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(54) **REFERENCE DEFORMABLE BODY, ULTRASONIC DIAGNOSTIC APPARATUS, AND ULTRASONIC DIAGNOSTIC METHOD**

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(57) **ABSTRACT**

A reference deformable body the type of which can be identified, an ultrasonic diagnostic apparatus enabling identification of the type of the reference deformable body, and an ultrasonic diagnostic method are provided.

The ultrasonic diagnostic apparatus includes an ultrasonic probe (**3**) wherein a reference deformable body (**16**) is attached, a tomographic image constructing unit (**6**,**7**), and a display unit (**14**).

The ultrasonic diagnostic apparatus is characterized by further including a storing unit configured to store the relationship between the ID given to the reference deformable body (**16**) and a type of the reference deformable body (**16**), and a type identifying unit (**54**) configured to read out the type of the reference deformable body (**16**) corresponding to the ID of the reference deformable body (**16**) which is attached to ultrasonic probe (**3**) from storing unit (**52**) and identify the type of the reference deformable body.

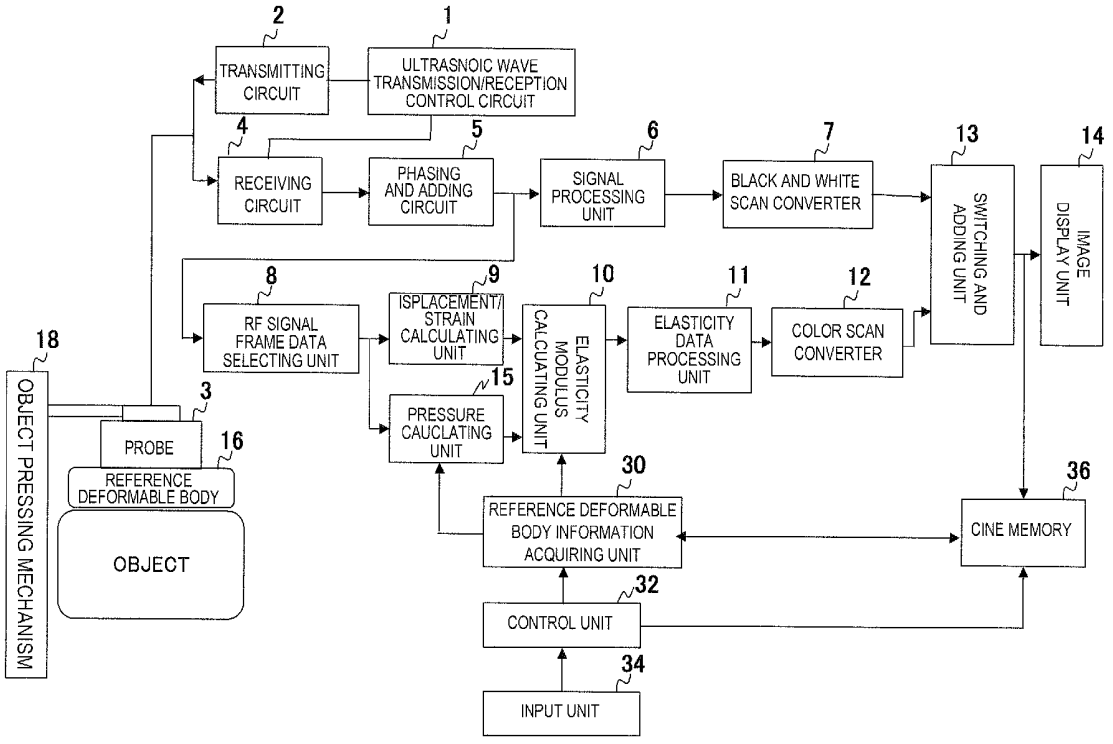


FIG. 1

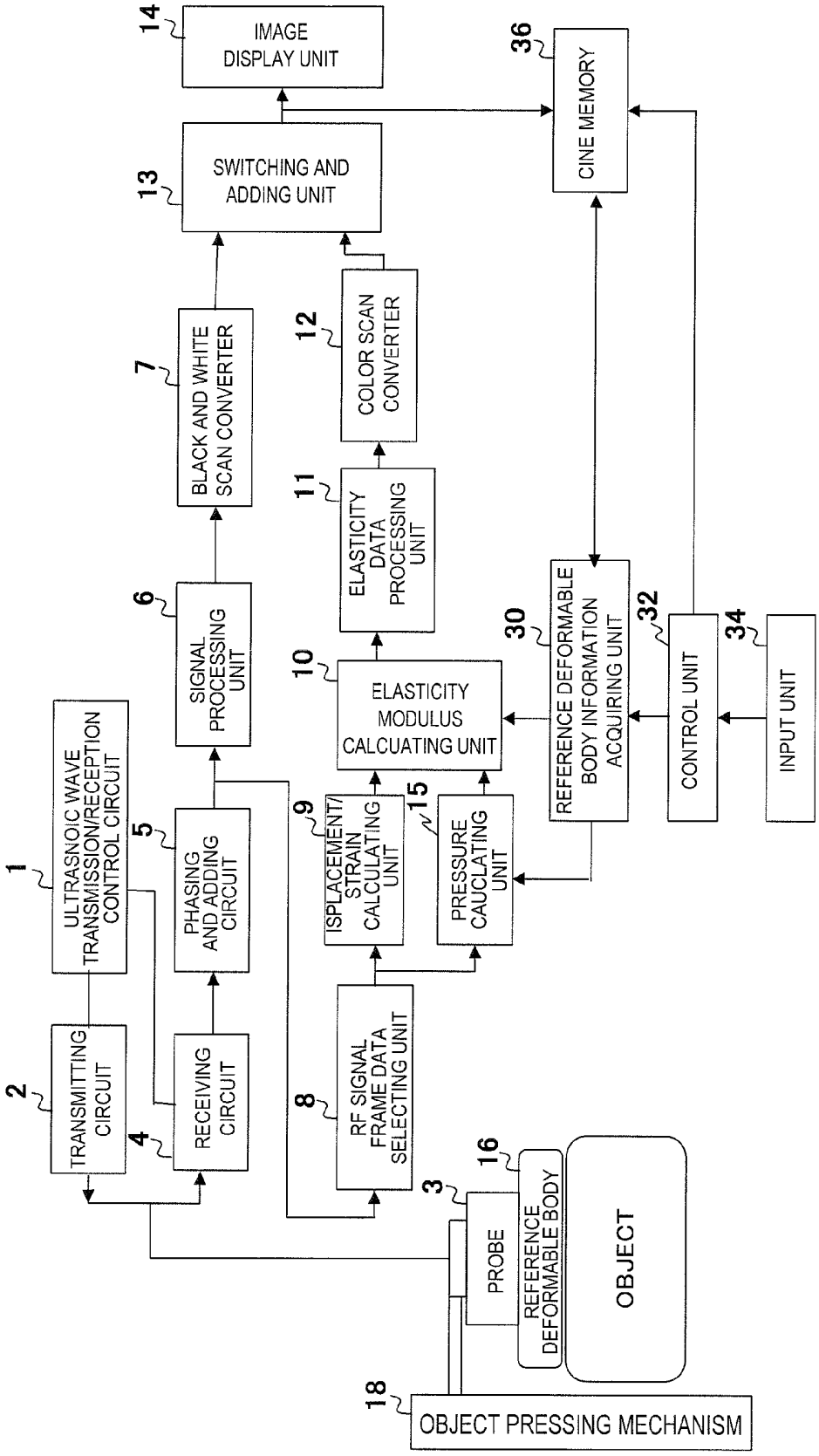

14
IMAGE DISPLAY UNIT
36
CINE MEMORY
13
SWITCHING AND ADDING UNIT
12
COLOR SCAN CONVERTER
7
BLACK AND WHITE SCAN CONVERTER
11
ELASTICITY DATA PROCESSING UNIT
6
SIGNAL PROCESSING UNIT
10
ELASTICITY MODULUS CALCUATING UNIT
30
REFERENCE DEFORMABLE BODY INFORMATION ACQUIRING UNIT
32
CONTROL UNIT
34
INPUT UNIT
1
ULTRASNOIC WAVE TRANSMISSION/RECEPTION CONTROL CIRCUIT
5
PHASING AND ADDING CIRCUIT
9
ISPLACEMENT/ STRAIN CALCULATING UNIT
15
PRESSURE CAUCLATING UNIT
2
TRANSMITTING CIRCUIT
4
RECEIVING CIRCUIT
8
RF SIGNAL FRAME DATA SELECTING UNIT
3
16
PROBE
REFERENCE DEFORMABLE BODY
OBJECT
18
OBJECT PRESSING MECHANISM

FIG. 2

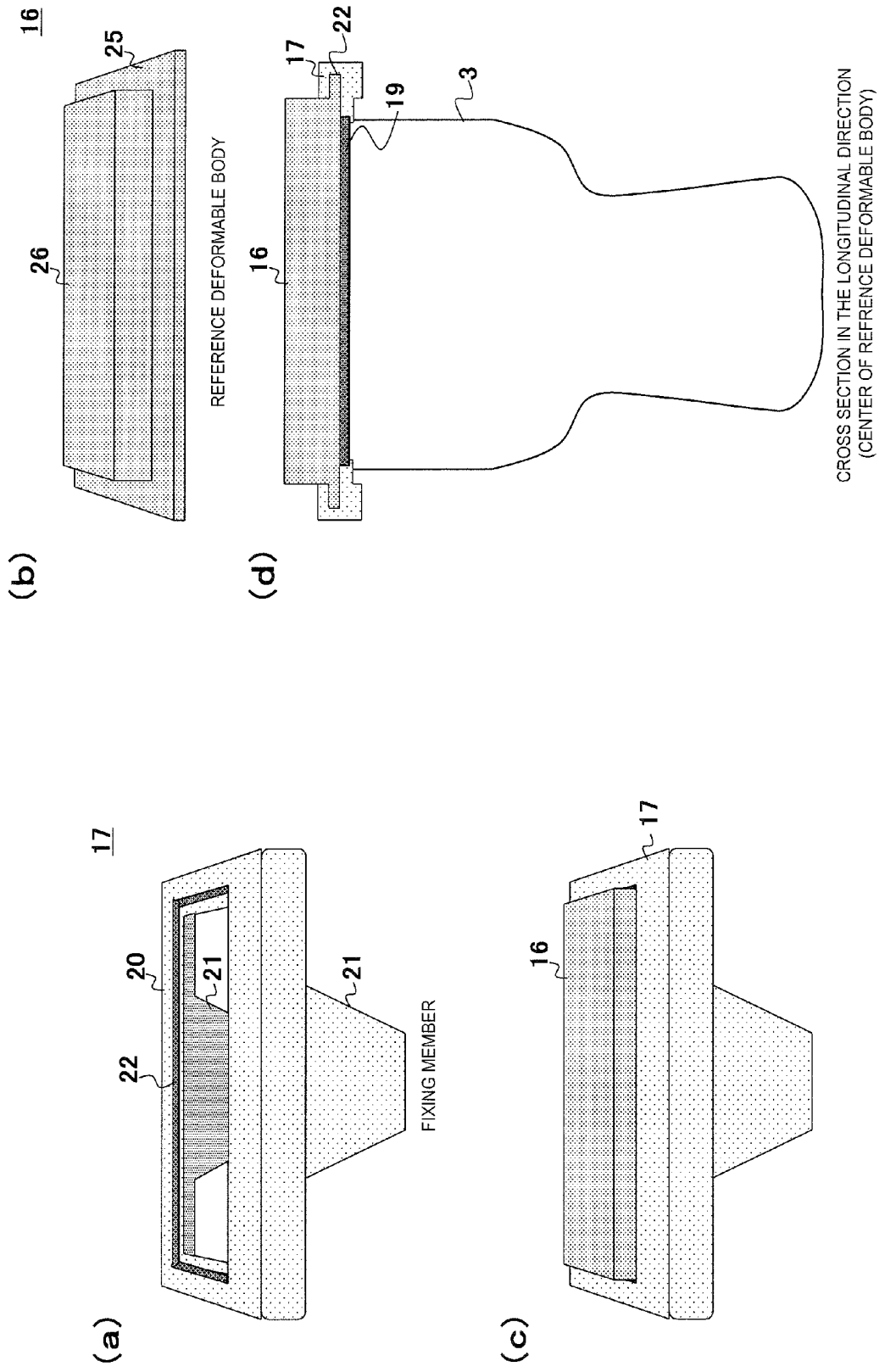

(a)
17
20
21
22
21
FIXING MEMBER
(b)
16
25
26
REFERENCE DEFORMABLE BODY
(c)
16
17
(d)
16
17
22
19
3
CROSS SECTION IN THE LONGITUDINAL DIRECTION
(CENTER OF REFRENCE DEFORMABLE BODY)

