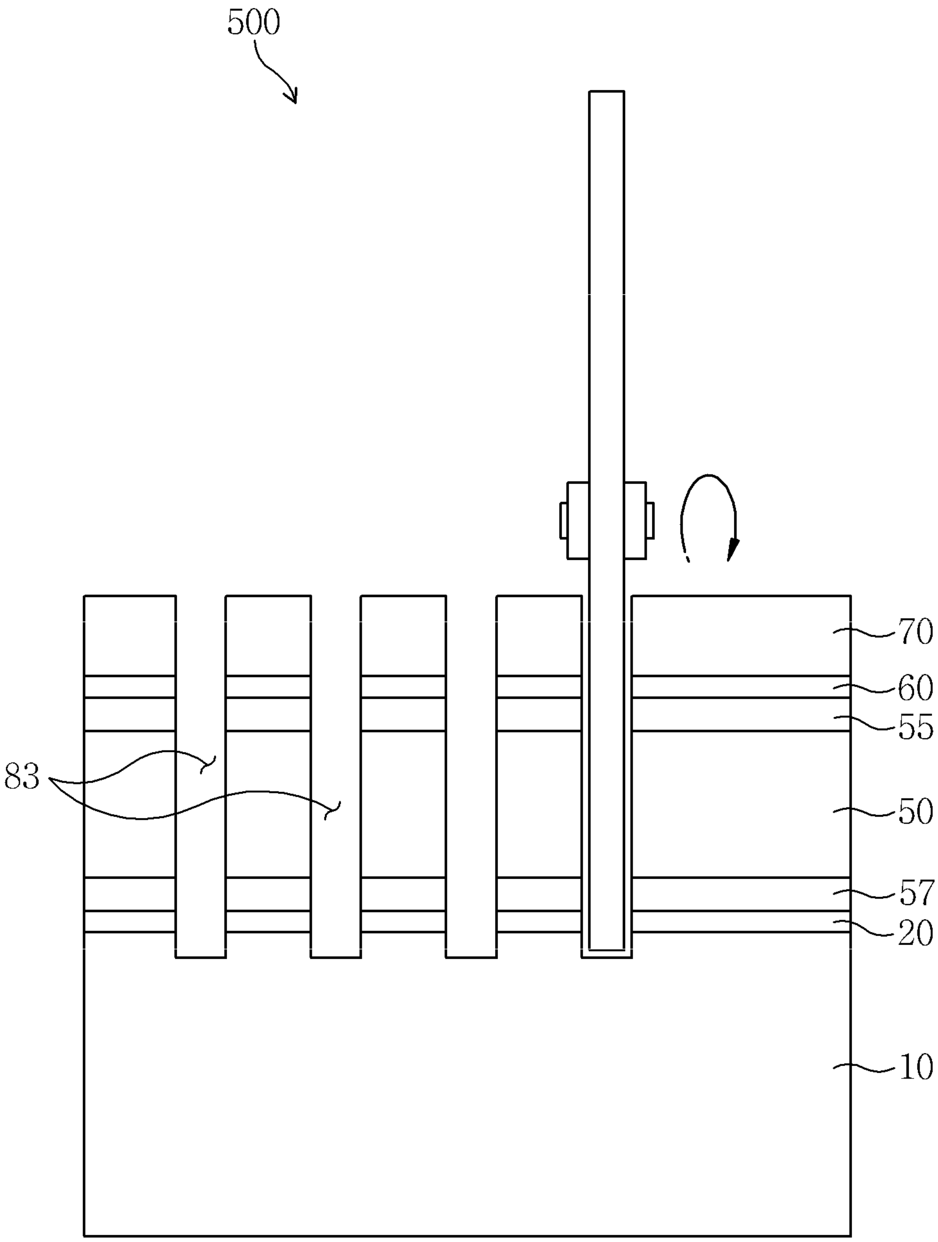


FIG.7

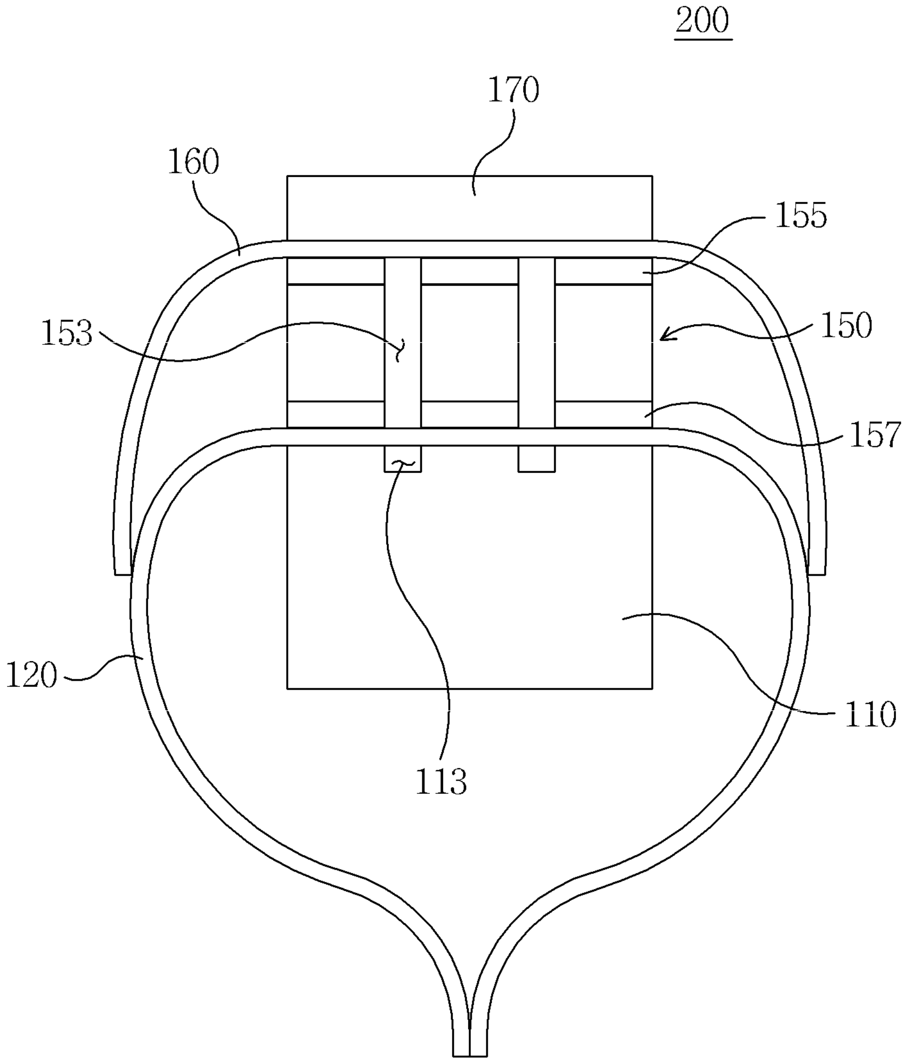


FIG.8

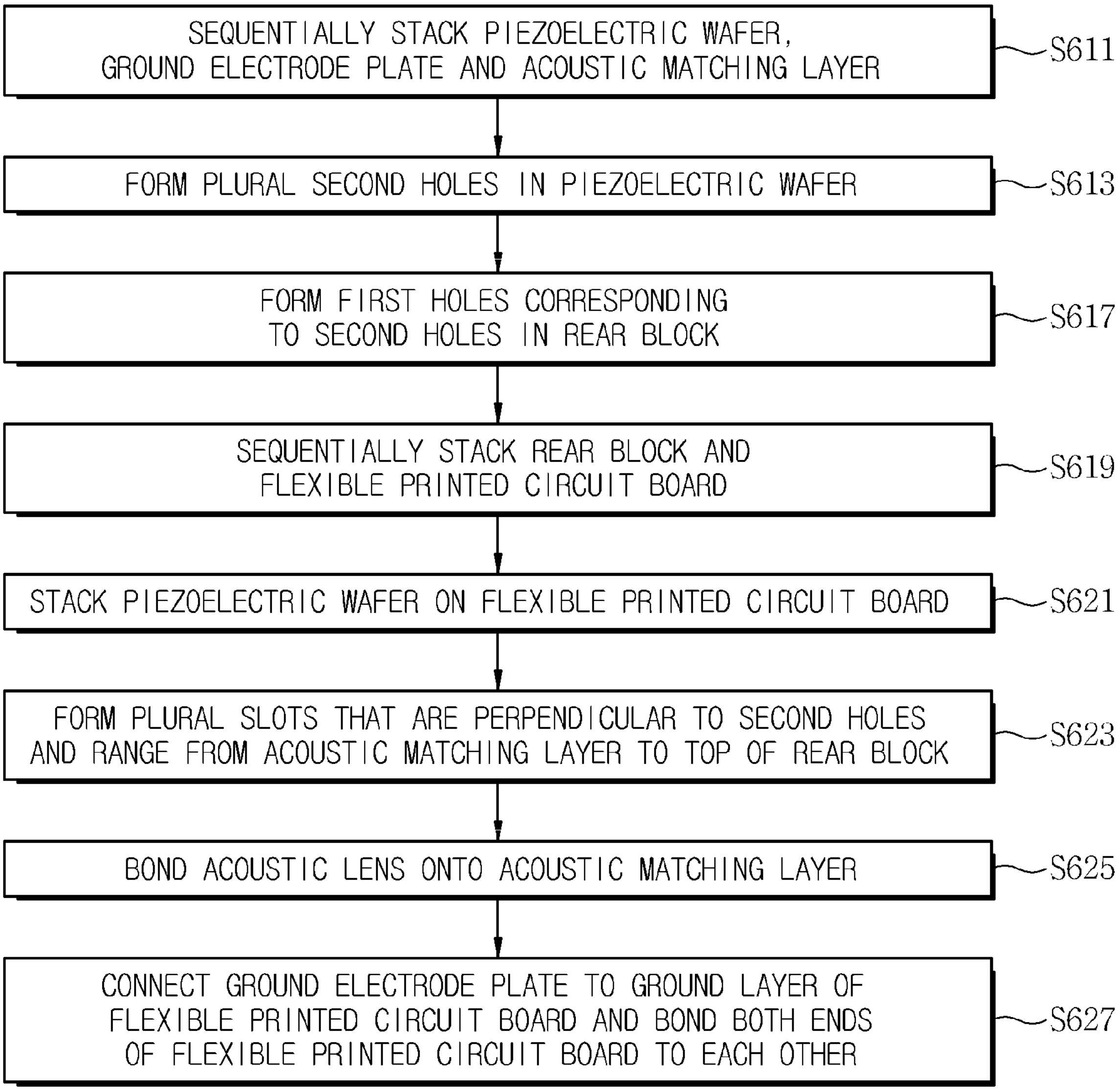

SEQUENTIALLY STACK PIEZOELECTRIC WAFER, GROUND ELECTRODE PLATE AND ACOUSTIC MATCHING LAYER
S611
FORM PLURAL SECOND HOLES IN PIEZOELECTRIC WAFER
S613
FORM FIRST HOLES CORRESPONDING TO SECOND HOLES IN REAR BLOCK
S617
SEQUENTIALLY STACK REAR BLOCK AND FLEXIBLE PRINTED CIRCUIT BOARD
S619
STACK PIEZOELECTRIC WAFER ON FLEXIBLE PRINTED CIRCUIT BOARD
S621
FORM PLURAL SLOTS THAT ARE PERPENDICULAR TO SECOND HOLES AND RANGE FROM ACOUSTIC MATCHING LAYER TO TOP OF REAR BLOCK
S623
BOND ACOUSTIC LENS ONTO ACOUSTIC MATCHING LAYER
S625
CONNECT GROUND ELECTRODE PLATE TO GROUND LAYER OF FLEXIBLE PRINTED CIRCUIT BOARD AND BOND BOTH ENDS OF FLEXIBLE PRINTED CIRCUIT BOARD TO EACH OTHER
S627

