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(54) **PROBE FOR ULTRASONIC DIAGNOSTIC APPARATUS**

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(57) **ABSTRACT**

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A probe for an ultrasonic diagnostic apparatus which is used for performing a test upon a subject is provided. The probe includes a case which forms an exterior of the probe, a piezoelectric object which is provided on an inside of the case and which generates an ultrasonic wave, a sound absorbing layer which is provided at a rear surface of the piezoelectric object and which prevents the ultrasonic wave from being delivered to a rear portion of the piezoelectric object, an acoustic matching layer which delivers the generated ultrasonic wave to a subject by matching a sound impedance of the piezoelectric object with a sound impedance of the subject, and a sound lens which concentrates the generated ultrasonic wave and radiates the concentrated ultrasonic wave toward the subject.

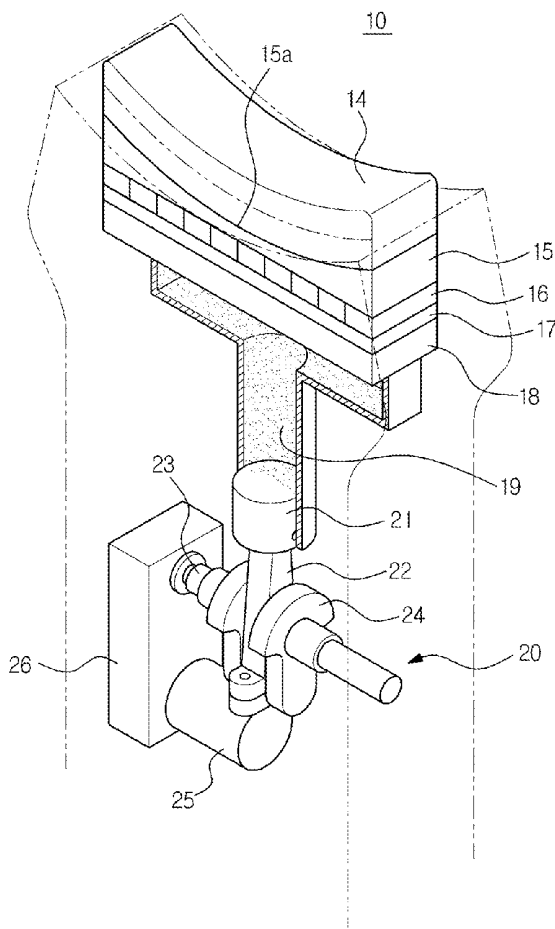
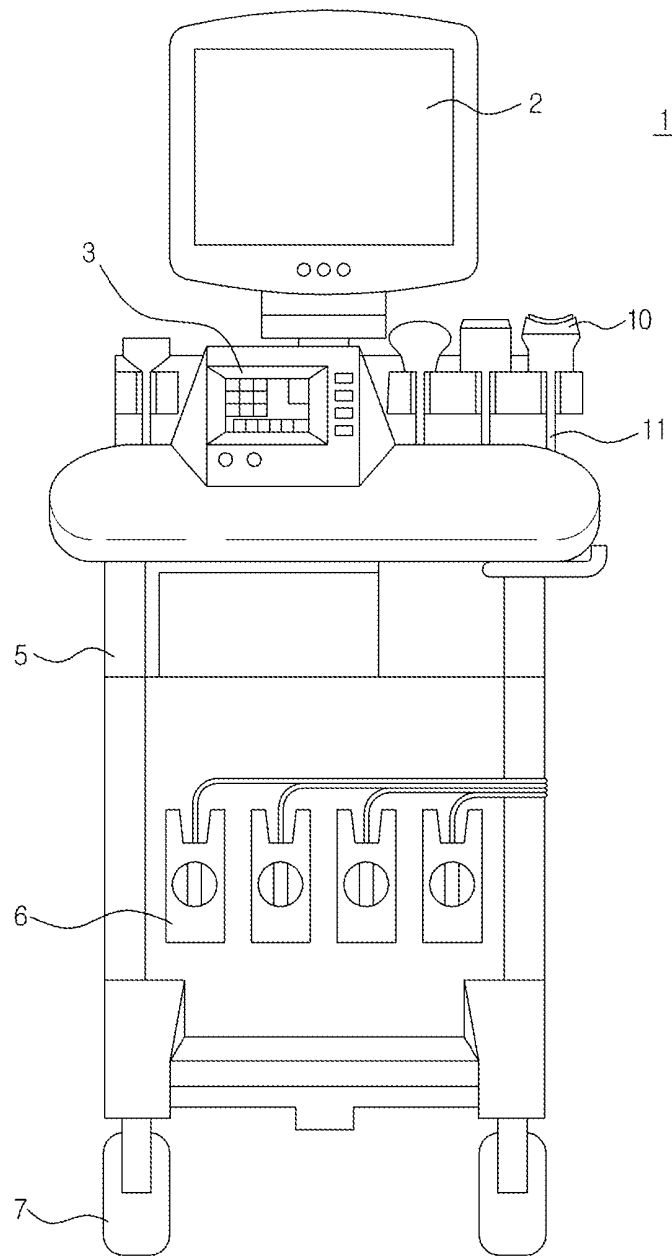


FIG. 1



case, an administrator operates the motor **25** by using a control member, such as a button (not shown) positioned at an outer side of the case **12**, and accordingly, the piston **21** may be operated. A structure, such as a crank shaft **23**, a crank arm **24**, and/or a connecting rod **22**, may be further provided for translating a rotational movement of the motor **25** to a reciprocal movement of the piston **21**. In addition, a reduction gear **26** may be provided for controlling a speed of the rotation of the motor **25**.