FIG. 3

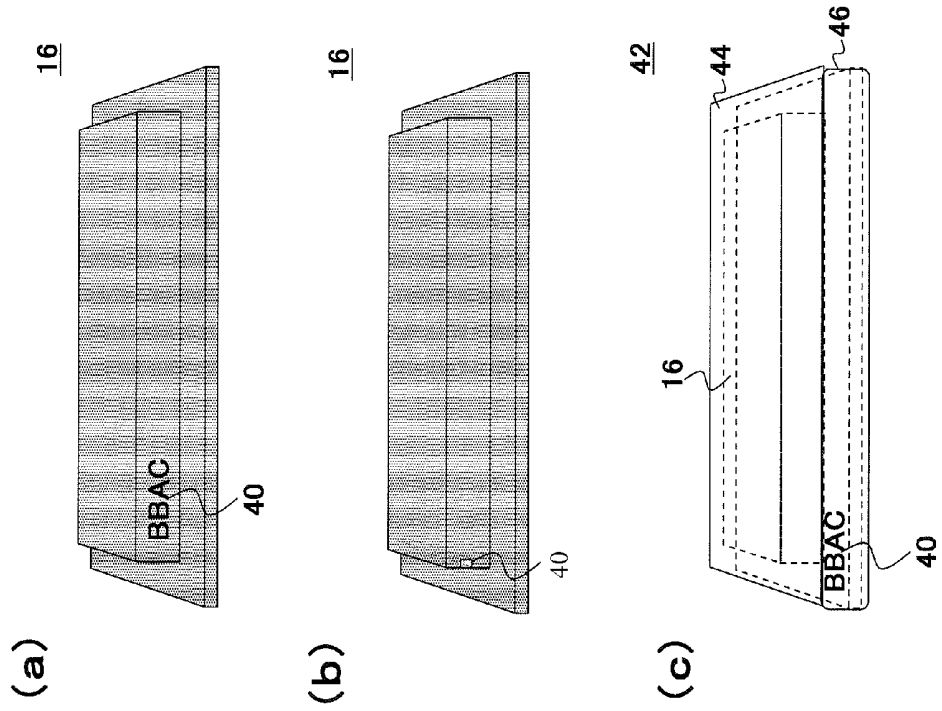


FIG. 4

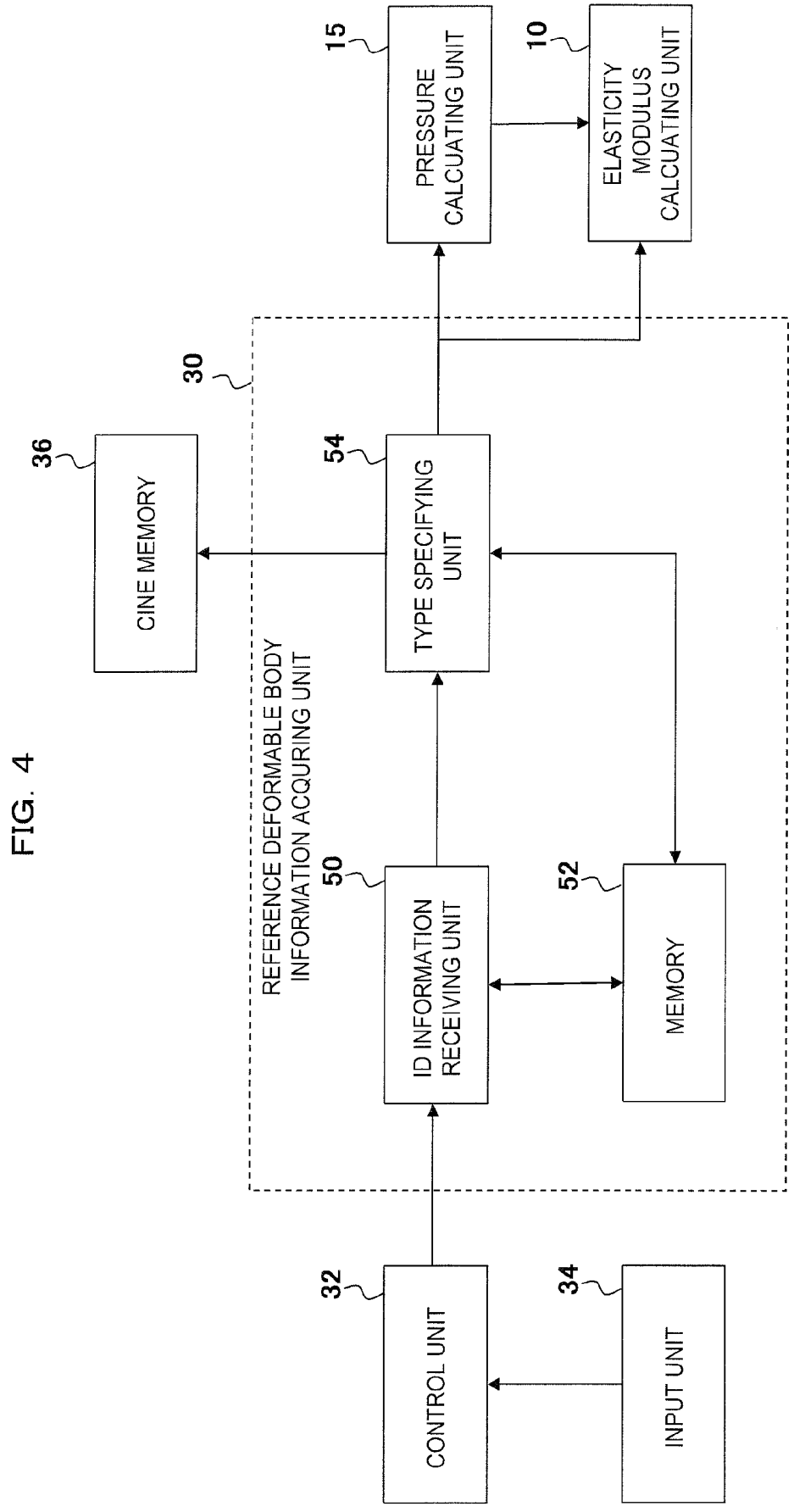

15
PRESSURE CALCUATING UNIT
10
ELASTICITY MODULUS CALCUATING UNIT
30
36
CINE MEMORY
54
TYPE SPECIFYING UNIT
REFERENCE DEFORMABLE BODY INFORMATION ACQUIRING UNIT
50
ID INFORMATION RECEIVING UNIT
52
MEMORY
32
CONTROL UNIT
34
INPUT UNIT

FIG. 5

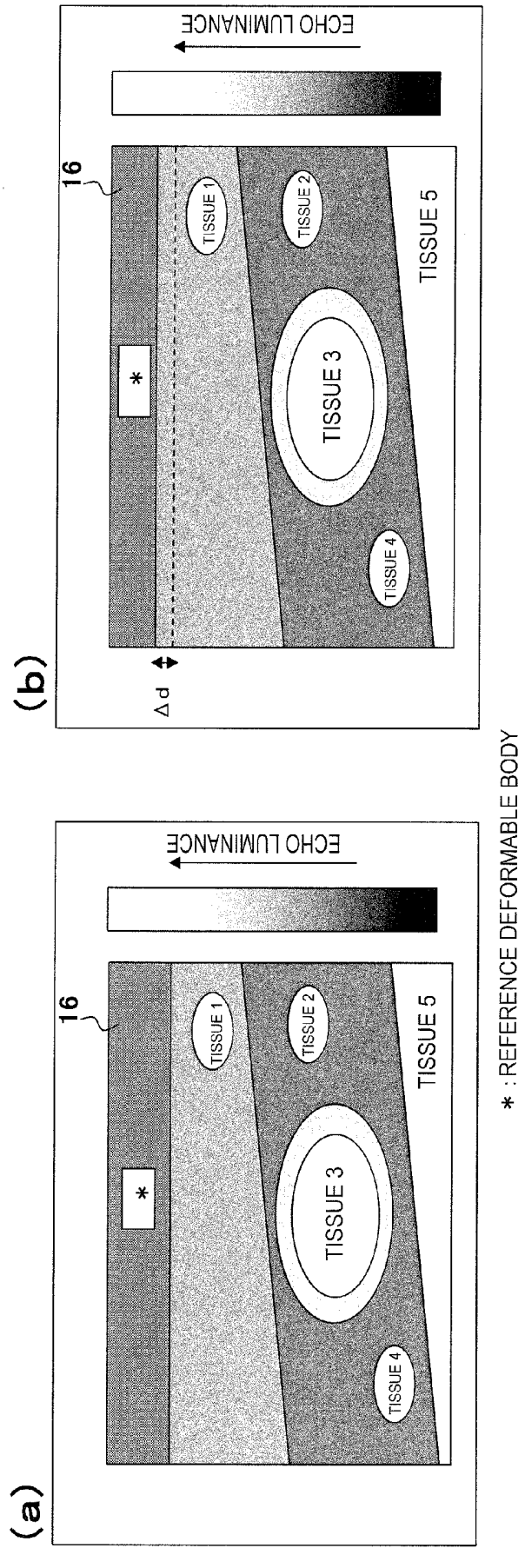

(a)
ECHO LUMINANCE
16
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
*
(b)
ECHO LUMINANCE
16
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
*
Δd
* : REFERENCE DEFORMABLE BODY