FIG.9

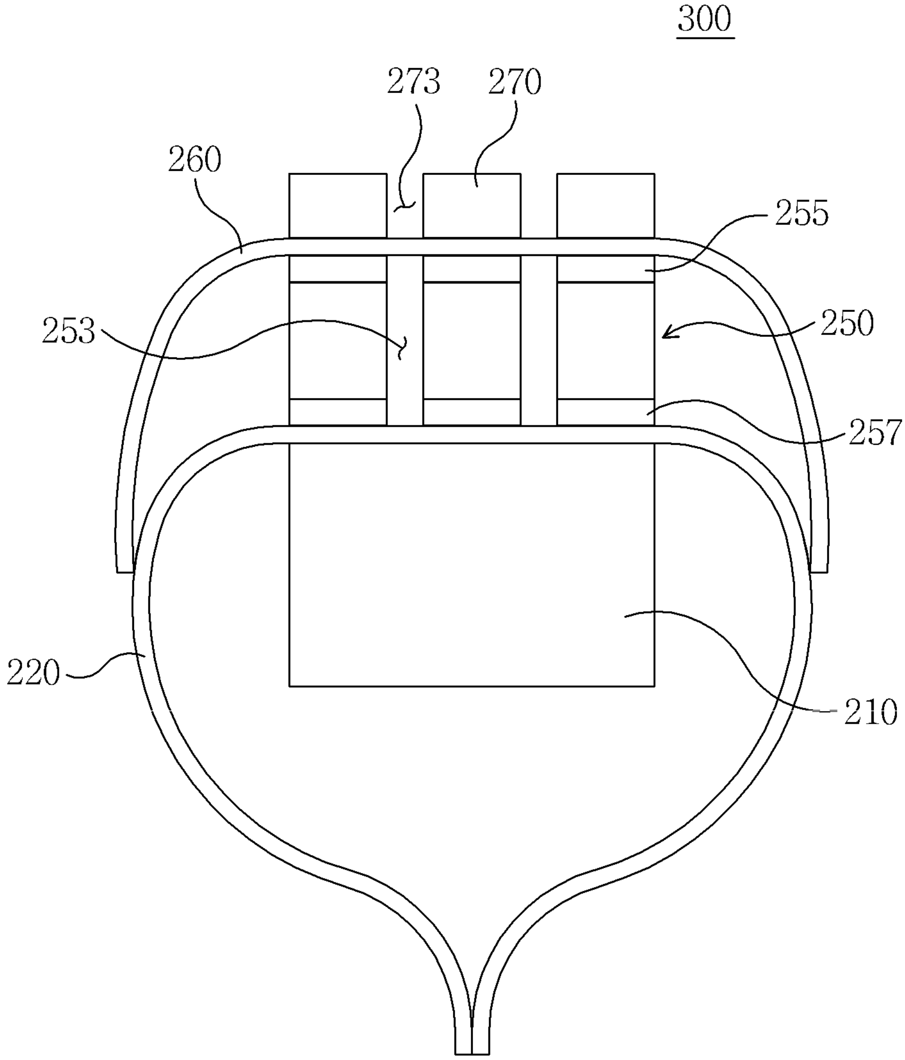


FIG.10

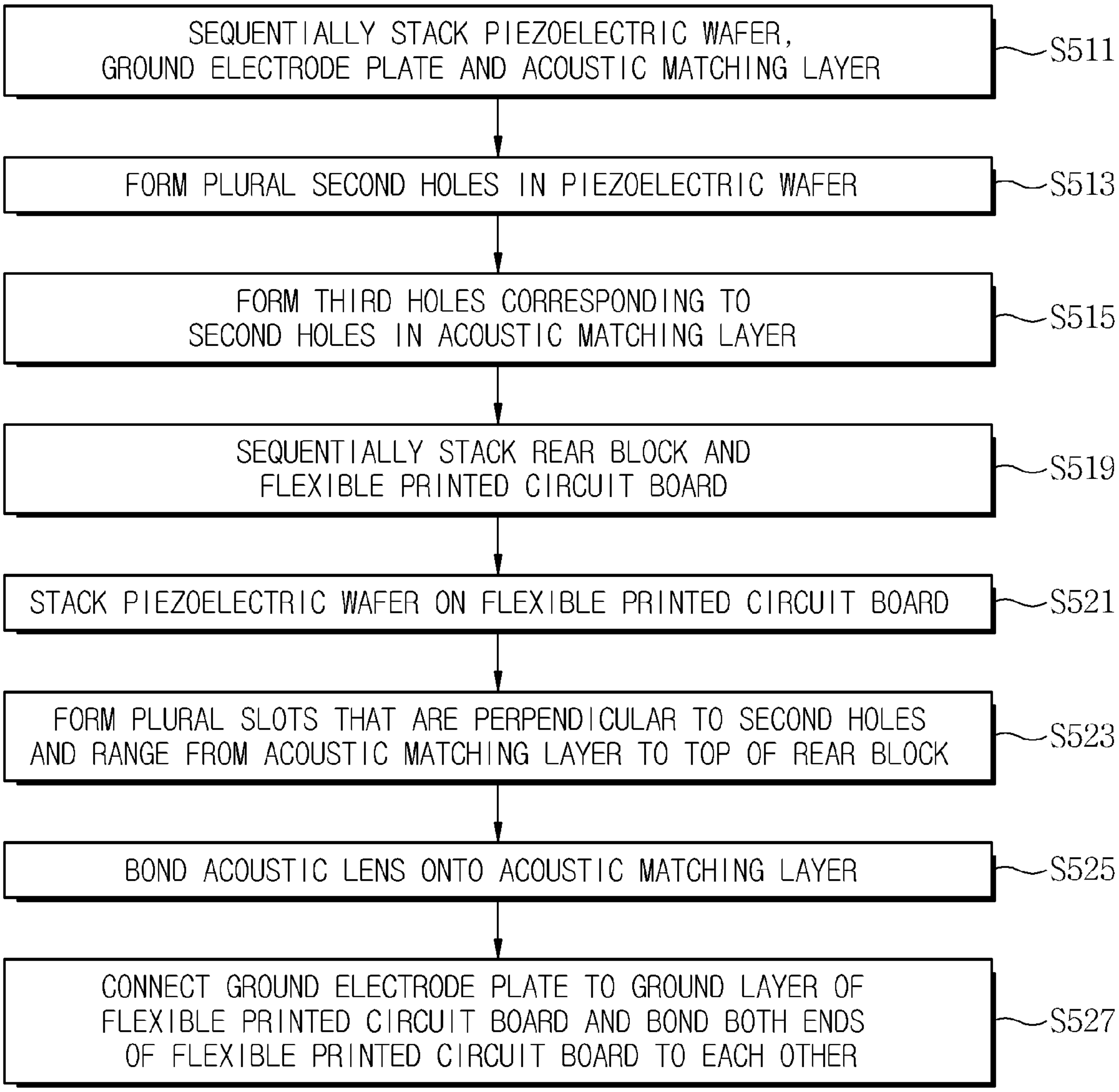

SEQUENTIALLY STACK PIEZOELECTRIC WAFER, GROUND ELECTRODE PLATE AND ACOUSTIC MATCHING LAYER
S511
FORM PLURAL SECOND HOLES IN PIEZOELECTRIC WAFER
S513
FORM THIRD HOLES CORRESPONDING TO SECOND HOLES IN ACOUSTIC MATCHING LAYER
S515
SEQUENTIALLY STACK REAR BLOCK AND FLEXIBLE PRINTED CIRCUIT BOARD
S519
STACK PIEZOELECTRIC WAFER ON FLEXIBLE PRINTED CIRCUIT BOARD
S521
FORM PLURAL SLOTS THAT ARE PERPENDICULAR TO SECOND HOLES AND RANGE FROM ACOUSTIC MATCHING LAYER TO TOP OF REAR BLOCK
S523
BOND ACOUSTIC LENS ONTO ACOUSTIC MATCHING LAYER
S525
CONNECT GROUND ELECTRODE PLATE TO GROUND LAYER OF FLEXIBLE PRINTED CIRCUIT BOARD AND BOND BOTH ENDS OF FLEXIBLE PRINTED CIRCUIT BOARD TO EACH OTHER
S527

