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(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

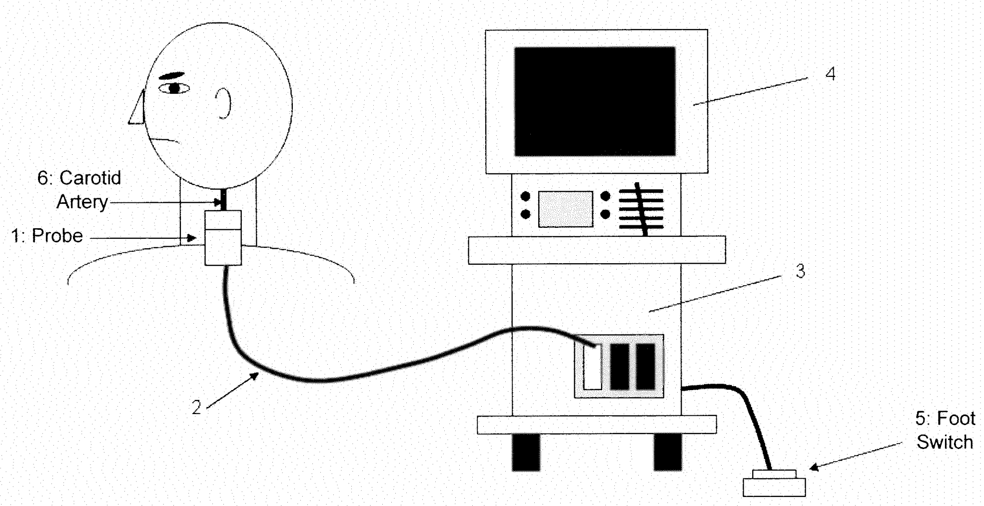
(72) Inventors:
- **MIGITA, Manabu**
  Osaka-shi, Osaka 540-6207 (JP)
- **ITOH, Yoshihiko**
  Osaka-shi, Osaka 540-6207 (JP)
- **KAWABATA, Akihiro**
  Osaka-shi, Osaka 540-6207 (JP)
- **SUGINOUCHI, Takehiko**
  Osaka-shi, Osaka 540-6207 (JP)
- **URABE, Makiko**
  Osaka-shi, Osaka 540-6207 (JP)
- **NISHIMURA, Yushi**
  Osaka-shi, Osaka 540-6207 (JP)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser
Leopoldstrasse 4
80802 München (DE)

(54) ULTRASONOGRAPH AND METHOD OF DIAGNOSIS USING SAME

(57) An ultrasonograph of the present invention comprises a probe (1), a controller (3) connected to the probe (1), and a display (4) connected to the controller (3) . The controller (4) causes the display (4) to display a detected image of a target object detected by the probe (1) and an angular position relationship image showing a relative angular position of the probe to the detected image of the target object. This enables even a non-expert to take accurate measurements.

FIG.1



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Description

Technical Field

[0001] The present invention relates to an ultrasonograph and a method of diagnosis using the same.

Background Art

[0002] Recently, an ultrasonograph has drawn attention as, for example, an instrument for determining a carotid condition, and has been know as being configured as described below.

[0003] For example, a conventional ultrasonograph comprises a probe, a controller connected to the probe, and a display connected to the controller. In the conventional ultrasonograph, a detected image of a target object (carotid artery) detected by the probe is displayed on the display (for example, see Non Patent Literature 1).

[0004] With the conventional ultrasonograph, however, it has been difficult for a person who is not a fully trained expert to take accurate measurements in determining a condition of a target object, or a carotid artery.

[0005] In this respect, when the conventional ultrasonograph is used to determine a carotid condition, the probe must be applied to a position bisecting a carotid artery longitudinally along the center line. However, different individuals have different locations and shapes of carotid arteries and the carotid arteries are not visible from the surface of the body.

[0006] Therefore, only a fully trained expert has been able to apply the probe accurately to a position bisecting a carotid artery longitudinally along the center line, and as a result, it has been difficult to take accurate measurements.

Citation list

Non Patent Literature

[0007]

Non Patent Literature 1: Journal of the American Society of Echocardiography February 2008 (p.p. 93 to 111)

Summary of Invention

Technical Problem

[0008] The present invention has been made under such circumstances. It is an object of the invention to provide an ultrasonograph and a method of diagnosis that enable even a non-expert to easily position a probe on the center line of a carotid artery so as to take accurate measurements.

Solution to Problem

[0009] One aspect of the invention is an ultrasonograph. The ultrasonograph comprises a controller to which a probe and a display are connected, wherein the controller causes the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the detected image of the target object.

[0010] As described below, the present invention has other aspects. Therefore, the disclosure of the invention is intended to provide some of the aspects of the invention, and is not intended to limit the scope of the invention as described and claimed herein.

Brief Description of Drawings

[0011]

[Figure 1] Figure 1 is a diagram for illustrating an ultrasonograph of Embodiment 1 according to the present invention.

[Figure 2] Figure 2 is a perspective view showing a probe of the ultrasonograph of Embodiment 1 according to the present invention.

[Figure 3] Figure 3 is a control block diagram of the ultrasonograph of Embodiment 1 according to the present invention.

[Figure 4] Figures 4 are diagrams of cross sections of a carotid artery for illustrating an operation of the ultrasonograph: Figure 4(a) is a diagram for illustrating a target object (region A) of the carotid artery; Figure 4(b) is a cross-sectional view taken at a plane perpendicular to the center line of the carotid artery and is for illustrating the membrane arrangement; Figure 4(c) is a cross-sectional view taken at a plane perpendicular to the center line of the carotid artery and is for illustrating a plaque; Figure 4(d) is a cross-sectional view taken at a plane including the center axis of the carotid artery and shows no particular condition;

Figure 4(e) is a cross-sectional view taken at a plane including the center axis of the carotid artery and shows a condition where careful watching is needed; and Figure 4(f) is a cross-sectional view taken at a plane including the center axis of the carotid artery and shows a diseased condition.

[Figure 5] Figures 5 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 5(a) shows the short axis scan state where the probe is perpendicular to the carotid artery; Figure 5(b) shows the probe in rotation; and Figure 5(c) shows the long axis scan state.

[Figure 6] Figures 6 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure

6(a) is a schematic diagram of a carotid artery; and Figure 6(b) is a schematic diagram of the probe.

[Figure 7] Figures 7 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 7(a) is a diagram in which the center in the lengthwise direction is aligned with the carotid artery; Figure 7 (b) is a diagram for illustrating an image from a transducer array 8; Figure 7(c) is a diagram for illustrating an image from a transducer array 9; Figure 7(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 7(e) is a diagram for illustrating an angular position relationship display image.

[Figure 8] Figures 8 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 8(a) is a diagram of a state where the center in the lengthwise direction is displaced to the side of a probe origin 1a; Figure 8(b) is a diagram for illustrating an image from a transducer array 8; Figure 8(c) is a diagram for illustrating an image from a transducer array 9;

Figure 8(d) is a diagram for illustrating an image from a transducer array 10; and Figure 8(e) is a diagram for illustrating an angular position relationship display image.

[Figure 9] Figures 9 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 9(a) is a diagram of a state where the center in the lengthwise direction is displaced to the opposite side of the probe origin 1a; Figure 9(b) is a diagram for illustrating an image from a transducer array 8; Figure 9(c) is a diagram for illustrating an image from a transducer array 9; Figure 9(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 9(e) is a diagram for illustrating an angular position relationship display image.

[Figure 10] Figures 10 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 10(a) is a diagram for illustrating a positional relationship between a carotid artery 6 and transducer arrays in the course of rotation; Figure 10(b) is a diagram for illustrating an image from a transducer array 8; Figure 10(c) is a diagram for illustrating an image from a transducer array 9; Figure 10(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 10(e) is a diagram for illustrating an angular position relationship image.

[Figure 11] Figures 11 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 11(a) is a diagram for illustrating a positional relationship between a carotid artery 6 and transducer arrays immediately before the end of rotation; Figure 11(b) is a diagram for illustrating an image from a transducer array 8; Figure 11(c) is a diagram for illustrating an image from a transducer array 9; Figure 11(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 11(e) is a diagram for illustrating an angular position relationship image.

[Figure 12] Figures 12 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 12(a) is a diagram for illustrating a positional relationship when the carotid artery 6 and the long axis of the transducer array 9 are aligned; Figure 12(b) is a diagram for illustrating an image from a transducer array 8;

Figure 12(c) is a diagram for illustrating an image from a transducer array 9; Figure 12(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 12(e) is a diagram for illustrating an angular position relationship image.

[Figure 13] Figures 13 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 13(a) is a diagram for illustrating a positional relationship when the probe is over-rotated; Figure 13 (b) is a diagram for illustrating an image from a transducer array 8;

Figure 13(c) is a diagram for illustrating an image from a transducer array 9; Figure 13(d) is a diagram for illustrating an image from a transducer array 10; and

Figure 13(e) is a diagram for illustrating an angular position relationship image.

[Figure 14] Figures 14 are diagrams for illustrating a rotating operation of the probe from the short axis scan to the long axis scan of the carotid artery: Figure 14(a) is a diagram for illustrating a positional relationship when the carotid artery 6 and the long axis of the transducer array 9 are in parallel but displaced sideways; Figure 14(b) is a diagram for illustrating an image from a transducer array 8; Figure 14(c) is a diagram for illustrating an image from a transducer array 9; Figure 14(d) is a diagram for illustrating an image from a transducer array 10; and Figure 14(e) is a diagram for illustrating an angular position relationship image.

[Figure 15] Figure 15 is a block diagram of Embodiment 2 according to the present invention.

[Figure 16] Figure 16 is a block diagram of Embodiment 3 according to the present invention.

Description of Embodiments

[0012] The present invention will now be described in detail. However, the detailed description below and attached drawings are not intended to limit the present invention.

[0013] The present invention attains main objects with an arrangement comprising a controller to which a probe and a display are connected, wherein the controller causes the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the detected image of the target object.

[0014] As described above, the present invention provides an arrangement comprising a controller to which a probe and a display are connected, wherein the controller causes the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the detected image of the target object. Therefore, even a non-expert can take accurate measurements.

[0015] According to the present invention, the controller can cause the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the target object. Therefore, the probe can be placed correctly with respect to the target object while the operator is viewing the images displayed on the display, and as a result, even a non-expert can take accurate measurements.

[0016] Embodiments of the present invention will now be described below with reference to appended drawings.

(Embodiment 1)

[0017] Figure 1 is a diagram for illustrating an ultrasonograph of Embodiment 1 according to the present invention. The ultrasonograph of the embodiment comprises a probe 1, a controller 3 with the probe 1 connected thereto by a cable 2, a display 4 connected to the controller 3, and a foot switch 5.

[0018] The controller 3 is configured to cause the display 4 to display a detected image of a carotid artery 6 (an exemplary target object of a subject) detected by the probe 1 and an angular position relationship image showing a relative angular position of the probe 1 to the carotid artery 6.