[0062] According to an exemplary embodiment, the motor **25** is connected to the reduction gear **26**, and the reduction gear **26** is connected to the connecting rod **22** through the crank shaft **23**. The rotational movement of the crank shaft **23** is translated to the reciprocal movement of the piston **21** through the connecting rod **22**. A crank journal may be coupled to the crank shaft **23** in order to fix the crank shaft **23**. One side of the connecting rod **22** is connected to the crank shaft **23** while the other side of the connecting rod **22** is coupled to the piston **21**. Accordingly, the driving force of the motor **25** is delivered to the piston **21**, and as the piston **21** moves, the moving layer **19** may also be moved, and based on the movement of the moving layer **19**, the radius of curvature of the transducer having the sound lens **15** varies. The variations of the radius of curvature of the piezoelectric material **17** and radius of curvature of the sound absorbing layer **18** follow the movement of the moving layer **19**, and the variation of the radius of curvature of the sound lens **15** remains the same, regardless of whether the piston **21** operates manually or automatically. Accordingly, in a case in which a body structure of the subject is different than the body structure of a previous subject, the radius of curvature of the sound lens **15** may be changed to a certain degree, and thus a performance of a diagnosis by using the same probe **10** in conjunction with the ultrasonic diagnostic apparatus **1** may be possible.

[0063] In addition, at a rear surface of the driving member **20**, a strain relief apparatus (not shown) which connects the cable **11** to the probe **10** is provided. The strain relief apparatus is configured to protect the cable **11** from an impact applied to the cable **11**, and is capable of restraining the impact, which is caused by a curvature of the cable **11**, which would otherwise be applied to an outer side of the probe **10** and to a contact point of the cable **11**.

[0064] According to an exemplary embodiment, a pad **14** is integrally attached to the cover portion **13**. Because an ultrasonic wave does not penetrate through a bone and air, in a case in which an ultrasonic diagnosis is being performed, an ultrasonic wave mediating material is applied in between the body of the subject and the probe **10**. In particular, a middle layer which is included within the ultrasonic wave mediating material is needed so that the ultrasonic wave radiated toward an inside of a human body is evenly spread and then the wave signal is reflected back toward the body **5**.

[0065] In a case in which the conventional ultrasonic wave mediating material is of a liquid type, most of the substance thereof is formed with moisture, and thereby becomes evaporated or displaced to a separate portion of the skin of a subject after a certain period of time elapses after the mediating material has been applied on the skin of the subject and the probe **10** has been operated thereon, and thus a continuous usage thereof is not possible. In addition, the conventional ultrasonic wave mediating material of a liquid type is less useful for obtaining an image of an organ which is located on a curved portion or at a position which is relatively proximate to a curved portion of the body of the subject.

[0066] Thus, in an exemplary embodiment, a pad which has the ultrasonic wave mediating material applied thereto by using a cross-linked polymer is used instead. However, in a case of the pad, an administrator must carry the pad separately, and in a case of performing a diagnosis, the pad must be held with one hand while the other hand is used for operating the probe **10**.

[0067] In order to remove the above constraints, the probe **10** according to an exemplary embodiment is provided with the pad **14**, which has the ultrasonic wave mediating material applied thereto by using a cross-linked polymer, mounted thereto for use. According to an exemplary embodiment, the pad **14** is integrally attached to the sound lens **15**, and the pad **14** protrudes through an opening portion of the cover portion **13**. In addition, the pad **14** may be attached to a front surface of the cover portion **13**. Thus, the pad **14** may be placed into direct contact with the skin of the subject, and accordingly, a test may be performed without using a separate ultrasonic wave mediating material. The foregoing aspect as such may provide an advantage in view of a recent trend in which an administrator performs a diagnosis relating to the subject while simultaneously performing other activities. Further, the foregoing aspect may also provide an advantage relating to an improvement in a compactness of the diagnostic apparatus.

[0068] FIG. **5** is a perspective view which illustrates a probe configured for use in conjunction with an ultrasonic diagnostic apparatus, according to another exemplary embodiment, and FIG. **6** is a cross-sectional view which illustrates a cross section B-B as indicated in FIG. **5**.

[0069] As illustrated in FIGS. **5** and **6**, a probe **30** for use in conjunction with an ultrasonic diagnostic apparatus according to another exemplary embodiment further includes a base member **40** which is detachably mounted to a cover portion **33**. The probe **30** also includes a cable **31**, which is similar to the cable **11** described above with respect to FIG. **2**; a concave portion **33a** of the cover portion **33**, which is similar to the concave portion **13a** of the cover portion **13** described above with respect to FIG. **4**; an acoustic matching layer **36** which is similar to the acoustic matching layer **16** described above with respect to FIGS. **3** and **4**; and a piezoelectric object **37** which is similar to the piezoelectric object **17** described above with respect to FIGS. **3** and **4**. A further detailed description of these items will therefore be omitted for brevity.

[0070] As illustrated in FIGS. **5** and **6**, a sound lens **35** of the probe **30** may further include a concave portion **35a**. In addition, a moving layer **39** which changes the radius of curvature of the sound lens **35** may be provided at a rear surface of an sound absorbing layer **38**, and a driving member **20** may be provided at a rear surface of the moving layer **39** for causing the moving layer **39** to move. The base member **40** may include a concave portion **41** which has a shape which is similar to a shape of the concave portion **35a** of the sound lens **35**, and the concave portion **41** of the base member **40** facilitates performance of a diagnosis by increasing a contact area with respect to the skin of the subject.