FIG.11A

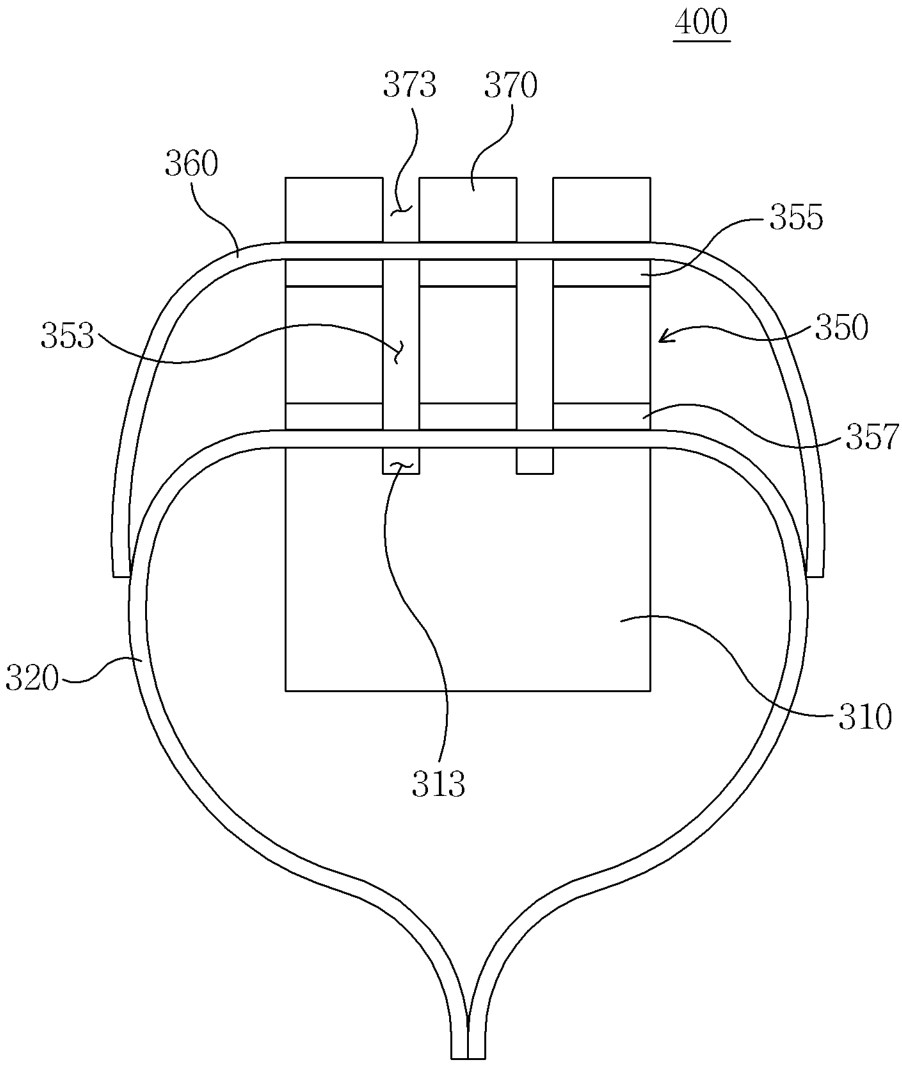


FIG.11B