[0019] The probe 1 is composed of a number of (for example, three) transducer arrays 8 to 10 arranged in parallel to each other on the front side (or the side of a contact section with the subject) of a body casing 7, as shown in Figure 2.

[0020] The probe 1 is also provided with a grip section 7a of a smaller diameter on an area of the cable 2 side of the body casing 7. The probe 1 is also provided with a contact section 7b that is oblong and has a larger diameter on an area opposite from the cable 2.

[0021] As shown in Figure 2, a number of transducer arrays 8 to 10 extend in the lengthwise direction of the front surface (contact surface) of the contact section 7b. These extending transducer arrays 8 to 10 are spaced in parallel to each other.

[0022] Each of these transducer arrays 8 to 10 is composed of a number of ultrasonic transducers 11 arranged in line. As is well known, each of these transducer arrays 8 to 10 is arranged to obtain a wide detected image by sequentially switching a number of ultrasonic transducers 11 to change focus positions while the transducers are being driven.

[0023] Further, the transducer arrays 8 to 10 thus arranged in parallel to each other can provide a detected image of a strip-shaped area having a width.

[0024] As shown in Figure 2, the probe 1 is also provided with a probe origin marker 12 on the top of the contact section 7b of the body casing 7 on one end side of the transducer arrays 8 to 10. As described below, the operator refers to the position of the probe origin marker 12 to adjust the position the probe 1.

[0025] Figure 3 is an electrical block diagram of the ultrasonograph. As shown in Figure 3, a transducer group selecting unit 13 is connected to the transducer arrays 8 to 10 of the probe 1.

[0026] An electrical signal sent from an ultrasonic wave transmitting/receiving unit 14 of the controller 3 causes the transducer group selecting unit 13 to sequentially switch a number of ultrasonic transducers 11 to drive the transducers on each transducer array 8 to 10 basis.

[0027] With the electrical signal is applied, the ultrasonic transducers 11 of the transducer arrays 8 to 10 radiate ultrasonic waves toward the carotid artery 6 portion. Reflected waves from the carotid artery 6 portion are received by the ultrasonic transducers 11 that have previously radiated ultrasonic waves and converted to an electrical signal by the ultrasonic transducers 11.

[0028] The converted electrical signal is then sent to the ultrasonic wave transmitting/receiving unit 14 through the transducer group selecting unit 13. The sequence of control is performed in a transmission/reception controlling unit 15. The signal sent to the ultrasonic wave transmitting/receiving unit 14 is then processed in a signal processing unit 16. Thereafter, an image signal is generated in an image creating unit 17.

[0029] The image signal generated in the image creating unit 17 is then processed in an image analyzing unit 18, an item position analyzing unit 19, and a probe guiding image creating unit 20, in this order, and is sent to a display synthesizer unit 21.

[0030] The display synthesizer unit 21 has been supplied with an image signal generated in the image creating unit 17. Therefore, a probe guiding image generated in the probe guiding image creating unit 20 is superimposed on the image signal generated in the image creating unit 17, as described below.

[0031] The display synthesizer unit 21 is also adapted to be supplied with data calculated in an IMT CALCULATING unit 22. Therefore, the data is also superimposed on the image signal generated in the image creating unit 17 as visual information.

[0032] Figure 4(a) is a diagram showing a carotid artery 6 (target object (region A)) portion of a human body (subject) 23. After images in Figures 6 to 13, which will be described below, are displayed, any image in Figures 4(d) to 4(f) is displayed on the display 4. Figures 4(d) to 4(f) show detected images of the carotid artery 6 bisected longitudinally at a plane including the center line of the carotid artery. Figure 4(d) is an image showing no particular condition, Figure 4(e) is an image showing a condition where careful watching is needed, and Figure 4(f) is an image showing a diseased condition.

[0033] These conditions will be described with reference to Figure 4(b). As shown in Figure 4(b), the carotid artery 6 is composed of an endothelial cell 6a, a tunica intima 6b, a tunica media 6c, and a tunica adventitia 6d, from the inside to the outside.

[0034] In the case of Figure 4(b), since neither endothelial cell 6a, tunica intima 6b, nor tunica media 6c is raised toward a blood flowing area 6e, a large opening area of the blood flowing area 6e is observed. Therefore, the condition of Figure 4(b) is normal, showing no particular condition. On the other hand, in the case of Figure 4(c), since the endothelial cell 6a, the tunica intima 6b, and the tunica media 6c are raised toward a blood flowing area 6e due to plaque development (region B), the opening area of the blood flowing area 6e is reduced. Therefore, Figure 4(c) shows a diseased condition.

[0035] Figure 4(d) is an image showing no particular condition. In Figure 4(d), as an example, data calculated in the IMT CALCULATING unit 22 in Figure 3 is displayed as 0.6 mm. Similarly, it is displayed as 1.3 mm in Figure 4(e). In Figure 4(f), the displayed image shows a much higher level due to plaque development.

[0036] Both of the value 0.6 mm in Figure 4(d) and the value 1.3 mm in Figure 4(e) are referred to as an IMT value (a value of combined thickness of the endothelial cell 6a and the tunica media 6c). Since the case where the IMT value is at or above 1.1 mm is defined as a diseased condition according to the criteria of The Japan Academy of Neurosonology, it is determined that Figure 4(d) shows no particular condition, Figure 4(e) shows a condition where careful watching is needed, and Figure 4(f) shows a diseased condition, as described above.

[0037] The facts shown in Figures 4 are well known and further description will be omitted. In order to acquired such detected images as shown in Figures 4(d) to 4(f) with the conventional art, however, a fully trained expert must operate the probe 1.

[0038] In contrast, according to the ultrasonograph of the embodiment, even a non-expert can merely operate the probe as shown in Figures 5(a) to 5(c) to easily acquire detected images as shown in Figures 4(d) to 4(f). In the operation in Figure 5(a), the operator first presses the probe 1 against a neck 23 with the lengthwise direction of the transducer arrays 8 to 10 of the probe 1 (see Figure 2) being substantially perpendicular to the neck 23 (carotid artery 6). Essentially, the probe 1 is in the short axis scan state relative to the carotid artery 6.

[0039] At this time, the operator determines where the carotid artery 6 runs on the probe 1. From this state, as in the operation in Figure 5(b), the operator slowly rotates the probe 1 in a plane substantially in parallel to the contact surface into an upright position such that the lengthwise direction is along the center line of the carotid artery.

[0040] In the operation in Figure 5(c), the lengthwise direction of the carotid artery 6 is aligned with the lengthwise direction of the transducer arrays 8 to 10; the probe 1 is essentially rotated from the short axis scan state to the long axis scan state relative to the carotid artery 6. In this way, detected images of the longitudinally bisected carotid artery 6 as shown in Figures 4(d) to 4(f) can be acquired.

[0041] At this time, the display 4 displays angular position relationship images of the probe 1 generated in the probe guiding image creating unit 20, so that even a non-expert can align the probe 1 with appropriate positions of the carotid artery 6 based on the display.

[0042] The sequence of operation will now be described with reference to Figures 6 to 14. Figure 6(a) is a schematic view of the carotid artery 6. Figure 6(a) shows a tunica adventitia 6d, the center axis 6f of the carotid artery 6, and detectable limits indicative of a detection range 6g on both sides of the center axis 6f.

[0043] Figure 6(b) is a schematic view of the probe 1. As shown in Figure 6(b), a probe origin 1a is located on one end side of the transducer arrays 8 to 10. The probe origin 1a is located on the same side as the probe origin marker 12 on the body casing 7 of the probe 1 (see Figure 2).

[0044] Figures 7 to 9 show display contents in association with the operation in Figure 5 (a) . Specifically, Figures 7 to 9 show display contents for the display 4 when the probe 1 is pressed against the neck 23 with the lengthwise direction of the transducer arrays 8 to 10 of the probe 1 (see Figure 2) being substantially perpendicular to the carotid artery 6.

[0045] Figure 7(a) is a diagram of a state where the lengthwise direction of the transducer arrays 8 to 10 is substantially perpendicular in the center to the carotid artery 6 as in the operation in Figure 5(b), and in any of the images from the transducer arrays 8 to 10 shown in Figures 7(b) to 7(d), horizontal sections of the carotid artery 6 that can be seen therein are located on the center line 4a.

[0046] Further, at this time, an angular position relationship image shown in Figures 7(e) also shows a state where a probe symbol 1b is perpendicular to a carotid center line symbol 1c and a middle point 1d of the probe symbol 1b is on the carotid center line symbol 1c.

[0047] The display 4 is now displaying the images in Figures 7(c) and 7(e). Specifically, the display 4 displays a large version of the image in Figure 7(c) and a smaller angular position relationship image shown in Figure 7(e) is displayed within a part of the image.

[0048] The image in Figures 7(e) is generated based on the images in Figures 7(b) to 7(d). Specifically, the images in Figures 7(b) and 7(d), as well as the image in Figure 7(c), are analyzed in the image analyzing unit 18 and the item position analyzing unit 19 to determine what state the transducer arrays 8 to 10 of the probe 1 are placed in with respect to the carotid artery 6 based on positions, sizes, shapes, and the like of the three images, and the probe guiding image creating unit 20 generates an angular position relationship image as shown in Figure 7(e). The angular position relationship image thus generated is displayed on the display 4.

[0049] The angular position relationship image shown in Figure 7(e) constitutes a guiding screen (operation navigating information screen) for the probe 1. Watching the image in Figure 7(e), the operator then rotate and move the probe 1.

[0050] For example, when the display in the display 4 is in the state shown in Figure 7(e), the lengthwise direction of the transducer arrays 8 to 10 (the position indicated by the center line symbol 1c, which will be represented by 1c hereinafter) is perpendicular in the center to the carotid artery 6. At this time, in any of the images from the transducer arrays 8 to 10 shown in Figures 7(b) to 7 (d), horizontal sections of the carotid artery 6 that can be seen therein are located on the center line 4a, as described above, and position adjustment for aligning the center of the transducer arrays 8 to 10 with the carotid artery 6 is completed.

[0051] In contrast, Figures 8 show a state where the lengthwise direction of the probe 1 (or transducer arrays 8 to 10) is still perpendicular to the carotid artery 6, while the center 1c in the lengthwise direction of the probe 1 (or transducer arrays 8 to 10) is displaced to the side of a probe origin 1a (or the side of the probe origin marker 12 on the body casing 7) in the lengthwise direction of the probe 1 (or transducer arrays 8 to 10).

[0052] Further, Figures 9 show a state where the lengthwise direction of the probe 1 is still perpendicular to the carotid artery 6, while the center in the lengthwise direction of the probe 1 (or transducer arrays 8 to 10) is displaced to the opposite side of a probe origin 1a (or the probe origin marker 12 on the body casing 7) of the probe 1. During operation in Figures 7 to 9, the images in Figures 7(c), 7(e), 8(c), 8(e), 9(c) and 9(e) are displayed on the display 4 as probe guiding images.