[0071] The base member **40** may be provided with a guide portion **42** so that the base member **40** may be inserted into the probe **30**. The guide portion **42** extends from the concave portion **41** of the base member **40**, and may be provided in a shape which corresponds to a case **32** and the cover portion **33** such that the guide portion **42** may be inserted into the case **32** and the cover portion **33** of the probe **30**. In addition, the base member **40** may be formed by using an elastic material, and

the elasticity of the material may enable the base member 40 to be inserted into the probe 30, although a size of the probe 30 may vary.

[0072] The concave portion 41 of the base member 40 may be provided with a pad (not shown), and the pad makes contact with the skin of the subject. Because the pad must adhere as closely as possible to the skin of the subject in order to minimize a loss of energy from the ultrasonic wave, the concave portion 41 of the case member 40, which is positioned in between the pad and the sound lens 35, may be provided such that a thickness of the concave portion 41 is as thin as possible.

[0073] The pad is provided at the base member 40, and the base member 40 is inserted into the probe 30 at the time of performing a diagnosis. In a case in which the base member 40 is provided with the pad, the base member 40 may be detached to be stored separately when the probe 30 is not being used.

[0074] Although a few exemplary embodiments have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these exemplary embodiments without departing from the principles and spirit of the present disclosure, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A probe for use in conjunction with an ultrasonic diagnostic apparatus, the probe comprising:

- a case which forms an exterior of the probe;
- a piezoelectric object which is provided at an inside of the case and which generates an ultrasonic wave;
- a sound absorbing layer which is provided at a rear surface of the piezoelectric object and which prevents the generated ultrasonic wave from being delivered to a rear portion of the piezoelectric object;
- an acoustic matching layer which is provided at a front surface of the piezoelectric object and which delivers the generated ultrasonic wave to a subject by matching a sound impedance of the piezoelectric object with a sound impedance of the subject; and
- a sound lens which is provided at a front surface of the acoustic matching layer and which concentrates the generated ultrasonic wave and radiates the concentrated ultrasonic wave toward the subject,

wherein the sound lens includes a concave portion which facilitates performance of a diagnosis along a curved surface of the subject.

2. The probe of claim 1, further comprising:

- a moving layer which is provided at a rear surface of the sound absorbing layer and which changes a radius of curvature of the sound lens, and
- a driving member which causes the moving layer to move.

3. The probe of claim 2, wherein the moving layer comprises compressed gas.

4. The probe of claim 2, wherein the moving layer comprises a liquid and a film surrounding the liquid.

5. The probe of claim 1, further comprising:

- a cover portion which is provided at a front surface of the sound lens and which makes contact with a skin of the subject, wherein the cover portion includes a concave portion having a same shape as a shape of the concave portion of the sound lens.

6. The probe of claim 5, further comprising:

- a pad which is protrudingly provided at a front surface of the cover portion and which ejects air from a contact surface at which the probe makes contact with the skin of the subject.

7. The probe of claim 6, wherein the pad is integrally attached to the sound lens.

8. The probe of claim 6, wherein the pad is provided at an outer side of a base member that is detachably mounted to the cover portion.

9. The probe of claim 2, wherein the driving member is positioned at a rear surface of the moving layer, and wherein the driving member includes a piston which causes the moving layer to move.

10. The probe of claim 9, wherein each of a radius of curvature of the piezoelectric object and a radius of curvature of the sound absorbing layer varies as the moving layer is moved by using the piston, and the concave portion flattens as the moving layer is moved.

11. The probe of claim 9, wherein the driving member further includes a motor which is coupled to the piston and which drives the piston in a full automatic manner.

12. The probe of claim 11, wherein each of a radius of curvature of the piezoelectric object and a radius of curvature of the sound absorbing layer varies when the piston is driven in a full automatic manner such that the moving layer is moved, and the concave portion flattens as the moving layer is moved.

13. The probe of claim 1, wherein the cover portion includes a flexible material.

14. A probe for use in conjunction with an ultrasonic diagnostic apparatus, the probe including a cover portion which forms an exterior of the probe and a transducer which is provided at an inner side of the cover portion and which reciprocally changes an electrical signal and a sound signal, wherein a first surface of the transducer includes a concave portion which facilitates performance of a diagnosis along a curved surface of a subject, and a second surface of the transducer includes a moving layer which changes a radius of curvature of a portion of the transducer which makes contact with the subject.

15. The probe of claim 14, further comprising:

- a pad which is attached to a front surface of the cover portion and which ejects air from a contact surface at which the probe makes contact with a skin of the subject.

16. The probe of claim 14, further comprising:

- a base portion which is detachably provided at the cover portion.

17. The probe of claim 16, further comprising a pad which is provided at an outer side of the base portion and which ejects air from a contact surface at which the probe makes contact with a skin of the subject.

18. The probe of claim 14, wherein the cover portion includes a concave portion having a same shape as a shape of the concave portion of the first surface of the transducer.

19. The probe of claim 14, further comprising:

- a driving member which is positioned at a rear surface of the moving layer and which causes the moving layer to move.

20. The probe of claim 19, wherein the driving member includes a piston which causes the moving layer to move, and a motor which is coupled to the piston and which drives the piston in a full automatic manner.