FIG. 6

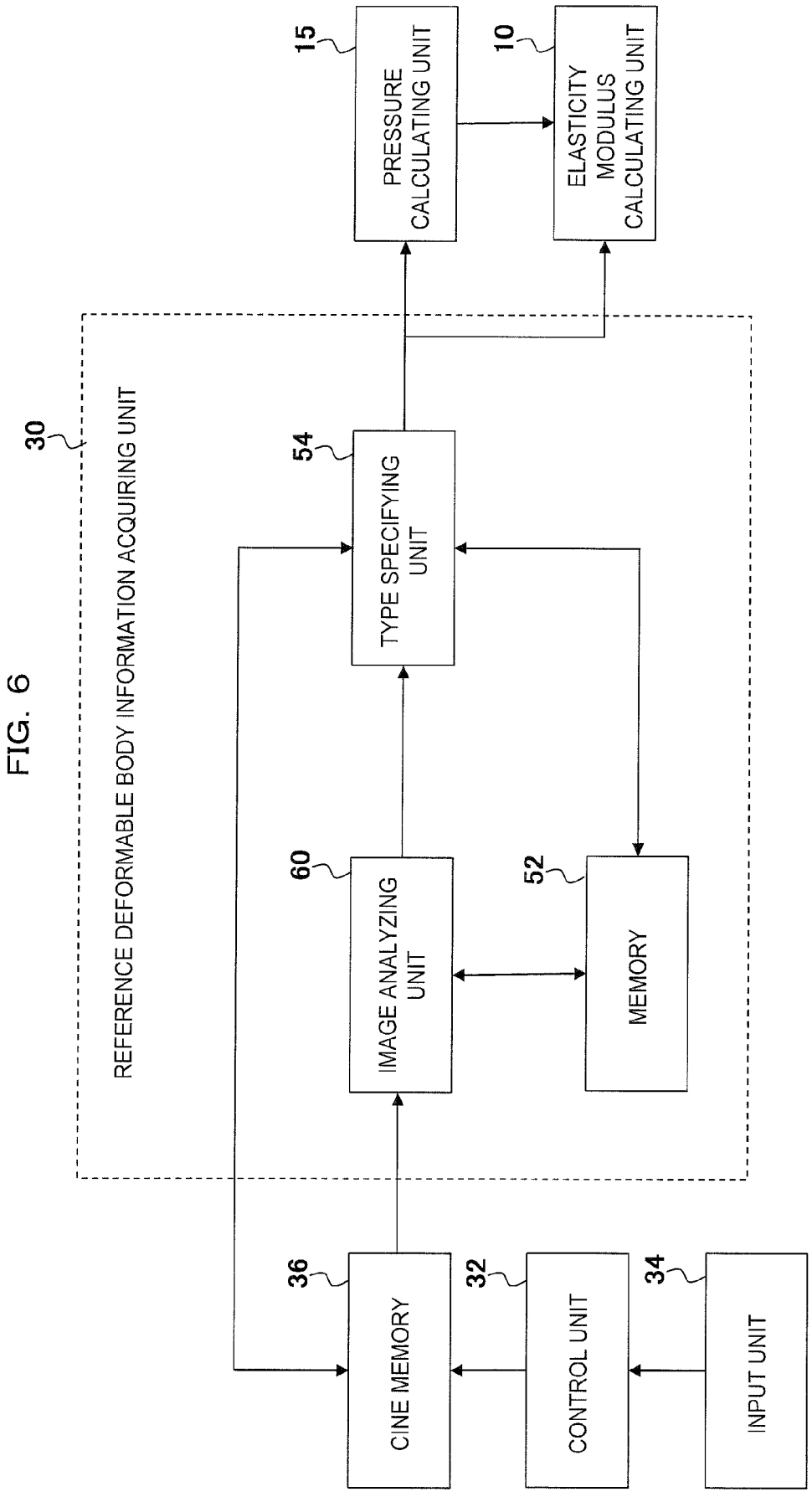

30
REFERENCE DEFORMABLE BODY INFORMATION ACQUIRING UNIT
15
PRESSURE CALCULATING UNIT
10
ELASTICITY MODULUS CALCULATING UNIT
54
TYPE SPECIFYING UNIT
60
IMAGE ANALYZING UNIT
52
MEMORY
36
CINE MEMORY
32
CONTROL UNIT
34
INPUT UNIT

FIG. 7

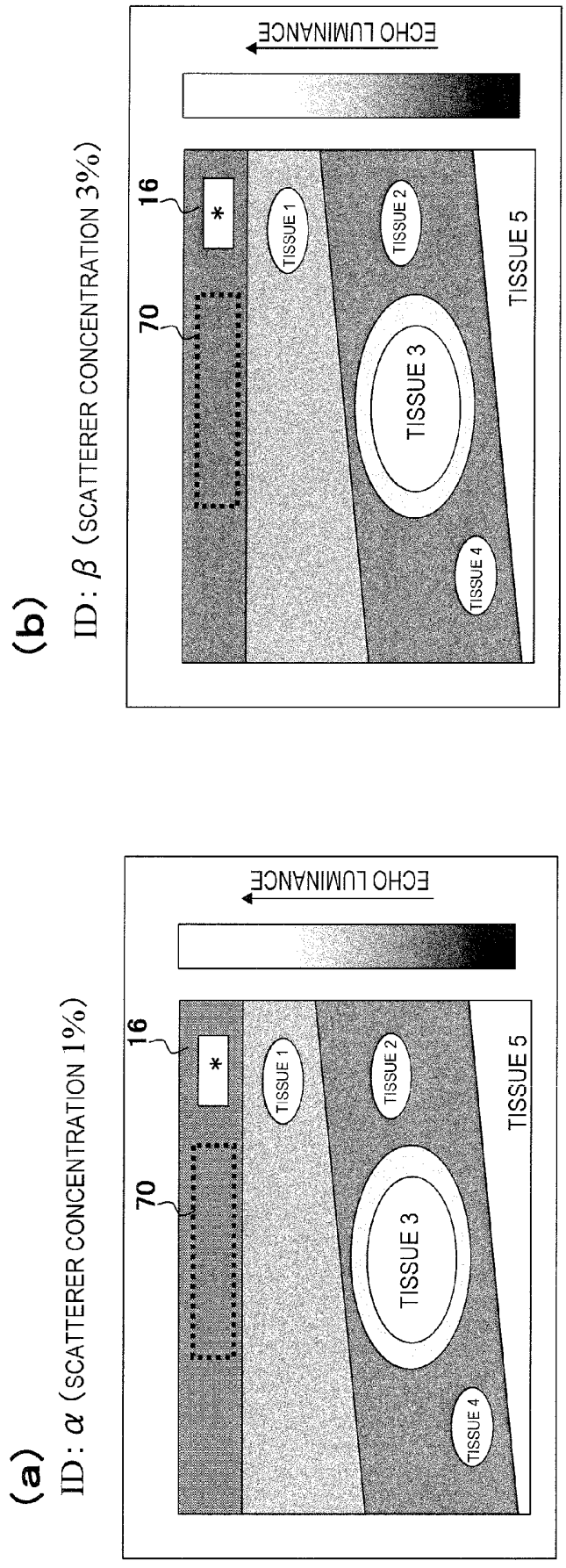

(a)
ID: α (SCATTERER CONCENTRATION 1%)
ECHO LUMINANCE
16
*
70
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
(b)
ID: β (SCATTERER CONCENTRATION 3%)
ECHO LUMINANCE
16
*
70
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
* : REFERENCE DEFORMABLE BODY

FIG. 8

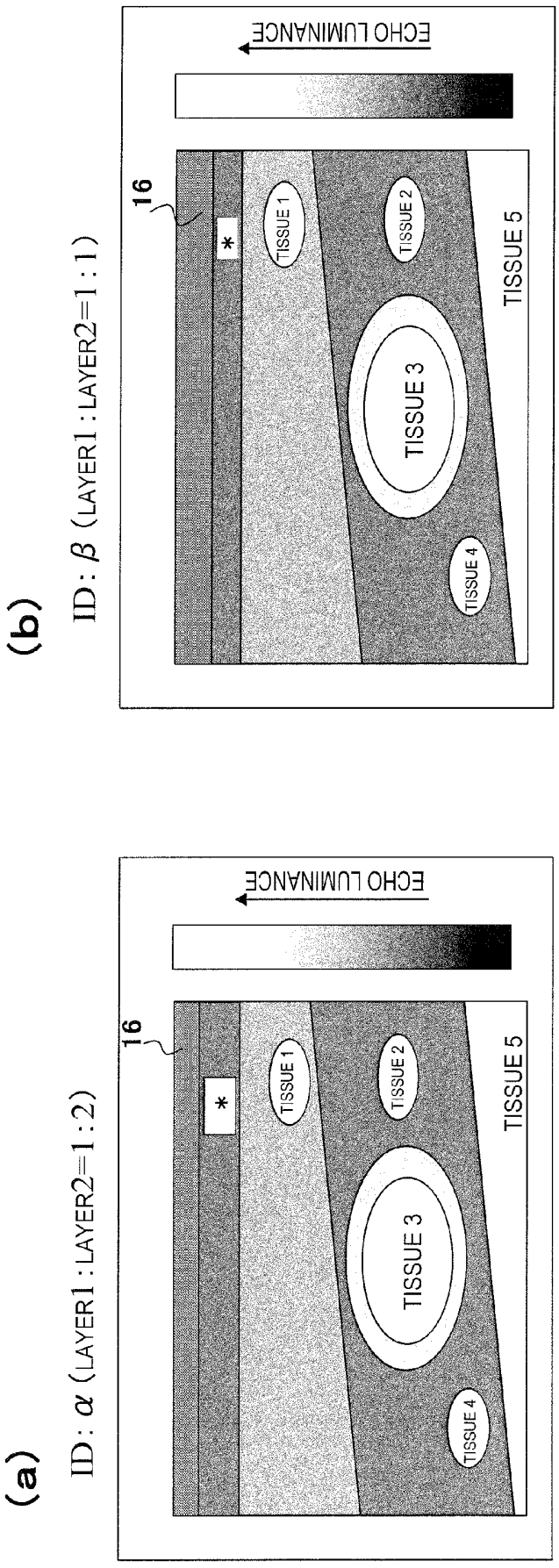

(a)
ID : α (LAYER1 : LAYER2=1 : 2)
(b)
ID : β (LAYER1 : LAYER2=1 : 1)
ECHO LUMINANCE
16
*
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
* : REFERENCE DEFORMABLE BODY

FIG. 9

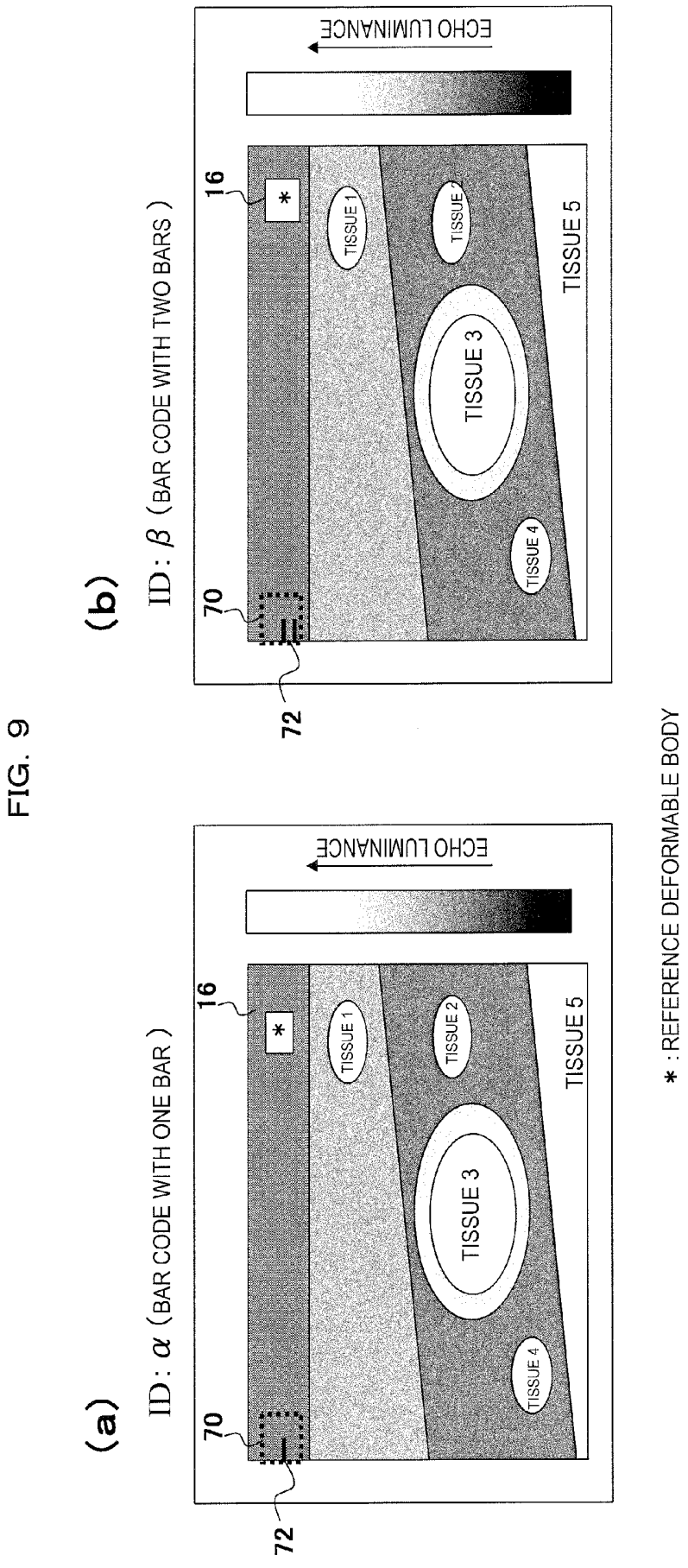

(a)
ID : α (BAR CODE WITH ONE BAR)
(b)
ID : β (BAR CODE WITH TWO BARS)
ECHO LUMINANCE
16
*
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
70
72
* : REFERENCE DEFORMABLE BODY