[0053] For example, when the images in Figures 8 are displayed, the operator moves the probe 1 horizontally along the neck 23 so as to place the middle point 1d of the probe symbol 1b on the carotid center line symbol 1c, based on the positional relationship between the middle point 1d of the probe symbol 1b in Figure 8(e) and the probe origin 1a (or the probe origin marker 12 on the body casing 7) .

[0054] For example, when the images in Figures 9 are displayed, the operator moves (in the direction opposite from that in Figures 8) the probe 1 horizontally along the neck 23 so as to place the middle point 1d of the probe symbol 1b on the carotid center line symbol 1c, based on the positional relationship between the middle point 1d of the probe symbol 1b in Figure 9(e) and the probe origin 1a (or the probe origin marker 12 on the body casing 7).

[0055] After the operator has made correction from the state shown in Figures 8 or 9 to the state shown in Figures 7, the operator rotates the probe 1 in a direction so as to align with the longitudinal direction of the carotid artery 6, as shown in Figure 5(b).

[0056] As shown in Figure 5(b), at a point where the probe is in rotation from the state shown in Figure 5(a) to the state shown in Figure 5(c), detected images of the carotid artery 6 are elliptical. In this case, only the image in Figures 10(c) is displayed on the display 4 among the images in Figures 10(b) and 10(d).

[0057] Further in this case, the operation navigating information screen (angular position relationship image) shows a state where the probe symbol 1b is oblique with respect to the carotid center line symbol 1c, as shown in Figure 10(e). At this time, the image in Figure 10(e) is also generated based on the images in Figures 10(b) to 10(d). Specifically, the three images in Figures 10(b) to 10(d) are analyzed in the image analyzing unit 18 and the item position analyzing unit 19 to determine what state the transducer arrays 8 to 10 of the probe 1 are placed in with respect to the carotid artery 6 based on positions, sizes, shapes, and the like of the three images, and the probe guiding image creating unit 20 generates an angular position relationship image as shown in Figure 10(e). The angular position relationship image thus generated is displayed on the display 4.

[0058] In this case, as shown in Figure 10(e), while the middle point 1d of the probe symbol 1b intersects the carotid center line symbol 1c, the operator moves the probe 1 vertically along the neck 23 because the probe symbol 1b is largely oblique with respect to the carotid center line symbol 1c.

[0059] The angular position relationship image shown in Figure 10(e) therefore constitutes a guiding screen for the probe 1. Watching the image in Figure 10(e), the operator then rotates the probe 1. During the rotation, however, the middle point 1d of the probe symbol 1b still intersects the carotid center line symbol 1c.

[0060] During the rotation of the probe 1, if the middle point 1d of the probe symbol 1b is displaced and it no longer intersects the carotid center line symbol 1c, the operator first repositions the middle point 1d of the probe symbol 1b to intersect the carotid center line symbol 1c as a corrective operation.

[0061] During the corrective operation, the position of the probe origin 1a (or the probe origin marker 12 on the body casing 7) in the image on the display 4 may also be viewed for reference, which can be relied upon to restore the middle point 1d of the probe symbol 1b into the state where it intersects the carotid center line symbol 1c. The operator then rotates the probe 1 again from the state shown in Figure 5(b) to the state shown in Figure 5 (c) .

[0062] Figures 11 show immediately before the final state during the rotation from the state shown in Figure 5(b) to the state shown in Figure 5(c). In this state, as shown in Figure 11(a), the probe symbol 1b is closer to a horizontal state than the state shown in Figure 10(e).

[0063] While the strip-shaped carotid artery 6 is emerging in Figure 11(c), there are an unclear portion 4b and a clear portion 4c that is somewhat clearer than the unclear portion 4b in Figures 11(b) to 11(d). Therefore, an angular position relationship image in Figures 11(e) is generated based on information of the unclear portions 4b in Figures 11(b) to 11(d).

[0064] Figures 12 show a state where the probe 1 is adjusted to a position bisecting a carotid artery 6 longitudinally along the center axis. In this case, as shown in Figure 12(a), the probe symbol 1b coincides with the carotid center line symbol 1c. An angular position relationship image in Figure 12(e) is generated based on clear appearance of the strip-shaped carotid artery 6 and the absence of any unclear portion 4b in Figure 12(c) and the presence of unclear portions 4b in Figures 12(b) and 12 (d) .

[0065] Figures 13 show a state where the probe 1 passes over a position bisecting a carotid artery 6 longitudinally along the center axis and further over-rotated. In this case, as shown in Figure 13(a), the probe symbol 1b is oblique with respect to the carotid center line symbol 1c toward the opposite side from that in Figure 11(e). An angular position relationship image in Figure 13(e) is generated based on appearance of the strip-shaped carotid artery 6 in Figure 13(c) and the presence of unclear portions 4b in Figures 13(b) and 13(d), which also takes into consideration information indicative of difference in the position of the probe origin 1a from that in Figures 11.

[0066] Figures 14 show a state where the probe 1 passes over horizontally a position bisecting a carotid artery 6 longitudinally along the center axis (or a state where the probe 1 is displaced sideways (horizontally) in Figure 5(c)). In this case, an angular position relationship image in Figure 14(e) is generated based on appearance of the strip-shaped carotid artery 6, the presence of strip-shaped unclear portions 4b, and the like in Figure 14 (c).

[0067] As understood in the above description, according to the embodiment, the operator can easily move and adjust the probe 1 to an appropriate portion of the carotid artery 6 based on the angular position relationship images (those in Figures 7(e) to 14(e)) displayed on the display 4, which provides improved operability.

(Embodiment 2)

[0068] In Embodiment 1 described above, a number of transducer arrays 8 to 10 are used to acquire detected images of the carotid artery 6 as shown in Figure 2. However, the probe 1 may be configured to move (swing) a single transducer array 9 (see Figure 15) to left and right from the center so as to provide three pseudo-transducer arrays 8 to 10 in a similar way to Figure 2.

[0069] In this case, displays in Figures 7 to 14 can be acquired from images at the center and images at the both sides from the center, which also allows the operator to easily move and adjust the probe 1 to an appropriate portion of the carotid artery 6, which provides improved operability.

[0070] Figure 15 is an electrical block diagram of an ultrasonograph according to the embodiment. In the ultrasonograph of the embodiment, the transducer array is provided with a Driver 24 for swinging the transducer array, and the Driver 24 is controlled by a swing controlling unit 25.

[0071] Depending on results of analysis by the item position analyzing unit 19, the range of left and right movement of the transducer array 9 may be varied. In this way, the amount of displacement of the carotid artery 6 such as shown in Figure 10 can be increased, and as a result, the accuracy of analysis by the item position analyzing unit 19 can be improved.

(Embodiment 3)

[0072] In Embodiments 1 and 2 described above, a single display unit 4 is adapted to display a detected image of the carotid artery 6 simultaneously with an angular position relationship image that shows an angular position relationship between the probe 1 and the carotid artery 6 by using the display synthesizer unit 21, as shown in Figures 2 and 15. However, as shown in Figure 16, the display unit 4 may be modified to have two or more display units (41 and 42) and each display unit may be configured to allow selection between displaying only the detected image of the carotid artery 6, displaying only the angular position relationship image that shows an angular position relationship between the probe 1 and the carotid artery 6, and displaying the detected image of the carotid artery 6 simultaneously with the angular position relationship image that shows an angular position relationship between the probe 1 and the carotid artery 6.

[0073] Figure 16 is an electrical block diagram of an ultrasonograph according to the embodiment. The ultrasonograph of the embodiment is provided with a display synthesizer/selection unit 26 in place of the display synthesizer unit 21, and is configured to control two or more (two in the embodiment) display units 41 and 42 for display.

[0074] Here, the display synthesizer/selection unit 26 can control any of the display units and images independently in any combination thereof and cause the display units 41 and 42 to display only the detected image of the carotid artery 6, display only the angular position relationship image that shows an angular position relationship between the probe 1 and the carotid artery 6, or display the detected image of the carotid artery 6 simultaneously with the angular position relationship image that shows an angular position relationship between the probe 1 and the carotid artery 6.

[0075] With such a configuration, another display unit can be provided separately from a display unit provided in the ultrasonograph main unit. In the description below, the display unit provided in the ultrasonograph main unit is referred to as a display unit 41, and the other display unit provided separately from the display unit provided in the ultrasonograph main unit is referred to as a display 42.

[0076] In this case, the display unit 42 may be located near the probe 1 or incorporated into the probe 1. Therefore, when the probe 1 is used to search the position of center of the carotid artery 6, the operator can operate the probe 1 while the operator is viewing an angular position relationship image displayed on the display unit 42. Therefore, a forced unnatural posture and eye movement of the operator can be reduced as much as possible, which provides improved operability.

[0077] Although currently possible preferred embodiments of the invention have been described above, it is understood that various modifications can be made to the embodiments and it is intended that all such modifications that fall within the true spirit and scope of the invention are covered by the attached claims.

Industrial Applicability

[0078] As described above, the present invention provides an arrangement comprising a controller to which a probe and a display are connected, wherein the controller causes the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the detected image of the target object. Therefore, even a non-expert can take accurate measurements. According to the present invention, the controller can cause the display to display a detected image of a target object detected by the probe and an angular position relationship image showing a relative angular position of the probe to the target object. Therefore, the operator can place the probe correctly with respect to the target object while the operator is viewing the images displayed on the display, and as a result, even a non-expert can take accurate measurements.

[0079] The ultrasonograph of the present invention is therefore expected to be widely utilized in examination of, for example, a carotid artery.

Reference Signs List

[0080]

1	Probe
1a	Probe origin
1b	Probe symbol
1c	Carotid center line symbol
1d	Middle point 1d
2	Cable
3	Controller
4	Display
4a	Center line
4b	Unclear portion
5	Foot switch
6	Carotid artery (an exemplary target object)
6a	Endothelial cell
6b	Tunica intima
6c	Tunica media
6d	Tunica adventitia
6e	Blood flowing area
6f	Center axis of carotid artery 6
6g	Detection range
7	Body casing
7a	Grip section
7b	Contact section
8, 9, 10	Transducer array
11	Ultrasonic transducer
13	Transducer group selecting unit
14	Ultrasonic wave transmitting/receiving unit
15	Transmission/reception controlling unit
16	Signal processing unit
17	Image creating unit
18	Image analyzing unit
19	Item position analyzing unit
20	Probe guiding image creating unit
21	Display synthesizer unit
22	IMT CALCULATING unit
23	Neck
24	Driver
25	Swing controlling unit
26	Display synthesizer/selection unit
41	Display unit
42	Display unit

Claims

1. An ultrasonograph comprising a controller to which a probe and a display are connected,
wherein based on an analysis on a detected image of a target object detected by the probe, the controller generates a positional relationship image showing a positional relationship between the probe and the target object, and causes the display to display the positional relationship image.

2. The ultrasonograph according to claim 1, wherein the controller is capable of having a plurality of displays connected thereto, and
wherein the controller generates a detected image of a target object detected by the probe, generates a positional relationship image showing a positional relationship between the probe and the target object based on an analysis on the generated detected image, and causes at least one of the plurality of displays to display the positional relationship image.