21. A method for performing a diagnosis with respect to a subject by using a probe in conjunction with an ultrasonic diagnostic apparatus,

the probe comprising:

- a case which forms an exterior of the probe;
 - a piezoelectric object which is provided at an inside of the case and which generates an ultrasonic wave;
 - a sound absorbing layer which is provided at a rear surface of the piezoelectric object and which prevents the generated ultrasonic wave from being delivered to a rear portion of the piezoelectric object;
 - an acoustic matching layer which is provided at a front surface of the piezoelectric object and which delivers the generated ultrasonic wave to a subject by matching a sound impedance of the piezoelectric object with a sound impedance of the subject; and
 - a sound lens which is provided at a front surface of the acoustic matching layer and which concentrates the generated ultrasonic wave and radiates the concentrated ultrasonic wave toward the subject,
- and the method comprising:
- applying a concave portion which is included within the sound lens to a curved surface of a skin of the subject;
 - receiving a reflection of the concentrated ultrasonic wave which has been radiated toward the subject; and
 - using the received reflection of the concentrated ultrasonic wave to facilitate performance of the diagnosis.

22. The method of claim **21**, wherein the probe further comprises a cover portion which is provided at a front surface of the sound lens and which makes contact with the skin of the subject, wherein the cover portion includes a concave portion having a same shape as a shape of the concave portion which is included within the sound lens, and a pad which is protrudingly provided at a front surface of the cover portion, and wherein the method further comprises using the pad to eject air from a contact surface at which the probe makes contact with the skin of the subject.

23. The method of claim **21**, further comprising:

- causing each of a radius of curvature of the piezoelectric object and a radius of curvature of the sound absorbing layer to vary; and
- causing the concave portion which is included within the sound lens to flatten in conjunction with the causing each of the radius of curvature of the piezoelectric object and the radius of curvature of the sound absorbing layer to vary.

24. The method of claim **23**, wherein the probe further includes a moving layer which is provided at a rear surface of the sound absorbing layer, and wherein the causing each of the radius of curvature of the piezoelectric object and the radius of curvature of the sound absorbing layer to vary includes causing the moving layer to move by operating a motor which drives a piston in a full automatic manner, which piston drives the moving layer.