FIG. 10

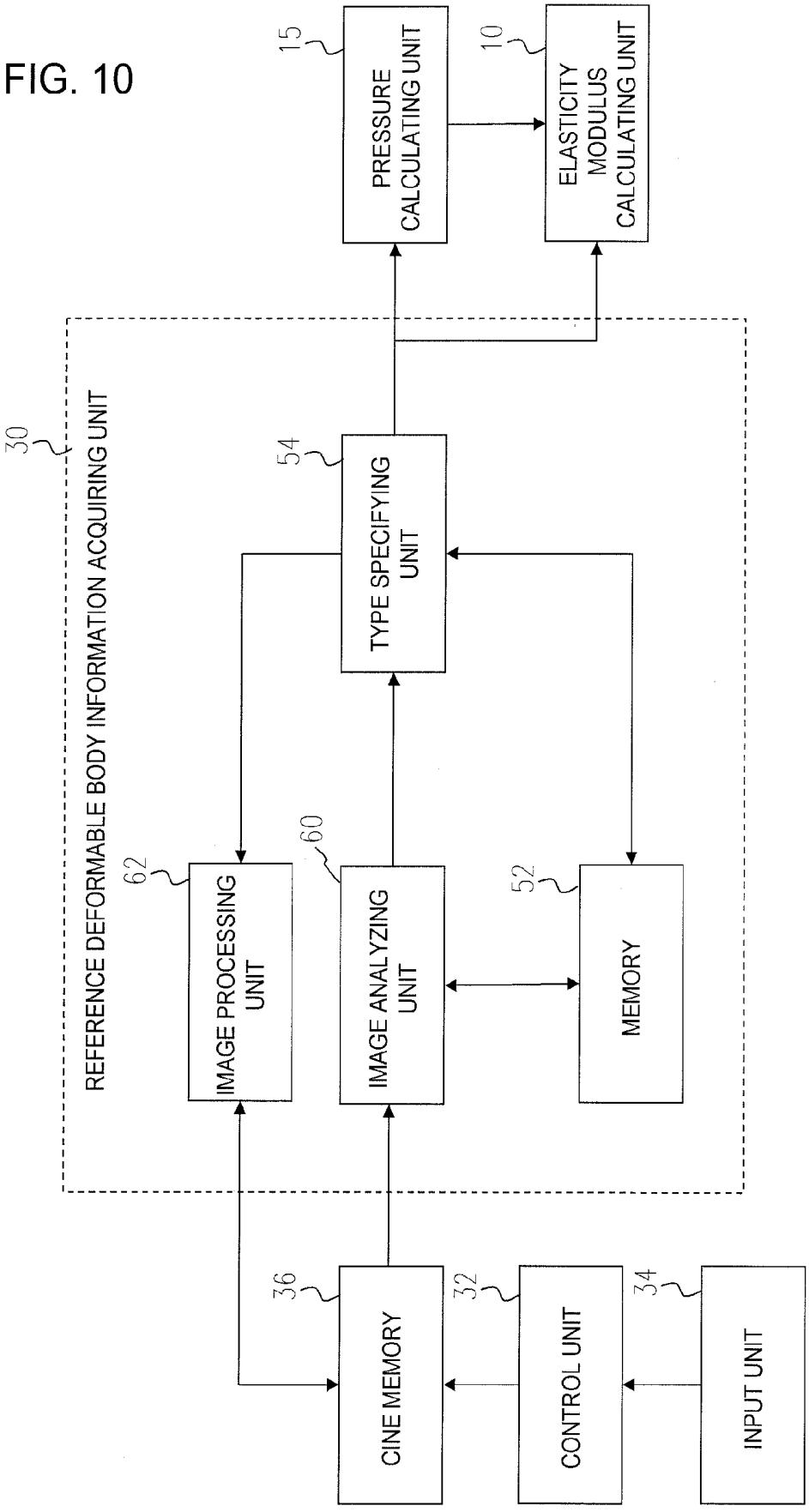
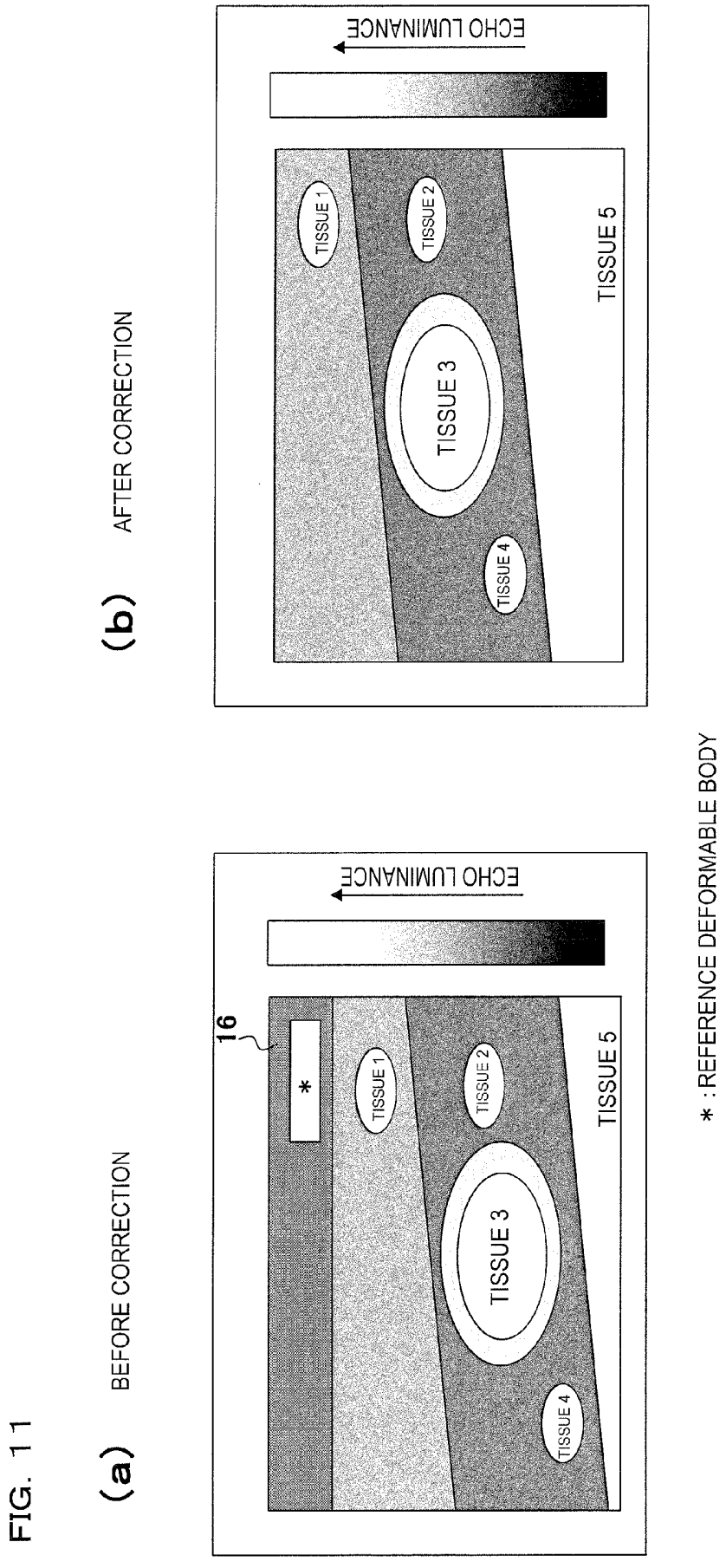

15
PRESSURE CALCULATING UNIT
10
ELASTICITY MODULUS CALCULATING UNIT
30
REFERENCE DEFORMABLE BODY INFORMATION ACQUIRING UNIT
54
TYPE SPECIFYING UNIT
62
IMAGE PROCESSING UNIT
60
IMAGE ANALYZING UNIT
52
MEMORY
36
CINE MEMORY
32
CONTROL UNIT
34
INPUT UNIT

FIG. 11


(a) BEFORE CORRECTION
(b) AFTER CORRECTION
ECHO LUMINANCE
TISSUE 1
TISSUE 2
TISSUE 3
TISSUE 4
TISSUE 5
16
*
* : REFERENCE DEFORMABLE BODY

REFERENCE DEFORMABLE BODY, ULTRASONIC DIAGNOSTIC APPARATUS, AND ULTRASONIC DIAGNOSTIC METHOD

FIELD OF THE INVENTION

[0001] The present invention relates to a reference deformable body to be attached on an ultrasonic wave transmission/reception surface of an ultrasonic probe, an ultrasonic diagnostic apparatus and ultrasonic diagnostic method for displaying a tomographic image of an imaging target portion in an object to be examined using ultrasonic waves or an elasticity image which presents hardness or softness of biological tissues.

DESCRIPTION OF RELATED ART

[0002] An ultrasonic diagnostic apparatus transmits an ultrasonic wave to the inside of an object to be examined using an ultrasonic probe, receives the reflected echo signal of the ultrasonic wave from the inside of the object according to the structure of the biological tissue, and constructs a tomographic image such as a B-mode image to display for diagnosis.

[0003] Ultrasonic diagnostic apparatuses of recent years measure an ultrasonic wave receiving signal by pressing an object using an ultrasonic probe manually or mechanically, acquire displacement of the tissues, and display an elasticity image of the biological tissues based on the acquired displacement data. At this time, the method has been disclosed wherein a reference deformable body is attached to the ultrasonic probe via a fixing member, the border between the object and the reference deformable body is detected from the RF signal frame data acquired by transmission and reception of the ultrasonic waves, and the pressure applied to the object is measured from the positional information of the border (for example, Patent Document 1).

PRIOR ART DOCUMENT

Patent Document

[0004] Patent Document 1: WO2005/120358

[0005] There are various types of reference deformable bodies to be attached to an ultrasonic probe. For example, since there are different sizes or shapes of ultrasonic probes, the size or shape of the reference deformable body best suited to each of those probes would be also different. For a linear-type ultrasonic probe, a linear-type reference deformable body is to be attached. For a convex-type of ultrasonic probe, a curved reference deformable body is to be attached. Also, when depth or size of a measuring portion or physical attribute of the object is different, hardness or thickness of the reference deformable body needs to be changed. In this manner, it is necessary to switch types of the reference deformable body to have optimal feature according to the measurement condition.

[0006] However, if the type of the reference deformable body is not identified, elasticity modulus calculation or ultrasonic wave transmission/reception setting cannot be executed properly.