3. The ultrasonograph according to claim 2, wherein the controller causes any of the plurality of displays to display the detected image.

4. The ultrasonograph according to any of claims 1 to 3, further comprising the probe connected to the controller.

5. The ultrasonograph according to any one of claims 1 to 4, further comprising the display connected to the controller.

6. The ultrasonograph according to any one of claims 1 to 5, wherein the positional relationship image is displayed on a part of the detected image.

7. The ultrasonograph according to claim 6, wherein a center line of the target object and a probe symbol indicative of a positional state of the probe including obliqueness of the probe with respect to the center line are displayed in the positional relationship image.

8. The ultrasonograph according to claim 7, wherein a probe origin indicative of position of origin of the probe is displayed in the positional relationship image.

9. The ultrasonograph according to claim 7 or 8, wherein detectable limits are displayed on both sides of the center line of the target object in the positional relationship image.

10. The ultrasonograph according to any one of claims 1 to 9, wherein the probe is composed of a plurality of transducer arrays arranged in parallel to each other, and each of the plurality of transducer arrays is composed of a plurality of ultrasonic transducers arranged in line.

11. The ultrasonograph according to claim 10, wherein the display unit displays an image of the target object acquired by the plurality of transducer arrays as an image showing a positional relationship including obliqueness of the probe with respect to the target object.

12. The ultrasonograph according to any one of claims 1 to 9, wherein the probe is composed of a single transducer array movable to a plurality of parallel positions, and the transducer array is composed of a plurality of ultrasonic transducers arranged in line.

13. The ultrasonograph according to claim 12, wherein the display unit displays an image of the target object acquired by moving the single transducer array to the plurality of parallel positions as an image showing a relative angular position of the probe to the target object.

14. The ultrasonograph according to any one of claims 1 to 12, wherein the probe is provided with a probe origin marker.

15. A diagnosis method using an ultrasonograph, comprising:

contacting a probe of an ultrasonograph with a detected area, and causing a display to display an image of positional relationship between a target object in the detected area and the probe;
rotating the probe while viewing the positional relationship image, and adjusting the rotation of the probe based on the positional relationship image of the probe with respect to the target object displayed on the display; and
causing a display to display an ultrasonic image of the target object.

16. The diagnosis method using an ultrasonograph according to claim 15, wherein the detected area is a neck and the target object is a carotid artery.

FIG.1

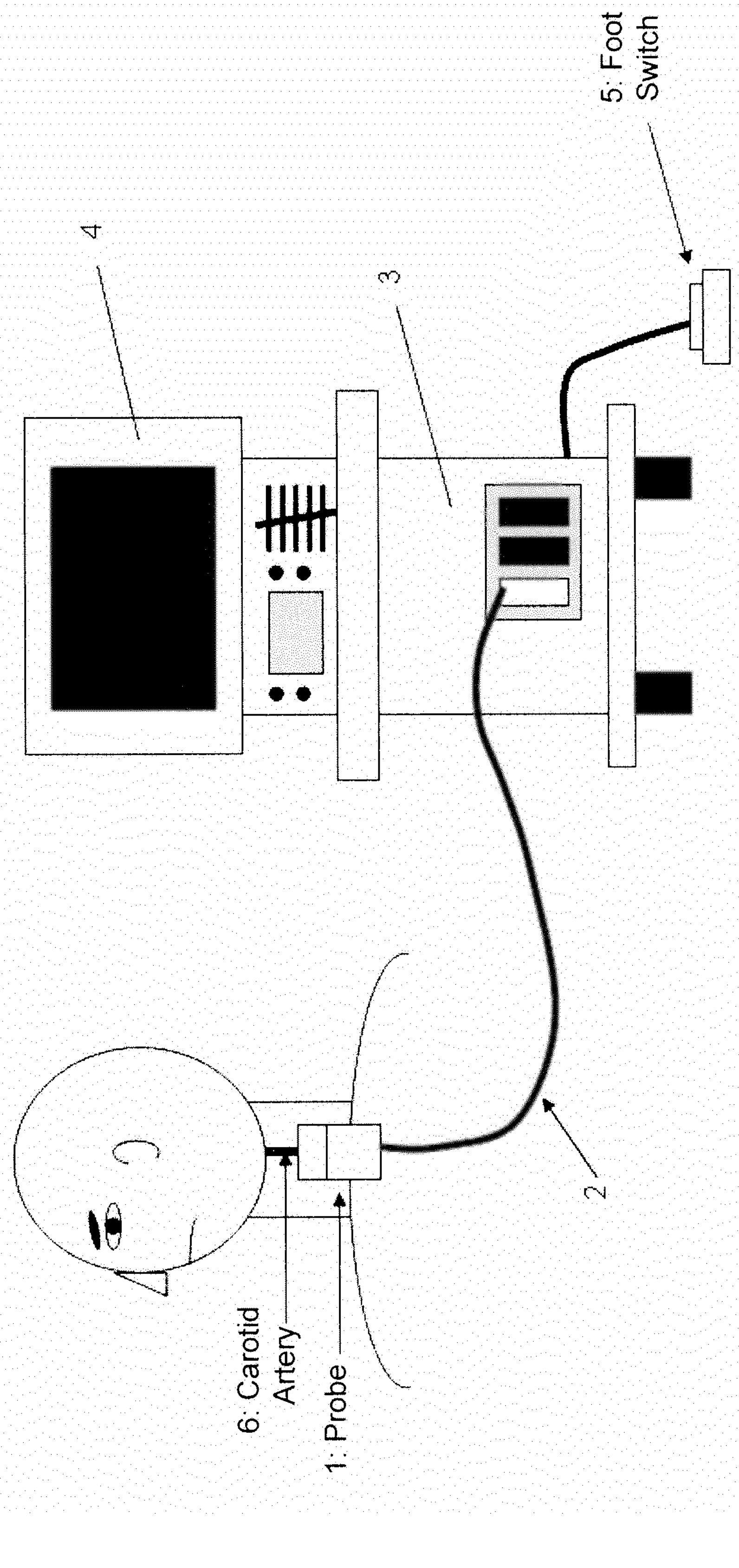


FIG.2

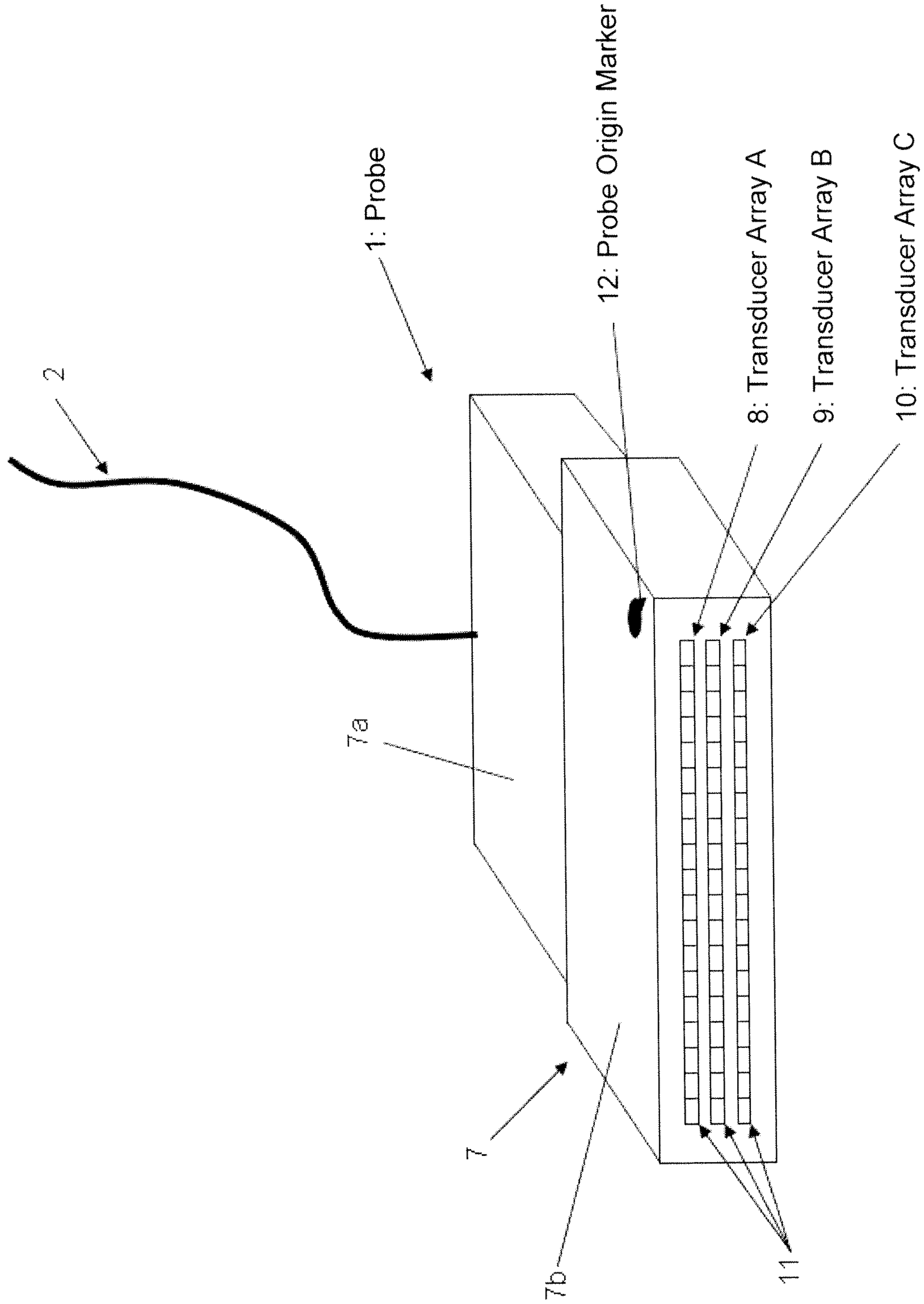

1: Probe
2
12: Probe Origin Marker
8: Transducer Array A
9: Transducer Array B
10: Transducer Array C
7a
7
7b
11