* * * * *

FIG. 2

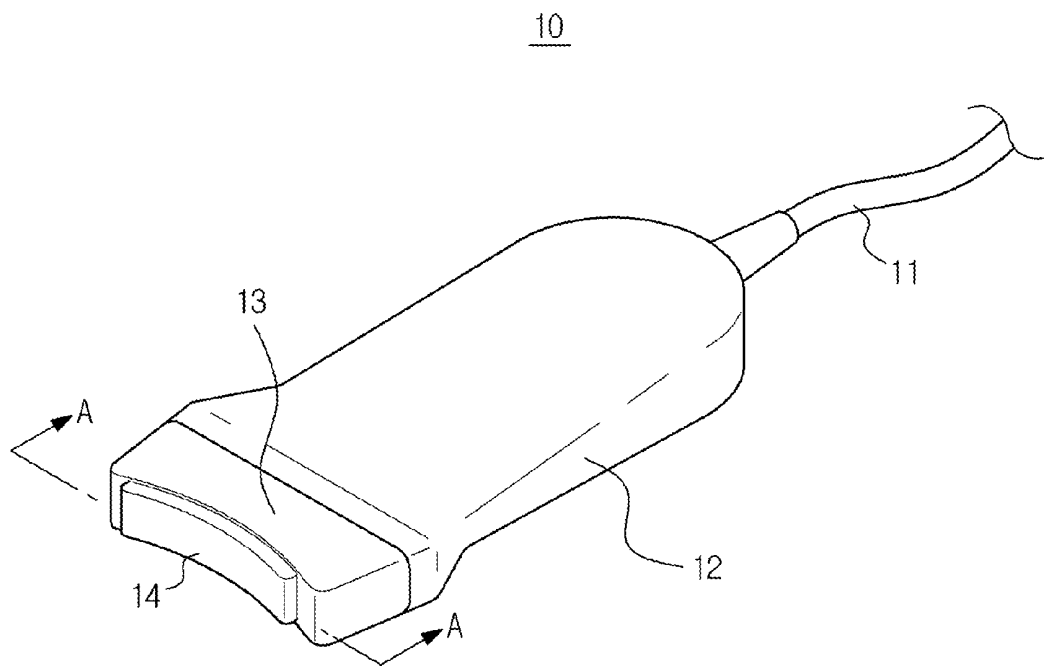


FIG. 3

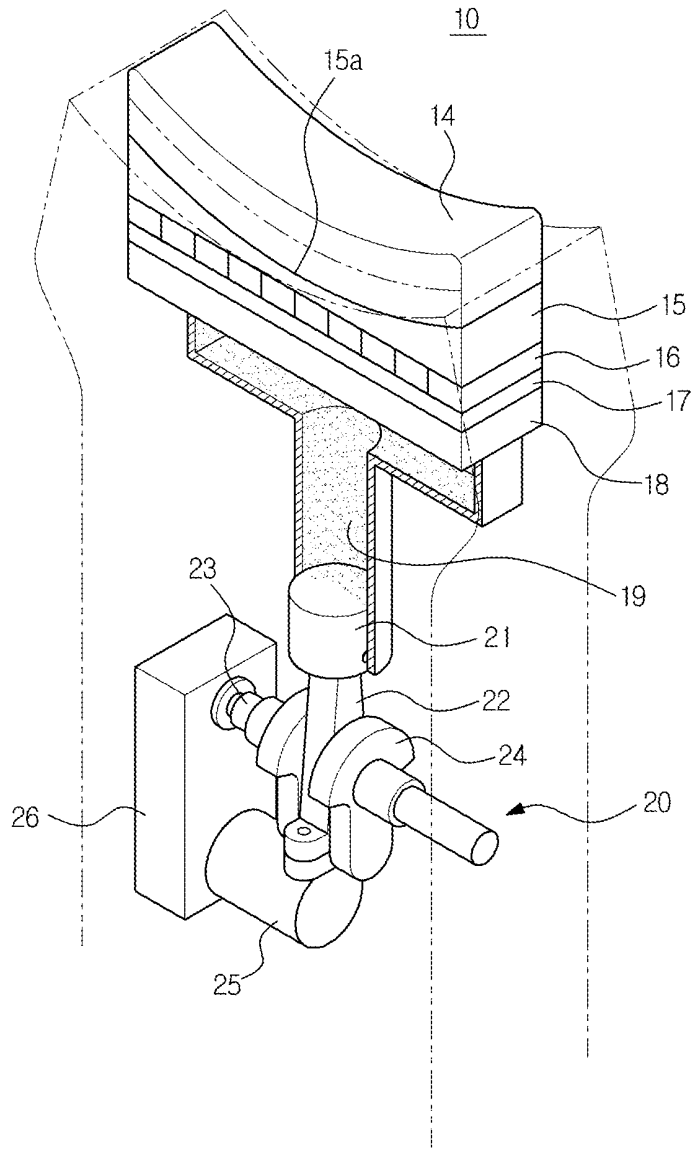


FIG. 4

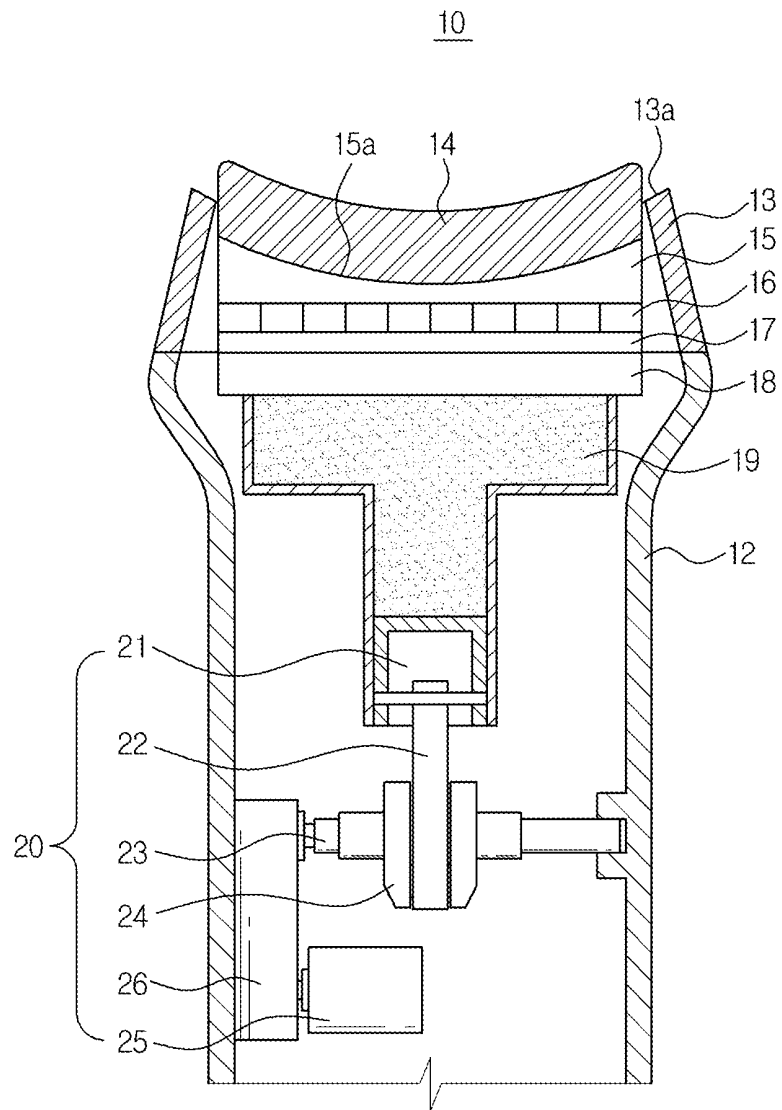


FIG. 5

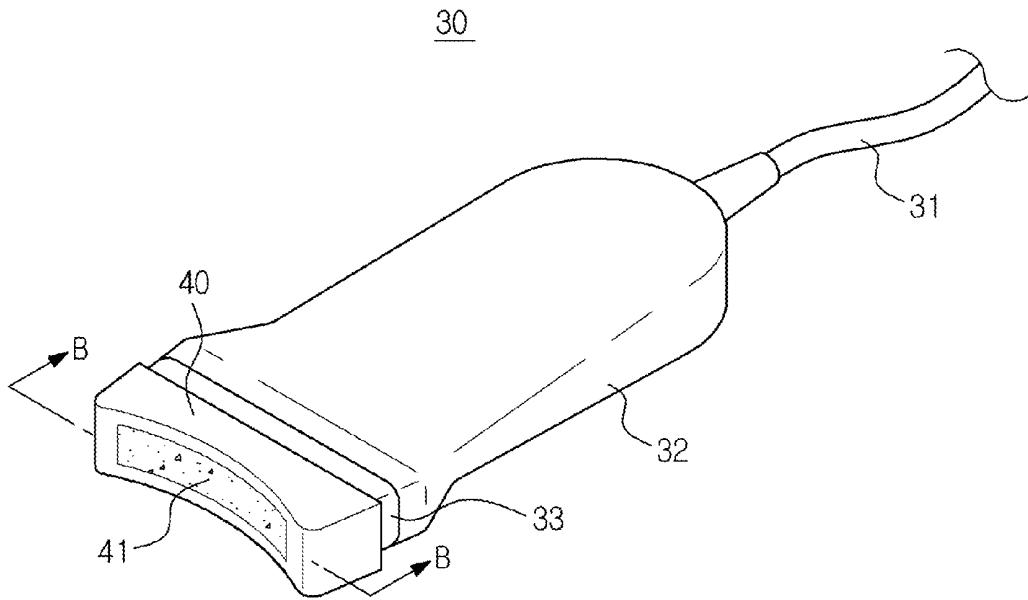
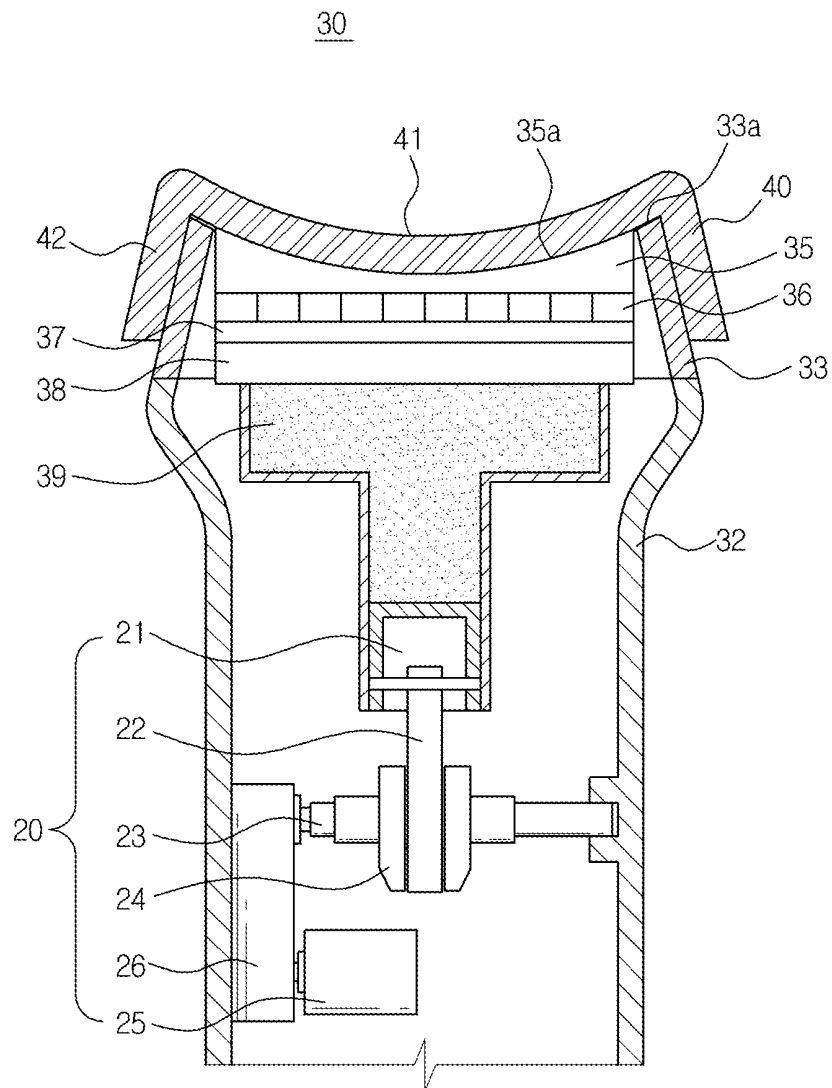


FIG. 6



PROBE FOR ULTRASONIC DIAGNOSTIC APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Korean Patent Application No. 10-2011-0133504, filed on Dec. 13, 2011 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field

[0003] Exemplary embodiments relate to a probe for use in conjunction with an ultrasonic diagnostic apparatus, and more particularly, to a probe for use in conjunction with an ultrasonic diagnostic apparatus which is capable of performing a test by closely adhering to a particular portion of a test subject.

[0004] 2. Description of the Related Art

[0005] In general, an ultrasonic diagnostic apparatus is an apparatus which is configured to radiate an ultrasonic signal toward a desired portion at an inside of a body from the surface of a subject and to obtain an image with reference to a cross section of a soft tissue or a blood flow by using the information included in the reflected ultrasonic signal in a non-invasive manner. The apparatus as such, as compared with other display apparatuses such as an X-ray photographing apparatus, a CT apparatus (Computerized Tomography Scanner), an MRI (Magnetic Resonance Image), or a nuclear medical diagnostic device, is smaller in size, less expensive, and capable of displaying images obtained in real time, and is not exposed to radiation of an X-ray, and thus relatively safer, thereby being used widely for the diagnosis of medical conditions relating to hearts, abdomens, genital organs, and in gynecology.

[0006] In particular, an ultrasonic diagnostic apparatus includes a probe which is configured to transmit an ultrasonic signal to a subject in order to obtain an ultrasonic image of the subject and to receive an echo signal that is reflected from the subject.