[0007] The objective of the present invention is to identify the type of a reference deformable body to be attached to an ultrasonic probe.

SUMMARY OF THE INVENTION

[0008] In order to achieve the objective of the present invention, the ultrasonic diagnostic apparatus comprises:

[0009] an ultrasonic probe having the ultrasonic wave transmitting/receiving surface on which a reference deformable body is attached;

[0010] a tomographic image constructing unit configured to transmit/receive an ultrasonic wave to/from an object to be examined via the reference deformable body, and generate a tomographic image based on the RF signal frame data of the cross-sectional region of the object; and

[0011] a display unit configured to display the tomographic image,

[0012] characterized in further comprising:

[0013] a storing unit configured to store the relationship between an ID given to the reference deformable body and the type of the reference deformable body; and

[0014] a type identifying unit configured to read out the type of the reference deformable body corresponding to the ID of the reference deformable body attached to the ultrasonic probe and to identify the type of the reference deformable body. Consequently, the type of the reference deformable body can be identified.

[0015] It also comprises an image analyzing unit configured to analyze feature quantity of the reference deformable body in the tomographic image, wherein:

[0016] the storing unit stores the relationship between the analyzed feature quantity of the reference deformable body and the type of the reference deformable body; and

[0017] the type identifying unit reads out the type of the reference deformable body corresponding to the feature quantity of the reference deformable body in the newly-obtained tomographic image, and identifies the type of the reference deformable body. Consequently, the type of the reference deformable body can be identified.

[0018] Furthermore, it comprises an image processing means configured to shift a tomographic image or an elasticity image toward the ultrasonic probe side in accordance with the thickness of the reference deformable body identified in the type identifying means. Furthermore, it comprises an ultrasonic wave transmission/reception control unit configured to control the focus of the ultrasonic wave in accordance with the thickness of the reference deformable body identified by the type identifying means, so that the ultrasonic wave will not be focused on the reference deformable body.

[0019] In the present invention, the type of a reference deformable body can be identified, and the information thereof can be reflected to calculation of elasticity or displayed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** shows the general configuration of the present invention.

[0021] FIG. **2** shows the attachment pattern of a reference deformable body related to the present invention.

[0022] FIG. **3** shows the display pattern of an ID related to the present invention.

[0023] FIG. **4** shows the first embodiment of the present invention.

[0024] FIG. **5** shows an embodiment of pressure measurement related to the present invention.

[0025] FIG. **6** shows the second embodiment of the present invention.

[0026] FIG. **7** shows a tomographic image of a reference deformable body in which scatterer is included, which is related to the present invention.

[0027] FIG. **8** shows a tomographic image of a reference deformable body formed by a plurality of different layers, which is related to the present invention.

[0028] FIG. **9** shows a tomographic image of a reference deformable body including bar code, which is related to the present invention.

[0029] FIG. **10** shows the third embodiment of the present invention.

[0030] FIG. **11** shows tomographic images before and after receiving correction process.

DESCRIPTION OF REFERENCE NUMERALS

[0031] **1**: ultrasonic wave transmission/reception control circuit, **2**: transmitting circuit, **3**: ultrasonic probe, **4**: receiving circuit, **5**: phasing and adding circuit, **6**: signal processing unit, **7**: black and white scan converter, **8**: RF signal frame data selecting unit, **9**: displacement/strain calculating unit, **10**: elasticity modulus calculating unit, **11**: elasticity data processing unit, **12**: color scan converter, **13**: switching and adding unit, **14**: image display unit, **15**: pressure calculating unit, **16**: reference deformable body, **30**: reference deformable body information acquiring unit, **32**: control unit, **34**: input unit, **36**: cine memory

DETAILED DESCRIPTION OF THE INVENTION

[0032] An embodiment of the present invention will be described referring to the diagrams. FIG. **1** shows a block diagram of the ultrasonic diagnostic apparatus related to the present invention. An ultrasonic diagnostic apparatus is for acquiring a tomographic image of a measuring portion in an object to be examined using ultrasonic waves and displaying an elasticity image that presents hardness or softness of biological tissues.

[0033] The ultrasonic diagnostic apparatus is Configured comprising ultrasonic wave transmission/reception control circuit **1**, transmitting circuit **2**, ultrasonic probe **3**, receiving circuit **4**, phasing and adding circuit **5**, signal processing unit **6**, black and white scan converter **7**, RF signal frame data selecting unit **8**, displacement/strain calculating unit **9**, elasticity modulus calculating unit **10**, elasticity data processing unit **11**, color scan converter **12**, switching and adding unit **13**, image display unit **14**, pressure calculating unit **15**, reference deformable body **16**, reference deformable body information acquiring unit **30**, control unit **32**, input unit **34** and cine memory **36** as shown in FIG. **1**.

[0034] Ultrasonic probe **3** is formed by disposing multiple strips of transducers therein, for transmitting and receiving ultrasonic waves to/from an object by scanning beams mechanically or electronically. Each transducer generally has the function that converts incoming pulse waves or continuous transmitting signals into ultrasonic waves and discharges the converted ultrasonic waves, and the function that converts the reflected echoes discharged from inside of the object into electronic signals (reflected echo signals) and outputs the converted signals.

[0035] Reference deformable body **16** is attached on the ultrasonic wave transmitting/receiving surface of ultrasonic probe **3**. Reference deformable body **16** is to be applied on the body surface of the object to give compression. Compressing motion renders transmission/reception of ultrasonic waves via ultrasonic probe, and provides stress distribution to the measuring portion in the body cavity.

[0036] Ultrasonic wave transmission/reception control circuit **1** controls the timing or focus for transmitting and receiving ultrasonic waves. Transmitting circuit **2** produces transmission pulses for generating ultrasonic waves by driving ultrasonic probe **3**, and sets the convergent point (focus) of the ultrasonic waves transmitted by an internal transmission phasing and adding circuit at a certain depth. Receiving circuit **4** amplifies the reflected echo signal received by ultrasonic probe **3** at a predetermined gain. The number of reflected echo signals which corresponds to the number of the amplified respective transducers is inputted to phasing and adding circuit **5**. Phasing and adding circuit **5** controls the phase of the reflected echo signal amplified in receiving circuit **4**, and forms RF signal frame data.

[0037] Signal processing unit **6** and black and white scan converter **7** are provided on one end of the output side of phasing and adding circuit **5**. Signal processing unit **6** inputs the RF signal frame data from phasing and adding circuit **5**, and executes various signal processing such as gain compensation, log compensation, detection, edge enhancement and filtering.

[0038] Black and white scan converter **7** obtains the RF signal frame data signal processed in signal processing unit **6** at a predetermined cycle, and reads out the tomographic image data based on the RF signal frame data at TV system cycle.

[0039] Also, RF signal frame data selecting unit **8**, displacement/strain calculating unit **9**, pressure calculating unit **15** and elasticity modulus calculating unit **10** are comprised on the output side of the other end of phasing and adding circuit **5**. Also, elasticity data processing unit **11** and color scan converter **12** are comprised on the latter part of elasticity modulus calculating unit **10**.

[0040] On the output side of black and white scan converter **7** and color scan converter **12**, switching and adding unit **13** is comprised. Image display unit **14** is a monitor for displaying a tomographic image based on the tomographic image data obtained by black and white converter **7** and an elasticity image based on the elasticity image data obtained by the color scan converter. Cine memory **36** on the output side of switching and adding unit **13** is for storing tomographic image data and elasticity image data with time information. The tomographic image data and elasticity image data stored in cine memory **36** are displayed on image display unit **14** according to the command from input unit **34**.

[0041] RF signal frame data selecting **8** sequentially stores the RF signal frame data outputted from phasing and adding circuit **5** (the currently stored RF signal frame data is set as RF signal frame data N) in the frame memory provided in RF frame data selecting unit **8**, selects one set of RF signal frame data from among the past RF signal frame data N−1, N−2, N−3, . . . N−M (the selected data is set as RF signal frame data X), and outputs a pair of RF signal frame data N and RF signal frame data X to displacement/strain calculating unit **9**. While RF signal frame data is described above as the signal to be

outputted from phasing and adding circuit **5**, it may also be the form of I,Q signal which is the complex-demodulated RF signal.

[0042] Displacement/strain calculating unit **9** executes one-dimensional or two-dimensional correlationship process based on the pair of RF signal frame data selected by RF signal frame data selecting unit **8**, measures displacement or moving vector (direction and size of displacement) of the respective measurement points on a tomographic image, generates displacement frame data, and calculates the strain from the generated strain frame data. The strain is to be calculated, for example, by performing spatial differentiation on the displacement. The moving vector is to be detected, for example, using the block matching method or the gradient method. Block matching method divides an image into blocks formed by, for example, N×N pixels, searches the block which is most approximated to the target block in the current frame from the previous frame, and performs encoding referring to the searched blocks.

[0043] Elasticity modulus calculating unit **10** calculates elasticity modulus from the strain information outputted from displacement/strain calculating unit **9** and from the pressure information outputted from pressure calculating unit **15**, generates numerical data of the elasticity modulus (elasticity frame data), and outputs the generated data to elasticity data processing unit **11** and color scan converter **12**. One of elasticity modulus, for example, Young's modulus Ym is to be obtained by dividing the stress (pressure) in each calculation point by the strain in each calculation point, as shown in the equation below. In the equation below, the index of i,j represents the coordinate of the frame data.

$$Ymi,j=\text{pressure(stress)}i,j/(\text{strain } i,j)(i,j=1, 2, 3 \ldots) \quad \text{[Equation 1]}$$

[0044] Here, the pressure given to the object is measured in pressure measuring unit **15**. Pressure measuring unit **15** obtains the pressure given to reference deformable body **16** by calculation, and outputs it as the pressure given to the object. The detail on this step will be described later.

[0045] Elasticity data processing unit **11** executes various image processing such as smoothing process in the coordinate plane of the calculated elasticity frame data, contrast optimization process, or smoothing process among the frames in the time axis direction.

[0046] Color scan converter **12** provides color information on light's three primary colors that are red(R), green(G) and blue(B) to the elasticity frame data outputted from elasticity data processing unit **11**. For example, large elasticity modulus is converted into red color code, and small elasticity modulus is converted into blue color code.

[0047] Also, object pressing mechanism **18** moves ultrasonic probe **3** in vertical directions using a device such as motor or wire so as to press the object, or an operator may manually move ultrasonic probe **3** in vertical direction.

First Embodiment

Manual Input of ID

[0048] Here, the first embodiment will be described referring to FIGS. **1**~**5**. In the first embodiment, an operator inputs an ID to make an ultrasonic diagnostic apparatus to identify the type of a reference deformable body, for reflecting the type to elasticity calculation or displaying the type. This ID is to be the index for identifying the type of the reference deformable body.

[0049] The ultrasonic diagnostic apparatus of the first embodiment mainly comprises input unit **34** configured to input an ID of reference deformable body **16**, control unit **32** configured to make the ID inputted by input unit **34** to be outputted to reference deformable body information acquiring unit **30**, reference deformable information acquiring unit **30** configured to acquire the type of reference deformable body **16** corresponding to the outputted ID and to reflect the type of reference deformable body **16** to calculation in pressure calculating unit **15** or elasticity modulus calculating unit **10**.

[0050] First, attachment pattern of reference deformable body **16** will be described using FIG. **2**. As shown in FIG. **2**(*a*), fixing member **17** is formed by frame body **20** having airspace in the center thereof and a pair of holding units **21** extended downward from the bottom surface of frame body **20**. Frame body **20** and holding units **21** are formed being integrated with each other. On holding unit **21**, a protruded portion is provided so as to fit in the slot on the side portion of ultrasonic probe **3** (not illustrated in the diagram). Accordingly, fixing member **17** can be mounted to ultrasonic probe **3** through one-touch operation. Also, on the inner-peripheral surface of the airspace in frame body **20**, slot portion **22** is provided for holding reference deformable body **16**. The width of lot portion **22** is about 3 mm, and the depth thereof is about 5 mm.