FIG.3

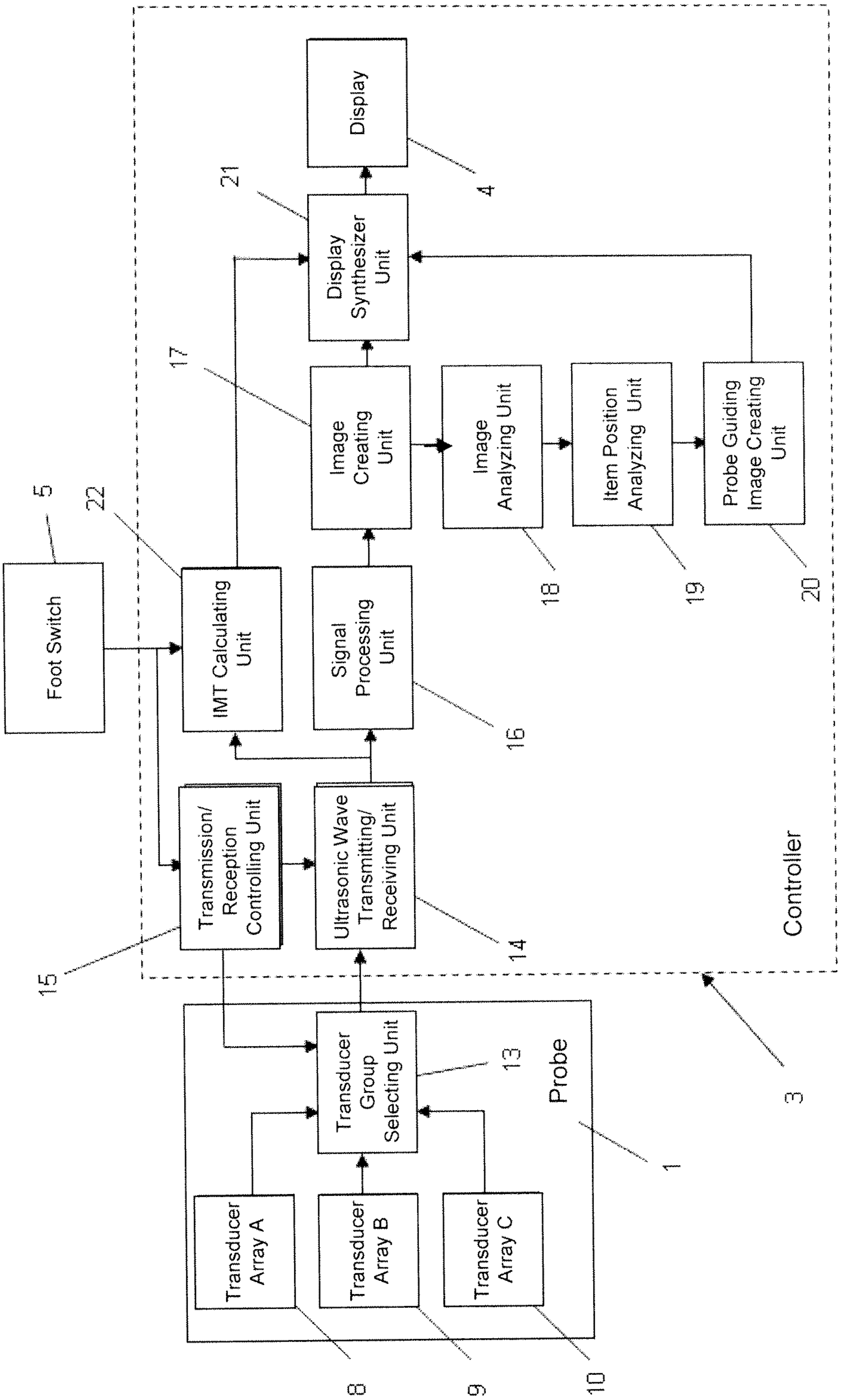

Transducer Array A
Transducer Array B
Transducer Array C
Transducer Group Selecting Unit
Probe
Transmission/ Reception Controlling Unit
Ultrasonic Wave Transmitting/ Receiving Unit
Foot Switch
IMT Calculating Unit
Signal Processing Unit
Image Creating Unit
Image Analyzing Unit
Item Position Analyzing Unit
Probe Guiding Image Creating Unit
Display Synthesizer Unit
Display
Controller
1
3
4
5
8
9
10
13
14
15
16
17
18
19
20
21
22

FIG.4

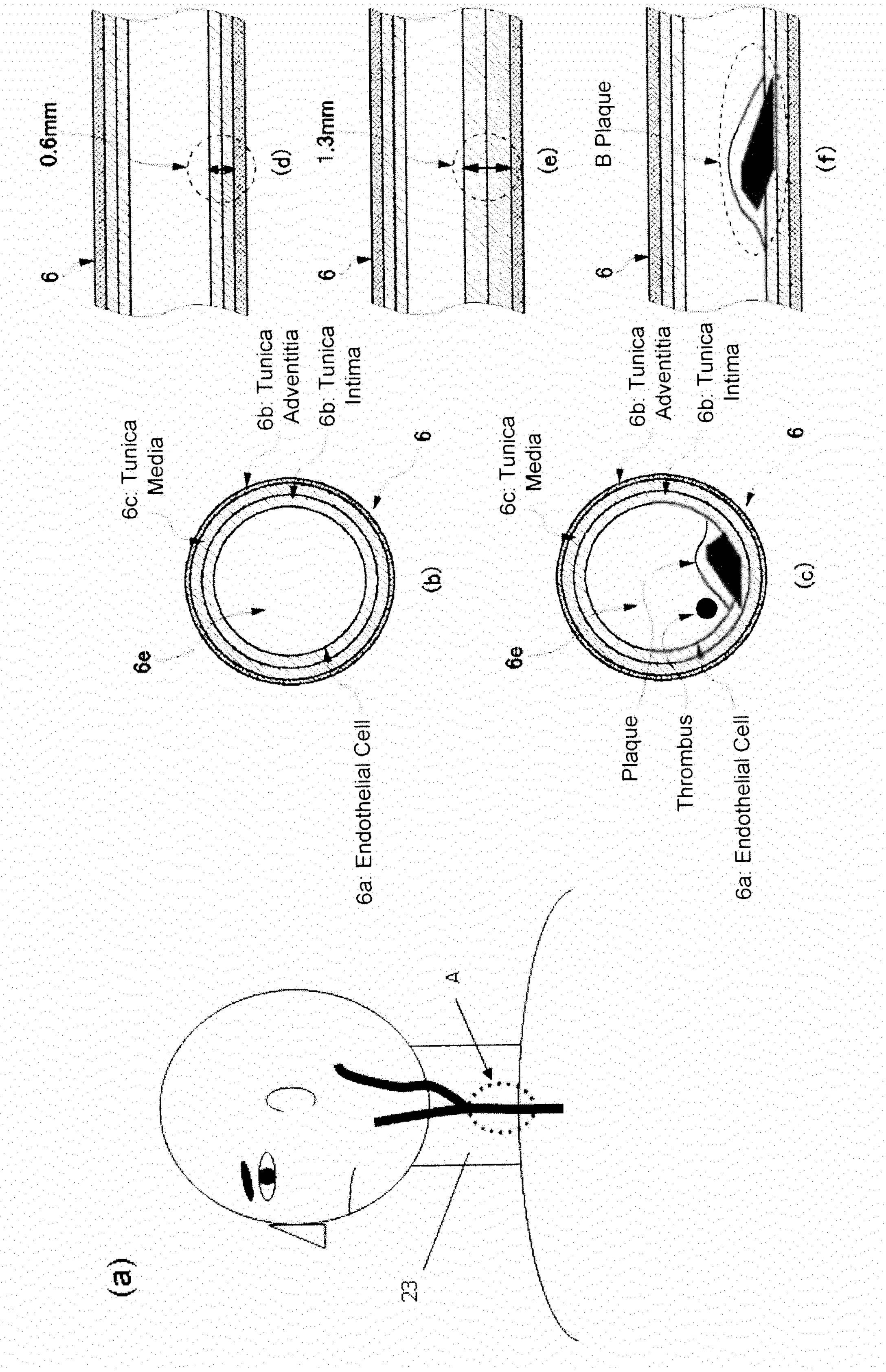
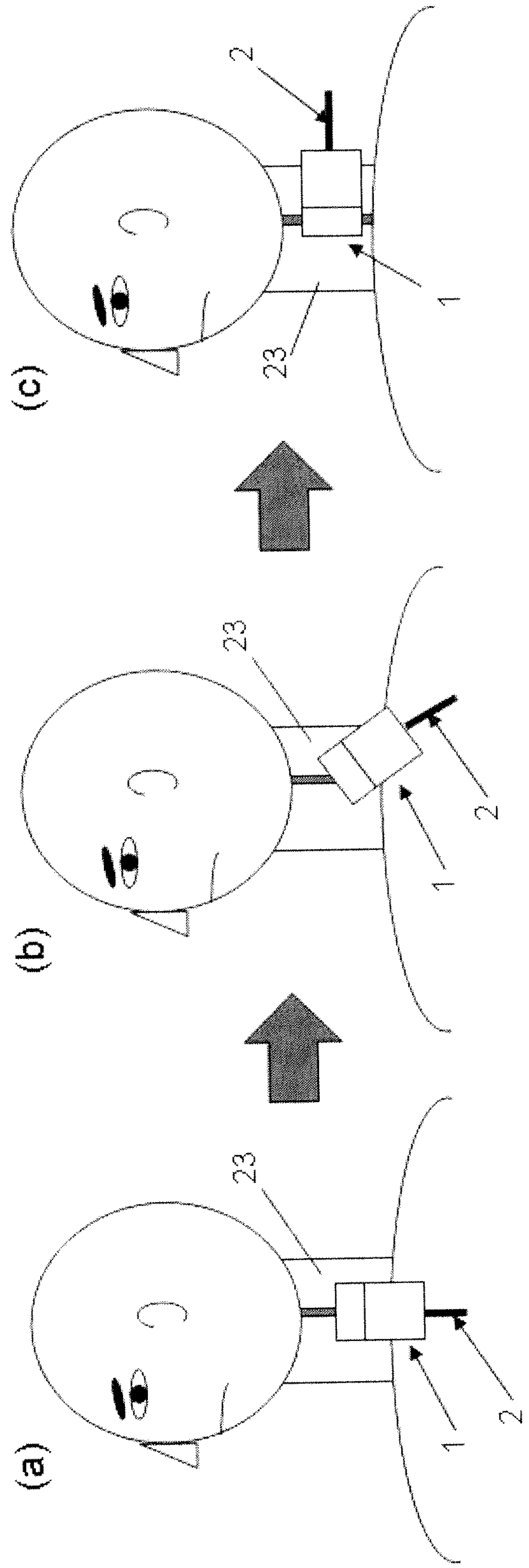

(a)
23
A
6a: Endothelial Cell
6e
(b)
6c: Tunica Media
6b: Tunica Adventitia
6b: Tunica Intima
6
Plaque
Thrombus
6a: Endothelial Cell
6e
(c)
6c: Tunica Media
6b: Tunica Adventitia
6b: Tunica Intima
6
6
0.6mm
(d)
6
1.3mm
(e)
6
B Plaque
(f)