[0007] A probe includes a transducer, a case which is provided with an open upper end thereof, and a cover portion which is coupled to the open upper end of the case in order to directly contact with a surface of the subject.

[0008] A transducer includes a piezoelectric layer which is configured to reciprocally change an electrical signal and a sound signal as a piezoelectric object vibrates, an acoustic matching layer which is configured to reduce a difference of a sound impedance between the piezoelectric layer and the subject so that the ultrasonic wave generated at the piezoelectric layer is delivered primarily to the subject, a lens layer which is configured to concentrate the ultrasonic wave which proceeds to a front portion of the piezoelectric layer to a certain position, and a sound absorbing layer which is configured to reduce a distortion of an image by preventing the ultrasonic wave from proceeding to a rear portion of the piezoelectric layer.

[0009] A probe which is configured for use in conjunction with an ultrasonic diagnostic apparatus includes at least one of a concave-type probe which is used for a diagnosis relating to an abdomen and which has a concave surface thereof, a linear-type probe which is used for a diagnosis relating to one or more of breasts, a thyroid, and testicles and which has a flat

surface thereof, an endocavity-type probe which is used for a diagnosis relating to a uterus and an ovary, and a hockey stick-type probe.

[0010] A muscular skeletal system (for example, shoulders and knees) having a curved surface thereof may not be convenient for using a linear-type probe provided with a flat surface thereof, as a footprint of the probe has a length which falls approximately within a range of between 40 mm and 50 mm, and thus the probe may not closely adhere to the curved surface of the subject. Therefore, multiple uses of a probe having a small footprint, such as a hockey stick probe, are required in order to perform a scan, and in a case in which a probe other than a linear-type probe is used, the probe may not be closely in contact with the subject, as the body figure of the subject and the shape of a probe may not be in correspondence to each other.

[0011] In addition, when an ultrasonic test is performed, an ultrasonic wave does not penetrate a bone and air, so in a case in which a probe configured for an ultrasonic diagnostic apparatus directly contacts the skin of the subject, the collection of data is not possible. Thus, in a case in which an ultrasonic wave diagnosis is being performed, a liquid is typically applied on the skin in order to eject the air which is situated in between the probe and the skin of the subject, or a pad provided with a liquid applied thereon is used.

SUMMARY

[0012] Therefore, it is an aspect of exemplary embodiments described herein to provide a probe which is configured for use in conjunction with an ultrasonic diagnostic apparatus that may be used for a diagnosis of a medical condition relating to a muscular skeletal system of a subject.

[0013] Additional aspects of the exemplary embodiments will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the exemplary embodiments.

[0014] In accordance with one aspect of one or more exemplary embodiments, a probe for use in conjunction with an ultrasonic diagnostic apparatus includes a case, a piezoelectric object, a sound absorbing layer, an acoustic matching layer and a sound lens. The case may form an exterior of the probe. The piezoelectric body may be provided at an inside of the case and may generate an ultrasonic wave. The sound absorbing layer may be provided at a rear surface of the piezoelectric object and may prevent the ultrasonic wave from being delivered to a rear portion of the piezoelectric object. The acoustic matching layer may be provided at a front surface of the piezoelectric object and may deliver the generated ultrasonic wave to a subject by matching a sound impedance of the piezoelectric object with a sound impedance of the subject. The sound lens may be provided at a front surface of the acoustic matching layer and may concentrate the generated ultrasonic wave and radiate the concentrated ultrasonic wave toward the subject. The sound lens may include a concave portion which facilitates performance of a diagnosis along a curved surface of the subject.

[0015] The probe may further include a moving layer which is provided at a rear surface of the sound absorbing layer and which changes a radius of curvature of the sound lens, and a driving member which causes the moving layer to move.

[0016] The moving layer may include compressed gas.

[0017] The moving layer may include a liquid and a film surrounding the liquid.

[0018] The probe may further include a cover portion which is provided at a front surface of the sound lens and which makes contact with a skin of the subject. The cover portion may include a concave portion having a same shape as a shape of the concave portion of the sound lens.

[0019] The probe may further include a pad which is protrudingly provided at a front surface of the cover portion and which ejects air from a contact surface at which the probe makes contact with the skin of the subject.

[0020] The pad may be integrally attached to the sound lens.

[0021] The pad may be provided at an outer side of a base member that is detachably mounted to the cover portion.

[0022] The driving member may be positioned at a rear surface of the moving layer, and may include a piston which causes the moving layer to move.

[0023] Each of a radius of curvature of the piezoelectric object and a radius of curvature of the sound absorbing layer may vary as the moving layer is moved by using the piston, and the concave portion may flatten as the moving layer is moved.

[0024] The driving member may further include a motor which is coupled to the piston and which drives the piston in a full automatic manner.

[0025] Each of a radius of curvature of the piezoelectric object and a radius of curvature of the sound absorbing layer may vary when the piston is driven in a full automatic manner such that the moving layer is moved, and the concave portion may flatten as the moving layer is moved.

[0026] The cover portion may include a flexible material.

[0027] In accordance with another aspect of one or more exemplary embodiments, a probe for use in conjunction with an ultrasonic diagnostic apparatus is provided. The probe includes a cover portion which forms an exterior of the probe and a transducer which is provided at an inner side of the cover portion and which reciprocally changes an electrical signal and a sound signal. A first surface of the transducer may include a concave portion which facilitates performance of a diagnosis along a curved surface of a subject, and a second surface of the transducer may include a moving layer which changes a radius of curvature of a portion of the transducer which makes contact with the subject.