[0051] As shown in FIG. **2**(*b*), reference deformable body **16** has a form wherein rectangle body **26** is provided to the central portion on the upper surface of a square-shaped flat-plate body **25**. Rectangle body **26** of reference deformable body **16** has the size which can be protruded from the airspace in fixing member **17**. Also, flat-plate body **25** has about 3 mm of thickness which can be fit in slot portion **22** of fixing member **17**.

[0052] Reference deformable body **16** is formed based on oil-based gel material, water-based gel material such as acrylamide or silicon, etc. Acrylamide is formed as acrylamide gel wherein cross-linking agent (BIS) is polymerized in the presence of catalytic agent. This is polymer gel having 3-dimensional meshed structure, and has texture like agar or gelatin. In this manner, the material that is a liquid solution and gets coagulated over time into a gel after coagulating agent is mixed in is preferable for reference deformable body **16**. If it is constituted by the material such as acrylamide having low viscosity, it is suited for pressure measurement since it responds to pressing operation quickly. Also, reference deformable body **16** may also be formed by a material based on aqueous resin gelled substance which is to be used as a phantom for diagnosis using ultrasonic waves.

[0053] FIG. **2**(*c*) shows a pattern wherein reference deformable body **16** is attached to fixing member **17**. The end portion of flat-plate body **25** is inserted into slot portion **22** formed on the inner-peripheral surface of frame body **20**, and reference deformable body **16** is attached to fixing member **17**. Since flat-plate body **25** which is reference deformable body **16** is an elastic body, flat-plate body **25** can be mounted in slot portion using the elasticity. Accordingly, when reference deformable body **16** is attached to fixing member **17**, rectangle body **26** of reference deformable body **16** is protruded from frame body **20** of fixing member **17**.

[0054] FIG. **2**(*d*) shows the cross-sectional view in the longitudinal direction of the condition that reference deformable body **16** and fixing member **17** are fixed on ultrasonic probe **3**. In the condition that reference deformable body **16** is attached

to fixing member **17** as shown in FIG. **2**(*c*), fixing member **17** is fixed on ultrasonic probe **3** via holding unit **22**. When fixing member **17** is fixed on ultrasonic probe **3**, reference deformable body **16** comes to contact transducers **19** provided on the upper part of ultrasonic probe **3**. In this condition, the upper surface of reference deformable body **16** is applied to an object, and executes transmission/reception of ultrasonic waves from/to transducers **19**.

[0055] Also, as shown in FIG. **3**, reference deformable body **16** or package **40** of reference deformable body **16** has ID **40**.

[0056] (1-1: ID on a Reference Deformable Body)

[0057] Concretely, as shown in FIG. **3**(*a*), ID **40** formed by letters is appended on the side surface of reference deformable body **16**. ID **40** is, for example, "BBAC" formed by four alphabetical letters. ID **40** is appended on the side surface (the part which does not contact the object) of reference deformable body **16** to avoid the influence thereof in transmission and reception of ultrasonic waves to/from the object. An operator can identify ID **40** by the order of alphabetical letters through checking ID **40** on the side surface of reference deformable body **16**. ID **40** may be presented also by numbers, symbols, figures, colors, and so on.

[0058] Also, as shown in FIG. **3**(*b*), by providing concavity and convexity for imprinting ID **40** in advance on a metal mold to form reference deformable body **16** and inpouring gel material of reference deformable body in the metal mold, ID **40** formed by concavity and convexity can be formed on the side surface of reference deformable body **16**. The operator can identify ID **40** by seeing or touching the concavity and convexity of ID **40** formed on the side surface of reference deformable body **16**. Also, surface treatment such as sawtooth or wave pattern may be worked on the side surface of reference deformable body **16**.

[0059] Also, ID **40** may be identified by dyeing reference deformable body **16**. For example, if reference deformable body **16** is white ID **40** is set as "BBAC", and if reference deformable body **16** is yellow ID **40** is set as "AAAA".

[0060] (1-2: ID on a Package)

[0061] As shown in FIG. **3**(*c*), ID **40** may be appended on case **42** which is for packaging reference deformable body **16**. Case **42** has case part **46** having airspace therein and cover part **44**, and reference deformable body **16** is contained and sealed between case part **46** and cover part **44**. By sealing and containing reference deformable body **16** inside of case **42**, deterioration of reference deformable body **16** can be minimized by keeping out dust or air.

[0062] The operator can identify the alphabetical letters, i.e. ID **40** of reference deformable body by seeing ID **40** on the case for packaging reference deformable body **16**.

[0063] (1-3: Manual Input of ID)

[0064] Next, as shown in FIG. **4**, the operator inputs ID **40** of reference deformable body **16** or ID **40** described on case **42** for containing reference deformable body **16** to input unit **34**. Control unit **32** outputs ID **40** inputted by input unit **34** to reference deformable body information acquiring unit **30**, and gives a command to identify the type of reference deformable body **16**. Then reference deformable body information acquiring unit **30** identifies the type of reference deformable body **16** from the outputted ID **40**, and reflects the type of reference deformable body **16** to calculation to be executed by pressure calculating unit **16** and elasticity modulus calculating unit **10**. Also, reference deformable body information acquiring unit **30** displays the type of reference deformable body **16** on image display unit **14**.

[0065] In concrete terms, reference deformable body information acquiring unit **30** is formed by ID information receiving unit **50** for receiving the inputted ID **40** of reference deformable body **16**, memory **52** for storing a plurality of relationships between IDs **40** of reference deformable body **16** and types of reference deformable body **16** in advance, and type identifying unit **54** for identifying the type of reference deformable body **16** corresponding to the inputted ID **40** based on the information stored in memory **52**. Also, in memory **52**, one type of reference deformable body (such as thickness, elasticity characteristic, acoustic characteristic and type of the probe) is stored corresponding to one ID **40** as shown in chart 1 below.

CHART 1

ID	Thickness (mm)	Elasticity characteristics (N/m)	Acoustic characteristics ($N \cdot s/m^3$)	Kind of probe (Applying part)
AAAA	8	100	1.5×10^6	Linear type
BAAA	7	100	1.5×10^6	Linear type
BBAA	7	50	1.5×10^6	Linear type
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
DDDD	5	30	1.0×10^6	Intracavitary type

[0066] Here, the thickness of reference deformable body **16** is the thickness of reference deformable body in the transmitting/receiving direction of ultrasonic waves, and is the initial thickness before applying pressure. Elasticity characteristics indicate elasticity modulus, viscoelasticity modulus, nonlinearity, Poisson's ratio, etc. of reference deformable body **16**. In the present embodiment, elasticity modulus is used as elasticity characteristic. Also, acoustic characteristics indicate acoustic velocity, rate of decrease, acoustic impedance, etc. of reference deformable body **16**. In the present embodiment, acoustic impedance is used as acoustic characteristic. The type of probe indicates the type of ultrasonic probe **3** to which reference deformable body **16** is attached. For example, there are different types such as linear type of ultrasonic probe **3** for pressing from outside of the body or a convex type of ultrasonic probe **3**, or an intracavitary type of ultrasonic probe **3** for pressing from inside of the object's body, and the applying part is to be determined.

[0067] The four alphabetical letters which indicate ID **40** respectively correspond to the type of each reference deformable body **16**. The far-left alphabet corresponds to the thickness of each reference deformable body **16**. For example, if the far left alphabet is A, it means that the thickness of the reference deformable body is 8 mm, B indicates that the thickness of the reference deformable body is 7 mm, C indicates that the thickness of the reference deformable body is 6 mm, and D indicates that the thickness of the reference deformable body is 5 mm. In this manner, the operator can recognize the thickness of reference deformable body **16** by only looking at ID **40**. In the same manner, the second left alphabet corresponds to the elasticity characteristics. The third left alphabet corresponds to the acoustic characteristic, and the far-right alphabet corresponds to the type of ultrasonic probe to which reference deformable body **16** is attached.

[0068] Then kind identifying unit **54** identifies the kind of reference deformable body **16** corresponding to the inputted ID **40** by reading it out from memory **52**. Input unit **34** may also input the information on characteristics (for example, elasticity characteristics, etc. of reference deformable body **16**) of reference deformable body **16** instead of ID **40**.

[0069] (1-4: Pressure Measurement)

[0070] Type identifying unit **54** outputs the type of reference deformable body **16** to pressure calculating unit **15**. Pressure calculating unit **15** detects the thickness and the elasticity modulus in particular from among the types of reference deformable body **16** (thickness, elasticity characteristics, acoustic characteristics, type of probe, etc.) outputted from reference deformable body information acquiring unit **30**. The detected thickness is the initial thickness of reference deformable body **16** before pressure is applied to the object.

[0071] Pressure calculating unit **15** obtains the strain of reference deformable body **16** deformed by the pressure applied to the object, from the RF signal frame data outputted from RF signal frame data selecting unit **8**. In concrete terms, pressure calculating unit **15** first extracts the RF signal frame data in the region including the border between the object and reference deformable body **16**. Then it obtains the coordinate of the border between the object and reference deformable body **16** based on the extracted RF signal frame data. For example, the threshold value is set with respect to the amplitude of the signal wave pattern of the RF signal frame data including the border, the threshold value is set as original point 0 in the depth direction (contact plane of the transducer and reference deformable body **16**), and the coordinate wherein the amplitude of the waveform of the RF signal frame data first surpasses the threshold value from in the depth direction from the original point is detected as the coordinate of the border.

[0072] While the border between the object and reference deformable body **16** is detected above based on the RF signal frame data, the tomographic image data outputted from black and white scan converter **16** may also be used for detecting the border. FIG. **5**(*a*) shows the condition of reference deformable body **16** before pressure is applied on the object. FIG. **5**(*b*) shows the condition of reference deformable body **16** after pressure is applied on the object. Pressure calculating unit **15** detects the coordinate of the border in the tomographic image based on the difference of the acoustic characteristics (acoustic velocity, rate of decrease and acoustic impedance) between tissue **1** and reference deformable body **16**.

[0073] Then pressure calculating unit **15** associates the initial thickness of reference deformable body **16** before pressure is applied with the coordinate of the border. Also, pressure calculating unit **15** calculates the displacement of reference deformable body **16** from the coordinate of the border after pressure is applied, based on the association between the initial thickness and the coordinate of the border. Pressure calculating unit **15** then calculates the strain from the calculated displacement and the initial thickness.

[0074] Also, elasticity modulus (a part of elasticity characteristics) of reference deformable body **16** is identified by type identifying unit **54** based on ID **40**. Consequently, by setting P as (pressure(stress)), Y as (elasticity modulus) and δd as (strain), their relationship can be expressed by the following equation.

$$P(\text{pressure(stress)})=Y(\text{elasticity modulus})\times\delta d(\text{strain}) \quad \text{[Equation 2]}$$

[0075] Pressure calculating unit **15** can obtain the pressure in the border between the object and reference deformable body **16** based on the above-mentioned equation 2.

[0076] (1-5: Calculation of Elasticity Modulus)

[0077] Elasticity modulus calculating unit **10** calculates elasticity modulus based on the above equation 1 from the strain information outputted from displacement/strain calculating unit **9** and the pressure information outputted from pressure calculating unit **15**, and generates numerical data (elasticity frame data) of the elasticity modulus. Elasticity modulus calculating unit **10** outputs the elasticity frame data to elasticity data processing unit **11**.