FIG.5



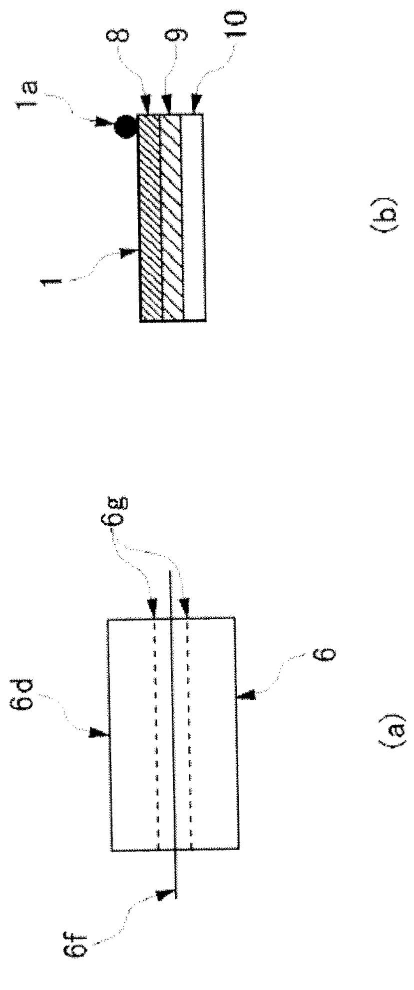


FIG.6

FIG.7

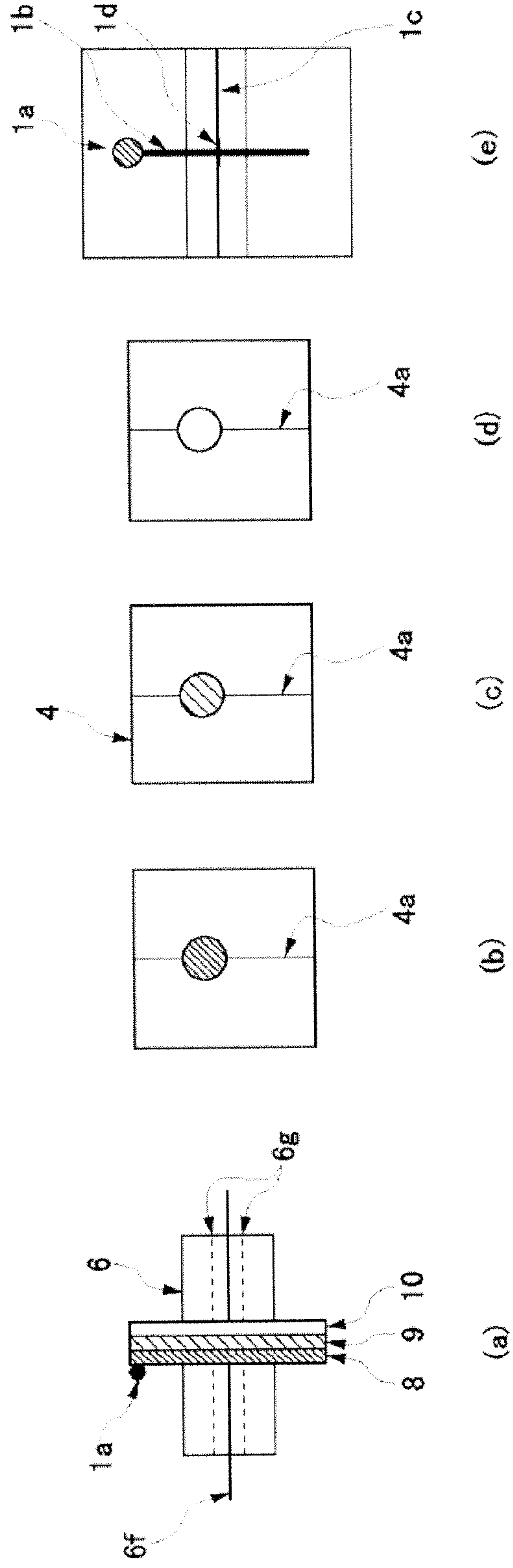


FIG.8

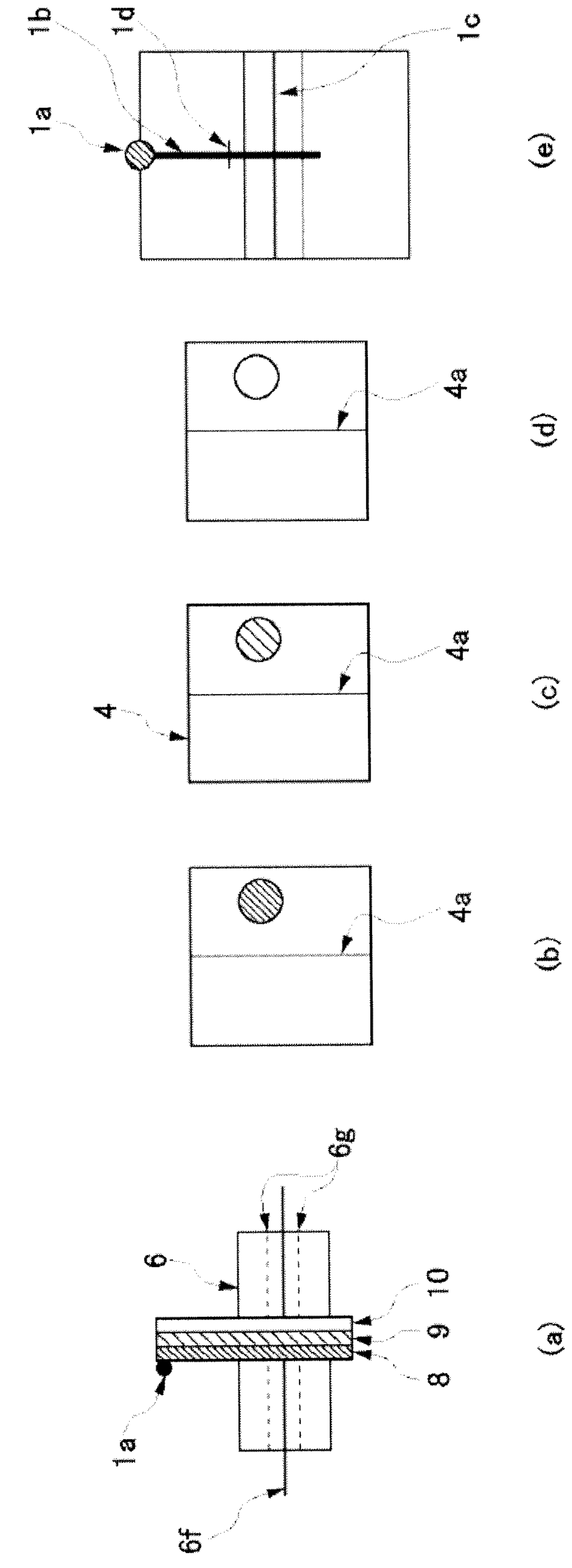


FIG.9

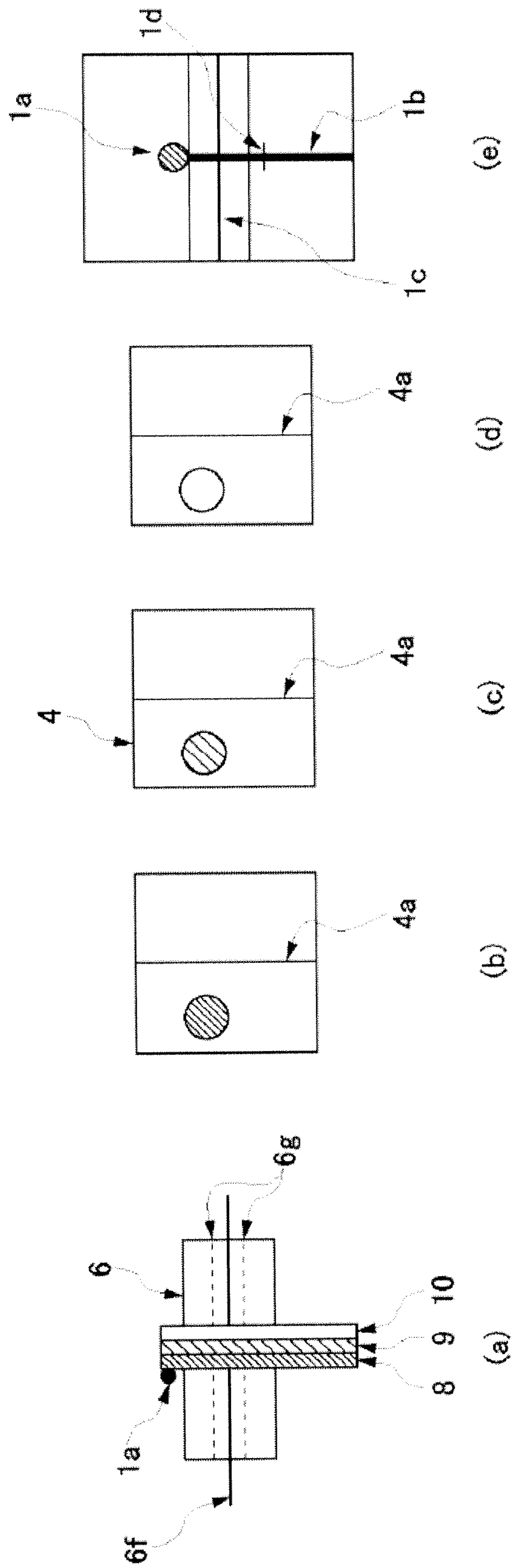


FIG.10