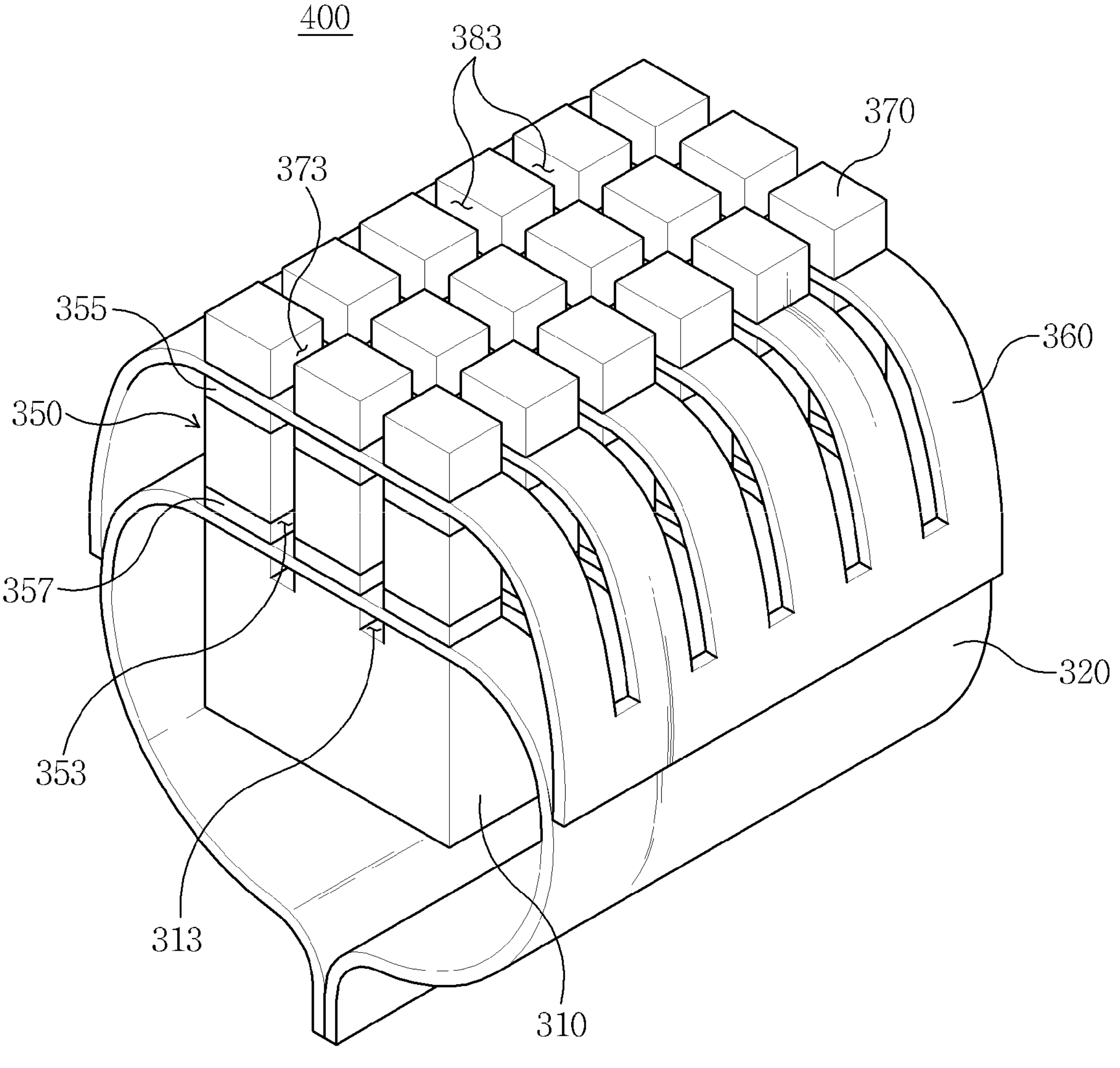
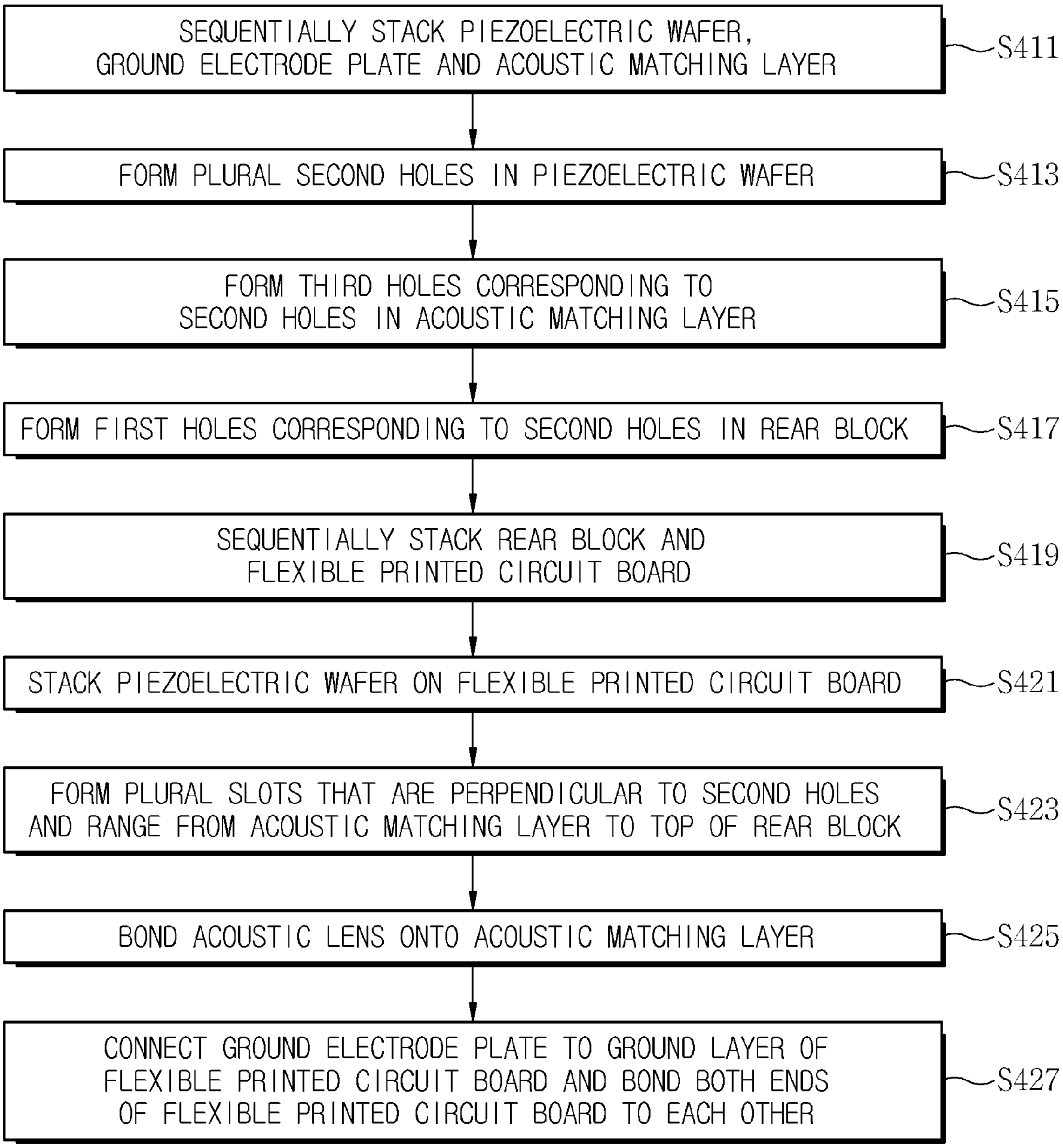