[0078] Color scan converter **12** appends hue information to the elasticity frame data outputted from elasticity data processing unit **11**, and image display unit **14** displays the elasticity image based on the elasticity image data acquired by the color scan converter. Though not shown in the diagram, image display unit **14** may also display the elasticity modulus outputted from elasticity modulus calculating unit **10** by numerical values.

[0079] As described above, in accordance with the present embodiment, it is possible to identify the type of reference deformable body **16** by ID **40**, and to reflect the identified information on elasticity calculation, whereby calculation of elasticity can be more stable.

[0080] (1-6: ID Display)

[0081] Also, type identifying unit **54** outputs the type of reference deformable body **16** or ID **40** to cine memory **36**. Cine memory **36** stores the type of reference deformable body **16** or the information on ID **40** along with the elasticity image or tomographic image. Image display unit **14** outputs the type of reference deformable body **16** or the information on ID **40** along with the elasticity image or tomographic image from cine memory **36** and displays them. In this manner, the type of the reference deformable body or ID **40** can be displayed.

[0082] The operator can execute the setting of ultrasonic waves properly since the type of reference deformable body **16** or ID **40** can be identified. Also, after performing the ultrasonic diagnosis, he/she can identify which type of reference deformable body was used for obtaining the elasticity image or tomographic image upon reviewing the elasticity image or tomographic image obtained by applying reference deformable body **16**.

[0083] Also, dedicated information on ultrasonic probe **3** is appended to ID **40** as shown in chart 1. Though not shown in the diagram, it is possible to set the procedure to display the warning or to make sounds when reference deformable body **16** is applied to a nondedicated ultrasonic probe **3** and transmission/reception of ultrasonic waves is executed.

Second Embodiment

ID Automatic Identification

[0084] (2-1: Echo Luminance)

[0085] Here, the second embodiment will be described using FIG. **6**~FIG. **9**. The difference from the first embodiment is that ID **40** of reference deformable body **16** is automatically identified.

[0086] Reference deformable body information identifying unit **30** is formed by image analyzing unit **60** configured to the tomographic image stored in cine memory **36**, memory **52** configured to store the relationship between a plurality of IDs **40** of reference deformable body **16** and feature quantity of the tomographic image of reference deformable body **16** in

advance, and type identifying unit **54** configured to identify the type of reference deformable body **16** corresponding to the inputted tomographic image based on the information stored in memory **52**.

[0087] Reference deformable body **16** includes, for example, a scatterer. Image analyzing unit **60** analyses the echo luminance in the tomographic image of reference deformable body **16** in which the scatterer outputted from cine memory **36** is included. The memory **52** stores plural echo luminance (0~255) of reference deformable body **16** by associating them with ID **40** respectively. For example, as shown in chart 2, it is assumed that there are two kinds (ID **40**: α,β) of reference deformable bodies **16** having different elasticity modulus or scatterer concentration that are stored in memory **52**. It is also assumed that the ultrasonic waves are transmitted/received to/from the respective reference deformable bodies **16** in the same condition.

CHART 2

ID	Elasticity modulus (kPa)	Scatterer concentration (%)	Echo luminance (0~255)	Thickness (mm)
α	10	1	50	8
β	20	3	100	7

[0088] FIG. **7** are tomographic images in the case that reference deformable body **16** (α,β) in which scatterer is included is attached. FIG. **7**(*a*) is a tomographic image in the case that reference deformable body **16** having α as ID **40** is attached, and FIG. **7**(*b*) is a tomographic image in the case reference deformable body **16** having β as ID **40** is attached.

[0089] The echo luminance of reference deformable body **16** is displayed in the region where is shallow in depth (for example, 0~5 mm) in the tomogaphic image. Image analyzing unit **60** analyzes the echo luminance in the shallow region of the tomographic image stored in cine memory **36**. For example, image analyzing unit **60** sets ROI **70** in reference deformable body **16** of the tomographic image, and analyzes the luminance information in ROI **70**. This ROI **70** is set via input unit **34** as one chooses. Also, it may be set so that ROI **70** is automatically set in the region which is shallow in depth (for example, 0~5 mm) in the tomographic image.

[0090] Image analyzing unit **60** analyzes statistical characteristics of the echo luminance such as the average value or dispersion value of the echo luminance in ROI **70**. Then type identifying unit **54** reads out the type of reference deformable body **16** corresponding to the characteristics of the echo luminance in the analyzed tomographic image from memory **52** and identifies it.

[0091] In concrete terms, if the average value of the echo luminance in ROI **70** is "50", type identifying unit **54** identifies that ID **40** of reference deformable **16** is α. Also, if the average value of the echo luminance in ROI **70** is "100", type identifying unit **54** identifies that ID **40** of the reference deformable body is β.

[0092] Then type identifying unit **54** outputs the type (here, elasticity modulus, scatterer concentration, echo luminance and thickness) or ID **40** of reference deformable body **16** to cine memory **36**. Cine memory **36** stores the information on the type or ID **40** of reference deformable body **16** along with the elasticity image or tomographic image. Image display unit **14** outputs the information on the type or ID **40** of reference deformable body **16** along with the elasticity image or tomographic image from cine memory **36**, and displays them. Accordingly, the operator can identify the type or ID **40** of reference deformable body, and set ultrasonic waves appropriately. Also, he/she can identify the type of reference deformable body **16** used for obtaining the elasticity image or tomographic image.

[0093] Also, as in the same manner as the first embodiment, elasticity modulus may be calculated based on the type of reference deformable body **16**. Type identifying unit **54** outputs the type of reference deformable body **16** to pressure calculating unit **15**, and pressure calculating unit **15** calculates the pressure. Then elasticity modulus calculating unit **10** calculates elasticity modulus from the strain information outputted from displacement/strain calculating unit **9** and the pressure information outputted from pressure calculating unit **15**, and generates the numerical data (elasticity frame data) of the elasticity modulus. Image display unit **14** displays the elasticity image or elasticity modulus based on the generated elasticity frame data.

[0094] (2-2: Attenuation Characteristics)

[0095] While the type of reference deformable body **16** is identified above from the average value of the echo luminance in reference deformable body **16**, there are cases, for example, that approximately average echo luminance is distributed even when the scatterer concentration of reference deformable body **16** is greatly different.

[0096] Given this factor, type identifying unit **54** may identify the type of reference deformable body **16** from attenuation characteristic of reference deformable body **16**. Attenuation characteristic is the feature that ultrasonic waves attenuate in proportion to the scatterer concentration. Image analyzing unit **60** analyzes the attenuation characteristics from distribution of the intensity of echo luminance in reference deformable body **16**. The intensity of echo luminance in reference deformable body **16** has the characteristic that it attenuates as moving from the shallow depth portion to the deep portion.

[0097] When the ultrasonic waves having low transmitting voltage are transmitted/received to/from ultrasonic probe **3** and the scatterer concentration of reference deformable body **16** is high, attenuation rate is great and the intensity of echo luminance attenuates drastically. ID **40** in this condition is set as α. Also, when the ultrasonic waves having high transmitting voltage are transmitted/received to/from ultrasonic probe **3** and the scatterer concentration is low, attenuation rate is small and the intensity of echo luminance attenuates gradually. ID **40** of this reference deformable body **16** is set as β. The relationship between the attenuation of reference deformable body **16** and ID **40** is stored in memory **52**.

[0098] Image analyzing unit **60** analyzes the attenuation rate from the distribution of the intensity in echo luminance of the scatterer in ROI **70**. Then type identifying unit **54** reads out and identifies the type of reference deformable body **16** corresponding to the attenuation rate from memory **52**. Type identifying unit **54**, in the case that the attenuation rate in ROI **70** is high, identifies that ID **40** of reference deformable body **16** is α. In the case that the attenuation rate in ROI is low, it identifies that ID **40** of reference deformable body **16** is β.

[0099] (2-3: Pattern of Scatterer)

[0100] Also, type identifying unit **54** may identify the type of reference deformable body **16** from density distribution (rarefaction density) of scatterer in reference deformable body **16**.

[0101] For example, in the case that density distribution of the scatterer of reference deformable body **16** gets higher as it moves from the shallow region to the deep region, ID **40** of reference deformable body **16** is set as α. In the case that the density distribution of the scatterer of reference deformable body **16** gets lower as it moves from the shallow region to the deep region, ID **40** of reference deformable body **16** is set as β. The relationship between the scatterer distribution of reference deformable body **16** and ID **40** is to be stored in memory **52**.

[0102] Image analyzing unit **60** analyzes density distribution of the scatterer from the echo luminance in ROI **70**. Then type identifying unit **54** reads out and identifies the type of reference deformable body **16** corresponding to the density distribution of the analyzed scatterer from memory **52**.

[0103] Type identifying unit **54**, in the case that the echo luminance in ROI **70** gets lower as it moves from the shallow region to the deep region, identifies that ID **40** of reference deformable body **16** is α. Type identifying unit **54**, in the case that the echo luminance in ROI **70** gets higher as it moves from the shallow region to the deep region, identifies that ID **40** of reference deformable body **16** is β. Type identifying unit **54** may also identify the type of reference deformable body **16** based on discreteness (dispersion in normal distribution) of the echo luminance distribution in the scatterer of reference deformable body **16**.

[0104] (2-4: Size and Form of Scatterer)

[0105] Also, deformable body type identifying unit **54** may identify the type of reference deformable body **16** from the size of the scatterer. For example, when the size of the scatterer included in reference deformable body **16** is 5 μm, ID **40** of reference deformable body **16** is set as α. When the size of the scatterer included in reference deformable body **16** is 10 μm, ID **40** of reference deformable body is set as β. At this time, it is to be assumed that a plurality of scatterers having even size are included in reference deformable body **16**. The relationship between the size of the scatterer in reference deformable body **16** and ID **40** is stored in memory **52**.

[0106] Image analyzing unit **60** analyzes the size of the scatterer from echo luminance in ROI **70**. Then type identifying unit **54** reads out and identifies the type of reference deformable body **16** corresponding to the size (5 μm or 10 μm) of the analyzed scatterer. Also, deformable body type identifying unit **54** can also identify the form of the scatterer in reference deformable body **16** using the pattern matching method. It is set so that the form of the scatterer is different for each ID **40** of reference deformable body **16**.

[0107] The relationship between the form of the scatterer of reference deformable body and ID **40** is stored in memory **52**. Image analyzing unit **60** analyzes the form of the scatterer from the echo luminance in ROI **70**. Then type specifying unit **54** executes the pattern matching method between the form of the scatterer stored in memory **54** and the form of the analyzed scatterer. Type identifying unit **54** reads out and identifies the type of reference deformable body **16** including the best matched scatterer stored in the memory.

[0108] (2-5: Layer and Barcode)

[0109] Also, deformable body type identifying unit **54** may identify the type by the pattern or barcode of reference deformable body **16**. As shown in FIG. **8**, reference deformable body **16** is assumed to be formed by a plurality of different kinds of layers (layer **1** and layer **2**). Layer **1** is on the side of ultrasonic probe **3**, and layer **2** is on the side of the object.

[0110] As shown in FIG. **8**(*a*), in the case that the ratio between layer **1** and layer **2** of reference deformable body **16** is (layer **1**:layer **2**=1:2), ID **40** of reference deformable body **16** is set as α. As shown in FIG. **8**(*b*), in the case that the ratio thereof is (layer **1**:layer **2**=1:1), ID **40** of reference deformable body is set as β. The relationship between the ratio between the layers of reference deformable body **16** and ID **40** is stored in memory **52**.