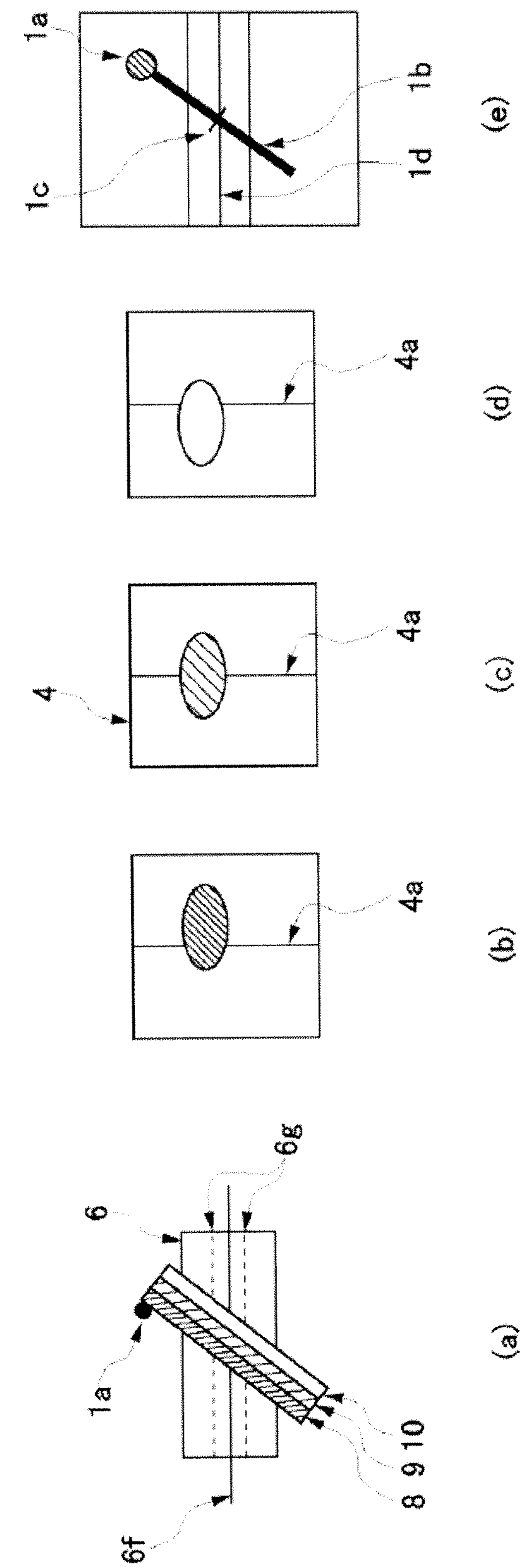


FIG.11

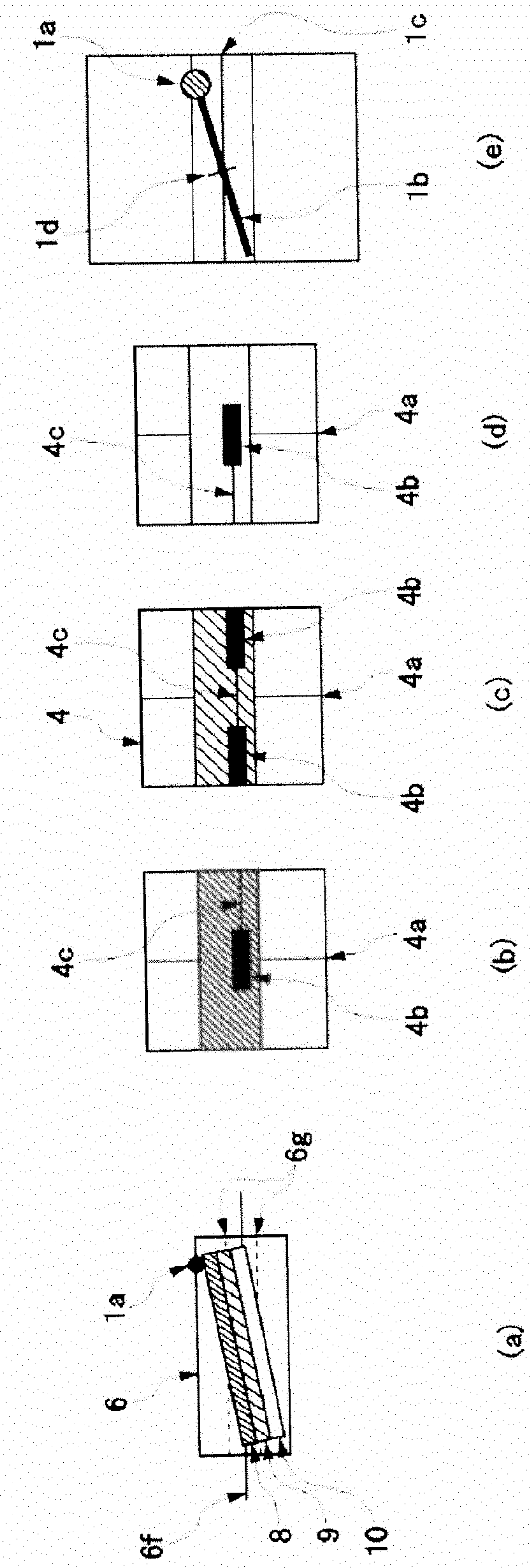


FIG.12

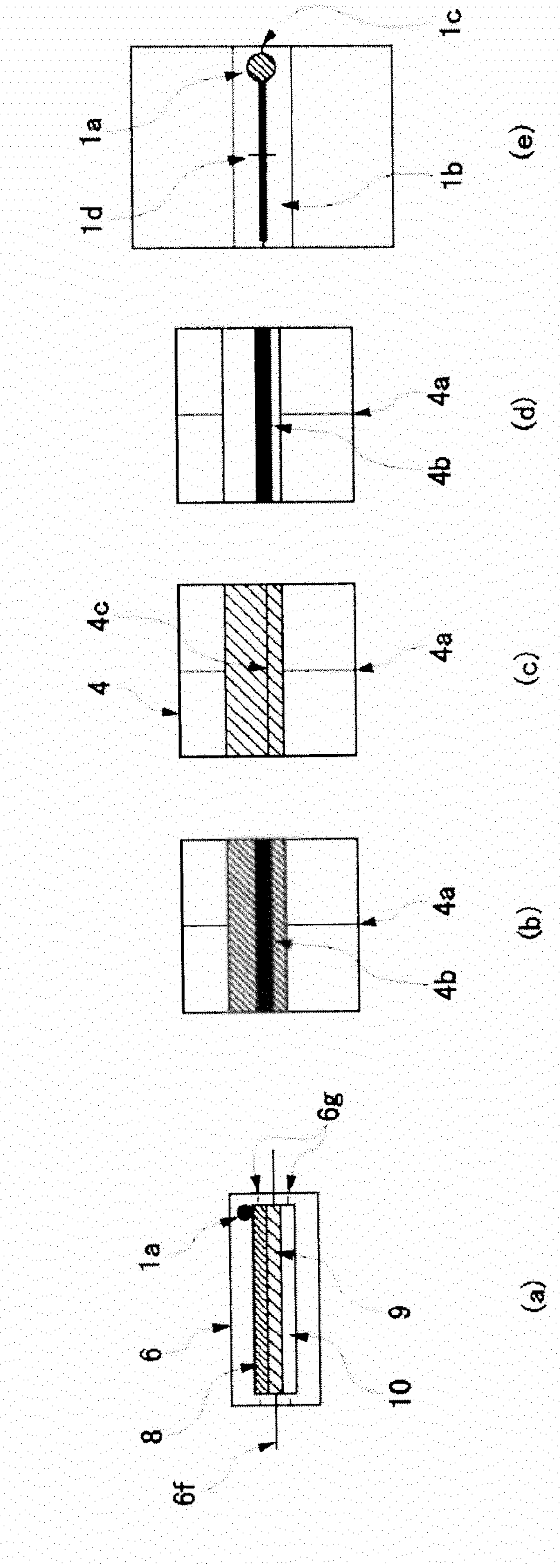


FIG.13

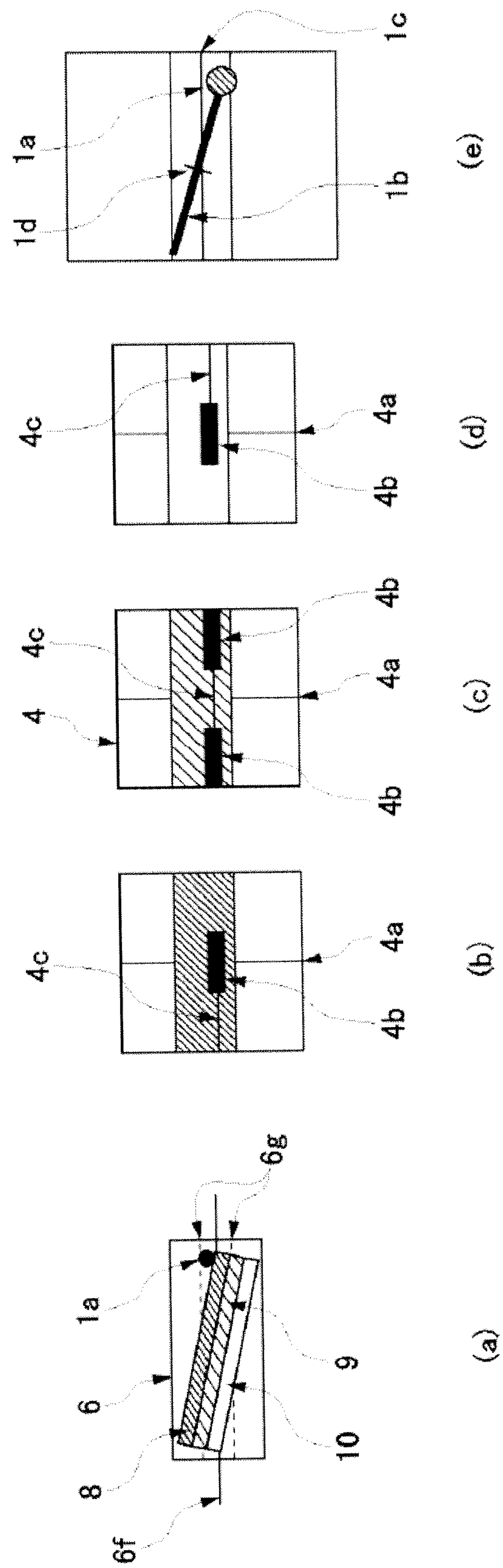
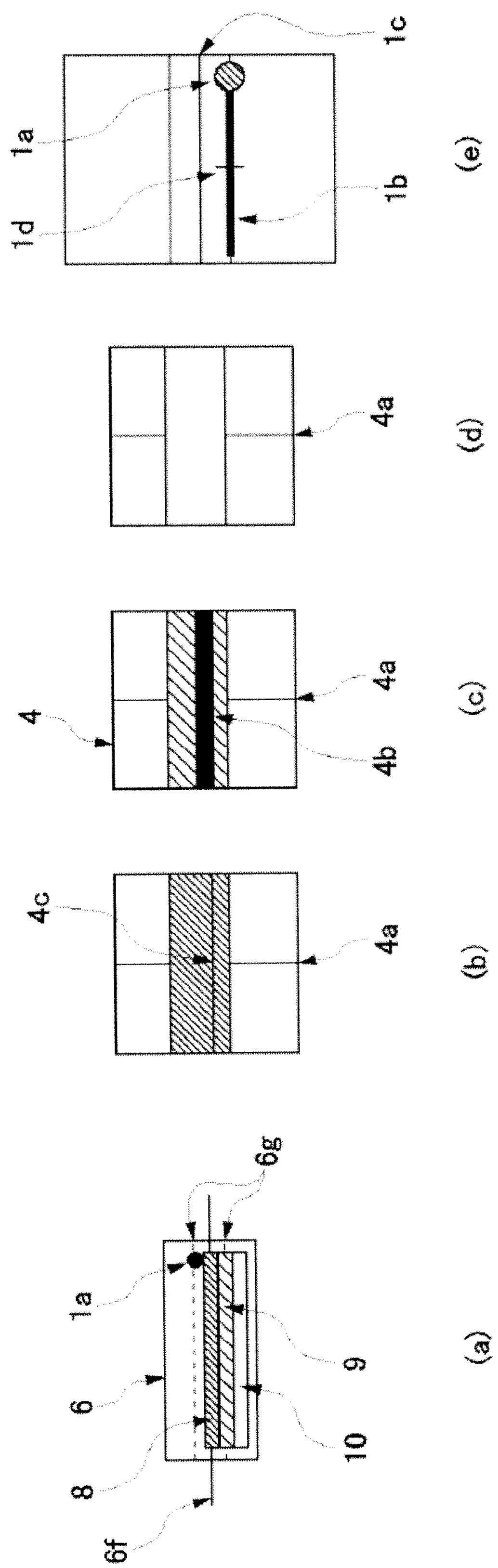