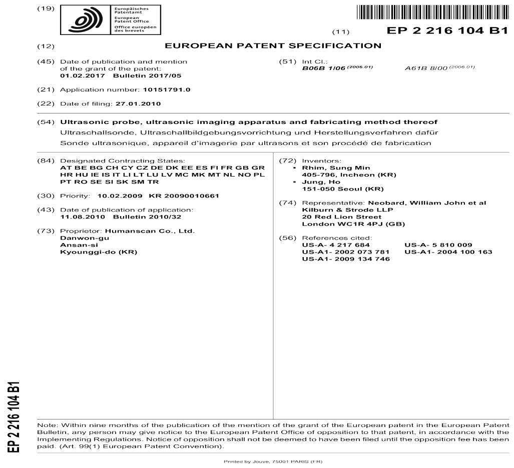
FIG.12


SEQUENTIALLY STACK PIEZOELECTRIC WAFER, GROUND ELECTRODE PLATE AND ACOUSTIC MATCHING LAYER
S411
FORM PLURAL SECOND HOLES IN PIEZOELECTRIC WAFER
S413
FORM THIRD HOLES CORRESPONDING TO SECOND HOLES IN ACOUSTIC MATCHING LAYER
S415
FORM FIRST HOLES CORRESPONDING TO SECOND HOLES IN REAR BLOCK
S417
SEQUENTIALLY STACK REAR BLOCK AND FLEXIBLE PRINTED CIRCUIT BOARD
S419
STACK PIEZOELECTRIC WAFER ON FLEXIBLE PRINTED CIRCUIT BOARD
S421
FORM PLURAL SLOTS THAT ARE PERPENDICULAR TO SECOND HOLES AND RANGE FROM ACOUSTIC MATCHING LAYER TO TOP OF REAR BLOCK
S423
BOND ACOUSTIC LENS ONTO ACOUSTIC MATCHING LAYER
S425
CONNECT GROUND ELECTRODE PLATE TO GROUND LAYER OF FLEXIBLE PRINTED CIRCUIT BOARD AND BOND BOTH ENDS OF FLEXIBLE PRINTED CIRCUIT BOARD TO EACH OTHER
S427

专利名称(译)	超声波探头，超声波成像装置及其制造方法		
公开(公告)号	EP2216104B1	公开(公告)日	2017-02-01
申请号	EP2010151791	申请日	2010-01-27
申请(专利权)人(译)	HUMANSCAN CO.，LTD.		
当前申请(专利权)人(译)	HUMANSCAN CO.，LTD.		
[标]发明人	RHIM SUNG MIN JUNG HO		
发明人	RHIM, SUNG MIN JUNG, HO		
IPC分类号	B06B1/06 A61B8/00 G01N29/24 H04R17/00		
CPC分类号	A61B8/00 A61B8/4455 A61B8/4483 B06B1/0629		
优先权	1020090010661 2009-02-10 KR		
其他公开文献	EP2216104A1		
外部链接	Espacenet		

摘要(译)

提供一种超声波探头，超声波成像设备及其制造方法。超声波探头包括具有预定厚度的后块，柔性印刷电路板堆叠在后块上以围绕后块的顶面和侧面并且具有形成在其上的布线图案，压电晶片堆叠在其上面。柔性印刷电路板，在其两侧分别形成有上下电极，在其中形成有多个第二孔，接地电极板层叠在压电晶片的顶面上，与上电极接合并连接到接地层柔性印刷电路板的一部分，一个堆叠在接地电极板顶面上的声匹配层，一个粘合在声匹配层上的声透镜，以及在垂直于第二个孔的方向上形成的多个槽声学匹配层到后块的顶部。在后块，压电晶片和声匹配层中的至少一个中形成孔，并且以矩阵阵列的形式形成布线图案，因此可以改善振动特性和聚焦以获得清晰的图像。



(19) Europäisches Patentamt European Patent Office Office européen des brevets

(11) **EP 2 216 104 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
01.02.2017 Bulletin 2017/05

(51) Int Cl.:
B06B 1/06 $^{(2006.01)}$ *A61B 8/00* $^{(2006.01)}$

(21) Application number: **10151791.0**

(22) Date of filing: **27.01.2010**

(54) **Ultrasonic probe, ultrasonic imaging apparatus and fabricating method thereof**
Ultraschallsonde, Ultraschallbildgebungsvorrichtung und Herstellungsverfahren dafür
Sonde ultrasonique, appareil d'imagerie par ultrasons et son procédé de fabrication

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **10.02.2009 KR 20090010661**

(43) Date of publication of application:
11.08.2010 Bulletin 2010/32

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US-A1- 2004 100 163
US-A1- 2009 134 746

EP 2 216 104 B1

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