[0111] Image analyzing unit **60** analyzes the ratio between layer **1** and layer **2** of reference deformable body **16** from the echo luminance of an elasticity image. In concrete terms, image analyzing unit **60** detects the border between layer **1** and layer **2**, and the border between layer **2** and tissue **1** based on the echo luminance. Then image analyzing unit **60** detects the height of layer **1** and layer **2** in the depth direction from the respective borders. Type identifying unit **54** then reads out and identifies ID **40** of reference deformable body **16** corresponding to the detected ratio between layer **1** and layer **2** from memory **52**.

[0112] Also, as shown in FIG. **9**, it is assumed that mark **72** formed by barcodes is appended to the side of reference deformable body **16**. As shown in FIG. **9**(*a*), in the case that reference deformable body **16** includes one strip of barcode, ID **40** of reference deformable body **16** is set as α. As shown in FIG. **9**(*b*), in the case that reference deformable body **16** includes two strips of barcodes, ID **40** of reference deformable body **16** is set as β. The relationship between the number of strips in barcode and ID **40** of reference deformable body **16** is stored in memory **52**. The echo luminance of barcode should be different from the echo luminance of reference deformable body **16**. The array direction of the barcode is the major-axis direction or minor-axis direction of reference deformable body **16**.

[0113] Image analyzing unit **60** analyzes the number of strips of barcode in reference deformable body **16** from the echo luminance of the elasticity image. Then type identifying unit **54** reads out and identifies ID **40** of reference deformable body **16** corresponding to the analyzed number of strips of barcode from memory **52**.

[0114] While barcode is used as mark **72** here, a concave portion or notch may also be used. Also, by stretching a very thin string (for example, a fish line) inside of reference deformable body **16** along the minor-axis direction of reference deformable body **16**, the information on the number of the strings or interval between the strips may be also used as mark **72**.

Third Embodiment

Image Processing

[0115] The third embodiment will now be described referring to FIGS. **10** and **11**. The difference from the first embodiment and the second embodiment is that image processing is executed by identifying the type of reference deformable unit **16**.

[0116] As shown in FIG. **10**, reference deformable body information acquiring unit **30** has image processing unit **62** for executing image processing with respect to the tomographic image (or elasticity image) stored in cine memory **36**, in addition to the above-described image analyzing unit **60**, memory **52** and type identifying unit **54**.

[0117] Type identifying unit **54** outputs ID **40** of reference deformable body **16** (includes thickness, elasticity character-

istics, acoustic characteristics, kind of probe, etc.) to image processing unit **62**. Image processing unit **62** detects thickness from ID **40**.

[0118] As shown in FIG. **11**, image processing unit **62** shifts the tomographic image toward the upper direction (the side of ultrasonic probe **3**) according to the "thickness" of reference deformable body **16** so as not to display reference deformable body **16**. FIG. **11**(*a*) shows the tomographic image before the correction, and FIG. **11**(*b*) shows the tomographic image after the correction.

[0119] In concrete terms, as shown in Chart 1, if ID **40** identified in type identifying unit **54** is AAAA, the thickness of reference deformable body **16** is 8 mm. Image processing unit **62** loads the thickness information of the reference deformable body from type identifying unit **54**, and shifts the tomographic image stored in cine memory **36** in the upper direction by 8 mm. If ID **40** is BAAA, the thickness of reference deformable unit **16** is 7 mm. Image processing unit **62** loads thickness information of the reference deformable body from type identifying unit **54**, and shifts the tomographic image stored in cine memory **36** in the upper direction by 7 mm.

[0120] In this manner, as shown in FIG. **11**(*b*), since reference deformable body **16** is not displayed on image display unit **14**, it is possible to broaden the display region of tissue **5** in the deep portion.

Fourth Embodiment

Focus Only on the Thickness Portion

[0121] Here, the fourth embodiment will be described. The difference from the first embodiment~the third embodiment is that transmission and reception of ultrasonic waves is controlled by identifying ID **40** of reference deformable body **16**.

[0122] In the present embodiment, though not shown in the diagram, reference deformable body information acquiring unit **30** is connected with ultrasonic-wave transmission/reception control circuit **1**.

[0123] Type identifying unit **54** outputs ID **40** of reference deformable body **16** (includes thickness, elasticity characteristics, acoustic characteristics, kind of probe, etc.) to ultrasonic-wave transmission/reception control circuit **1**. Ultrasonic-wave transmission/reception control circuit **1** detects "thickness" from ID **40**. Then ultrasonic-wave transmission/reception control circuit **1** controls focus of the ultrasonic waves according to the thickness so that the ultrasonic waves will not be focused on reference deformable body **16**.

[0124] In concrete terms, as shown in Chart 1, if ID **40** identified in type identifying unit **54** is AAAA, the thickness of reference deformable body **16** is 8 mm. Ultrasonic-wave transmission/reception circuit **1** loads the thickness information of the reference deformable body from type identifying unit **54**, and controls transmission circuit **2** and receiving circuit **4** so that ultrasonic waves will be focused at the depth deeper than 8 mm to avoid ultrasonic waves from being focused on reference deformable body **16**.

[0125] Accordingly, since ultrasonic waves are focused on tissues **1**~**5** of the object, image display unit **14** can display the tomographic image appropriately.

1. An ultrasonic diagnostic apparatus comprising:

an ultrasonic probe wherein a reference deformable body is attached on its ultrasonic transmitting/receiving surface;

a tomographic image constructing unit configured to transmit/receive ultrasonic waves to/from an object to be examined via the reference deformable body, and generate a tomographic image based on the RF signal frame data of a cross-sectional region of the object; and

a display unit configured to display the tomographic image,

characterized in further comprising:

a storing unit configured to store the relationship between an ID appended to the reference deformable body and a type of the reference deformable body; and

a type identifying unit configured to read out a type of the reference deformable body corresponding to the ID of the reference deformable body which is attached to the ultrasonic probe, and identify the type of the reference deformable body.

2. The ultrasonic diagnostic apparatus according to claim **1**, wherein a type of the reference deformable body includes at least one of thickness of the reference deformable body, elasticity characteristics including elasticity modulus, acoustic characteristics, scatterer concentration and the ultrasonic probe to be attached.

3. The ultrasonic diagnostic apparatus according to claim **1**, wherein the display unit displays at least one of an ID of the reference deformable body which is identified in the type identifying unit or type of the reference deformable body.

4. The ultrasonic diagnostic apparatus according to claim **1**, characterized in that the ID is appended at least to one of the reference deformable body or the package thereof.

5. The ultrasonic diagnostic apparatus according to claim **1**, characterized in further comprising:

a pressure calculating unit configured to read out information on thickness and elasticity modulus from among the types of the reference deformable body stored in the type identifying unit, and calculates the pressure applied on the reference deformable body;

a strain calculating unit configured to calculate strain of a tissue in the cross-sectional region based on the RF signal frame data; and

an elasticity modulus calculating unit configured to calculated elasticity modulus of the tissue based on the calculated pressure and strain.

6. The ultrasonic diagnostic apparatus according to claim **5**, wherein the pressure calculating unit calculates the pressure applied to the reference deformable body based on the strain and the elasticity modulus obtained from the thickness and displacement of the reference deformable body.

7. The ultrasonic diagnostic apparatus according to claim **5**, characterized in further comprising an elasticity image constructing unit configured to generate an elasticity image based on the elasticity modulus of a tissue calculated by the elasticity modulus calculating unit.

8. The ultrasonic diagnostic apparatus according to claim **1**, characterized in further comprising an image analyzing unit configured to analyze feature quantity of the reference deformable body in the tomographic image, wherein:

the storing unit stores the relationship between the analyzed feature quantity of the reference deformable body and a type of the reference deformable body, and

the type identifying unit reads out the type of the reference deformable body corresponding to the feature quantity of the reference deformable body in a newly-obtained tomographic image, and identify the type of the reference deformable body.

9. The ultrasonic diagnostic apparatus according to claim 8, wherein:

the feature quantity is the average value of the echo luminance in the tomographic image; and

the type identifying unit identifies the type of the reference deformable body based on the average value of the echo luminance in a newly-obtained tomographic image.

10. The ultrasonic diagnostic apparatus according to claim 8, wherein:

the feature quantity is the echo luminance of the scatterer included in the reference deformable body; and

the type identifying unit identifies the type of the reference deformable body based on the pattern, size or form of the scatterer in a newly-obtained tomographic image.

11. The ultrasonic diagnostic apparatus according to claim 8, wherein:

the feature quantity is a form of the reference deformable body or a feature substance included in the reference deformable body, and

the type identifying unit identifies the type of the reference deformable body based on the form or feature substance of the reference deformable body in a newly-obtained tomographic image.

12. The ultrasonic diagnostic apparatus according to claim 1, characterized in further comprising an image processing unit configured to shift a tomographic image or elasticity image toward the side of the ultrasonic probe, in accordance with the thickness of the reference deformable body identified by the type identifying unit.

13. The ultrasonic diagnostic apparatus according to claim 1, characterized in further comprising an ultrasonic-wave transmission/reception control unit configured to control focus of the ultrasonic wave so that the ultrasonic wave is not focused on the reference deformable body, in accordance with the thickness of the reference deformable body identified by the type identifying unit.

14. An ultrasonic diagnostic method using an ultrasonic diagnostic apparatus comprising:

an ultrasonic probe having the ultrasonic-wave transmitting/receiving side on which a reference deformable body is attached;

a tomographic image constructing unit configured to transmit/receive ultrasonic waves to/from an object to be examined via the reference deformable body, and generate a tomographic image based on RF signal frame data of a cross-sectional region of the object; and

a display unit configured to display the tomographic image,

characterized in further comprising:

a step that stores the relationship between an ID appended to the reference deformable body and a type of the reference deformable body;

a step that reads out a type of the reference deformable body corresponding to the ID of the reference deformable body attached to the ultrasonic probe from the storing unit; and

a step that identifies a type of the reference deformable body.

15. A reference deformable body characterized in being attached to the ultrasonic-wave transmitting/receiving surface of an ultrasonic probe, and an ID corresponding to at least one of the thickness, elasticity characteristics including elasticity modulus, acoustic characteristics and scatterer characteristics is appended thereto.

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专利名称(译)	参考可变形体，超声诊断设备和超声诊断方法		
公开(公告)号	US20110040185A1	公开(公告)日	2011-02-17
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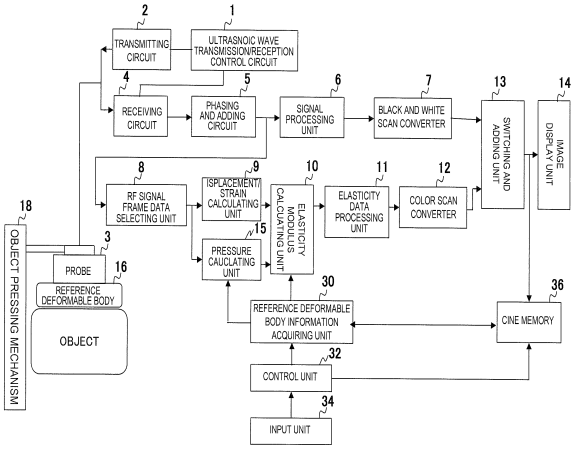
其他公开文献	US8197411		
外部链接	Espacenet USPTO		

摘要(译)

提供了一种可以识别其类型的参考可变形体，一种能够识别参考可变形体的类型的超声诊断设备，以及一种超声诊断方法。 超声诊断设备包括超声探头（3），其中附接有参考可变形体（16），断层图像构建单元（6,7）和显示单元（14）。 超声波诊断装置的特征在于，还包括：存储单元，被配置为存储给予参考可变形体（16）的ID与参考可变形体（16）的类型之间的关系，以及配置的类型识别单元（54）。读出与从存储单元（52）安装在超声波探头（3）上的基准可变形体（16）的ID对应的基准可变形体（16）的种类，确定基准可变形体的种类。