FIG.14



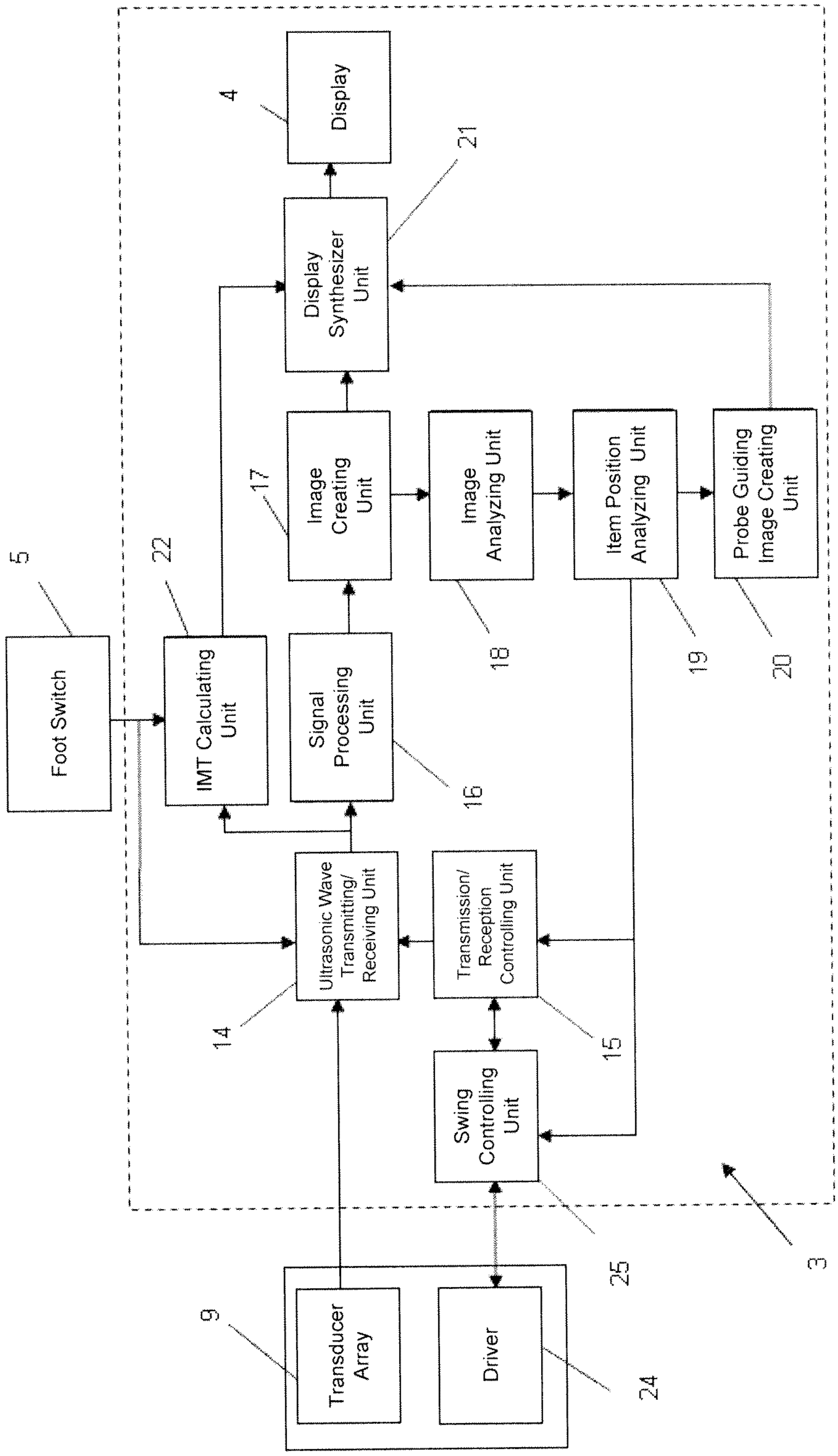
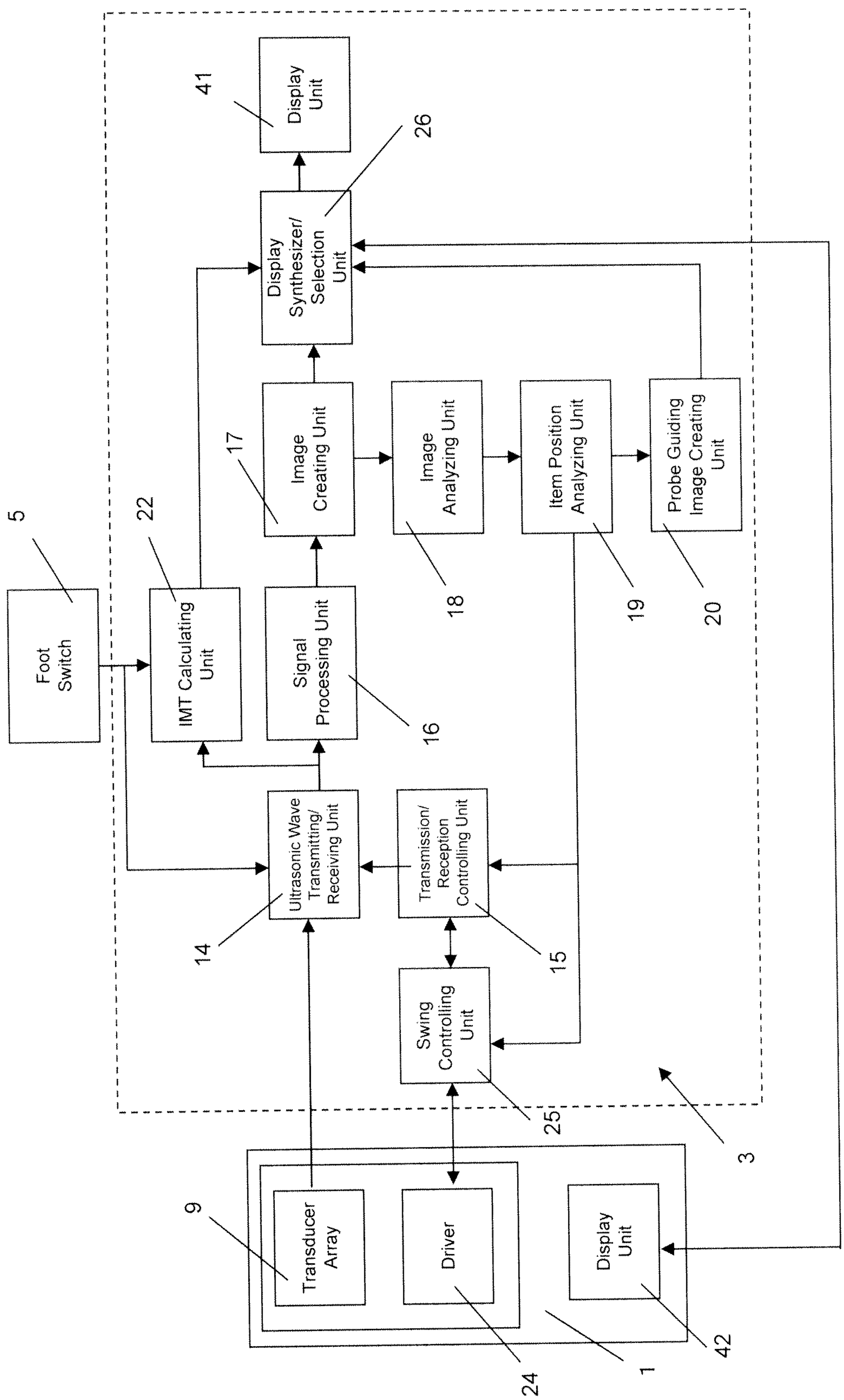

Display
4
Display Synthesizer Unit
21
Image Creating Unit
17
Image Analyzing Unit
18
Item Position Analyzing Unit
19
Probe Guiding Image Creating Unit
20
Foot Switch
5
IMT Calculating Unit
22
Signal Processing Unit
16
Ultrasonic Wave Transmitting/ Receiving Unit
14
Transmission/ Reception Controlling Unit
15
Swing Controlling Unit
25
Transducer Array
9
Driver
24
3

FIG.15

FIG.16


Foot Switch
5
IMT Calculating Unit
22
Signal Processing Unit
16
Image Creating Unit
17
Image Analyzing Unit
18
Item Position Analyzing Unit
19
Probe Guiding Image Creating Unit
20
Display Synthesizer/ Selection Unit
26
Display Unit
41
Ultrasonic Wave Transmitting/ Receiving Unit
14
Transmission/ Reception Controlling Unit
15
Swing Controlling Unit
25
3
Transducer Array
9
Driver
24
Display Unit
42
1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/005708

A. CLASSIFICATION OF SUBJECT MATTER
A61B8/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B8/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2009-56125 A (Canon Inc.), 19 March 2009 (19.03.2009), abstract; paragraphs [0030], [0051] to [0060], [0092] to [0101]; fig. 1, 2, 12 & EP 2185077 A & WO 2009/028354 A1	1-5,15,16 6-14
A	JP 2009-89911 A (UNEX Corp.), 30 April 2009 (30.04.2009), abstract; paragraphs [0002], [0035], [0044]; fig. 17 to 22 & US 2010/0210946 A & EP 2198784 A1 & WO 2009/047966 A1 & CN 101820820 A & KR 10-2010-0080533 A	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November, 2010 (26.11.10)	07 December, 2010 (07.12.10)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- *Journal of the American Society of Echocardiography,* February 2008, 93-111 **[0007]**

专利名称(译)	超声波检查和使用它的诊断方法		
公开(公告)号	[EP2478843A1]	公开(公告)日	2012-07-25
申请号	EP2010816907	申请日	2010-09-21
申请(专利权)人(译)	松下电器产业株式会社		
当前申请(专利权)人(译)	柯尼卡美能达，INC.		
[标]发明人	MIGITA MANABU ITOH YOSHIHIKO KAWABATA AKIHIRO SUGINOUCHI TAKEHIKO URABE MAKIKO NISHIMURA YUSHI		
发明人	MIGITA, MANABU ITOH, YOSHIHIKO KAWABATA, AKIHIRO SUGINOUCHI, TAKEHIKO URABE, MAKIKO NISHIMURA, YUSHI		
IPC分类号	A61B8/00		
CPC分类号	A61B8/42 A61B8/06 A61B8/0891 A61B8/4245 A61B8/4281 A61B8/463 A61B8/464		
代理机构(译)	GRÜNECKER，KINKELDEY，STOCKMAIR & SCHWANHÄUSSER		
优先权	2009216662 2009-09-18 JP		
其他公开文献	EP2478843A4		
外部链接	[Espacenet]		

摘要(译)

本发明的超声波检查仪包括探头（1），连接到探头（1）的控制器（3），以及连接到控制器（3）的显示器（4）。控制器（4）使显示器（4）显示由探头（1）检测到的目标物体的检测图像和表示探头相对于目标物体的检测图像的相对角度位置的角度位置关系图像。这使得即使是非专业人员也能够进行准确的测量。

FIG.1