[0028] The probe may include a pad which is attached to a front surface of the cover portion and which ejects air from a contact surface at which the probe makes contact with a skin of the subject.

[0029] The probe may further include a base portion which is detachably provided at the cover portion.

[0030] A pad may be provided at an outer side of the base portion. The pad may eject air from a contact surface at which the probe makes contact with a skin of the subject.

[0031] The cover portion may include a concave portion having a same shape as a shape of the concave portion of the first surface of the transducer.

[0032] The probe may further include a driving member which is positioned at a rear surface of the moving layer and which causes the moving layer to move.

[0033] The driving member may include a piston which causes the moving layer to move, and a motor which is coupled to the piston and which drives the piston in a full automatic manner.

[0034] As described above, exemplary embodiments capable of facilitating performance of a diagnosis of a medical condition relating to a subject at a single scan in a case in

which a medical condition relating to a muscular skeletal system (for example, shoulders and knees) is being diagnosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] These and/or other aspects will become apparent and more readily appreciated from the following description of exemplary embodiments, taken in conjunction with the accompanying drawings of which:

[0036] FIG. 1 is a drawing which illustrates a front surface of an ultrasonic diagnostic apparatus, in accordance with an exemplary embodiment.

[0037] FIG. 2 is a perspective view which illustrates a probe which is configured for use in conjunction with an ultrasonic diagnostic apparatus, in accordance with an exemplary embodiment.

[0038] FIG. 3 is a perspective view which illustrates a cross section A-A as indicated in FIG. 2.

[0039] FIG. 4 is a cross-sectional view which illustrates a cross section A-A as indicated in FIG. 2.

[0040] FIG. 5 is a perspective view which illustrates a probe which is configured for use in conjunction with an ultrasonic diagnostic apparatus, in accordance with another exemplary embodiment.

[0041] FIG. 6 is a cross-sectional view which illustrates a cross section B-B as indicated in FIG. 5.

DETAILED DESCRIPTION

[0042] Reference will now be made in detail to exemplary embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0043] FIG. 1 is a drawing which illustrates a front surface of an ultrasonic diagnostic apparatus, according to an exemplary embodiment. A probe according to one or more exemplary embodiments is not only used in conjunction with an ultrasonic diagnostic apparatus, but also is used in conjunction with various ultrasonic transducer apparatuses, and a probe for use in conjunction with an ultrasonic diagnostic apparatus will be described hereinafter as an example.

[0044] As illustrated in FIG. 1, an ultrasonic diagnostic apparatus 1 according to an exemplary embodiment is provided with a probe 10 having various types thereof for use in conjunction with the ultrasonic diagnostic apparatus. The probe 10 radiates an ultrasonic wave toward a subject and receives an echo of the ultrasonic wave from the subject. The ultrasonic diagnostic apparatus 1 is further provided with a control button 3, and a display apparatus 2 installed thereto, and includes a body 5 which is used for generating an image of the subject. The probe 10 for use in conjunction with the ultrasonic diagnostic apparatus 1 is connected to the body 5 by a cable 11 and a connector 6 that are integrally connected to the probe 10. At a lower side of the body 5, a supporting portion 7 which supports the ultrasonic diagnostic apparatus 1 is provided. The supporting portion 7 may include a transporting medium, such as, for example, wheels, which transporting medium is used for moving the ultrasonic diagnostic apparatus 1.

[0045] FIG. 2 is a perspective view which illustrates a probe which is configured for use in conjunction with an ultrasonic diagnostic apparatus, according to an exemplary embodiment, FIG. 3 is a perspective view which illustrates a cross

section A-A as indicated in FIG. 2, and FIG. 4 is a cross-sectional view which illustrates a cross section A-A as indicated in FIG. 2.

[0046] As illustrated in FIGS. 2, 3, and 4, the probe 10 for use in conjunction with the ultrasonic diagnostic apparatus 1 includes a case 12 which forms an exterior of the probe 10 and a cover portion 13 which is provided at an upper side of the probe 10. An upper side of the case 12 is open, and the cover portion 13 is coupled to an upper end of the case 12 which is open. An administrator may perform a test by holding the case 12 of the probe 10 and causing the cover portion 13 to make contact with the subject.

[0047] At an inner side of the cover portion 13, a transducer is provided. The transducer includes a piezoelectric object 17, an acoustic matching layer 16, a sound lens 15, and a sound absorbing layer 18.

[0048] The sound lens 15, the acoustic matching layer 16, the piezoelectric object 17, and the sound absorbing layer 18 are arranged in an order of appearance as the above from a front surface portion at which the contact is made with the subject.

[0049] The piezoelectric object 17 is positioned at an inner side of the cover portion 13, and is attached at a front surface of the sound absorbing layer 18. Electrode portions (not shown) are provided at both sides of the piezoelectric object 17. The piezoelectric object 17 converts an electrical signal to an ultrasonic wave, which is a sound signal, in order to release the ultrasonic wave into air, and converts the ultrasonic wave, which is reflected from the air, to an electrical signal, in order to transmit the electric signal to an apparatus.

[0050] The piezoelectric object 17 is configured to generate an ultrasonic wave by using a resonance phenomenon, and may be formed by using at least one of a ceramic from a lead zirconate ceramic material, such as, for example, lead zirconate titanate (PZT), a PNZT single crystal which is made of the solid solution of zinc niobate and titanate, and a PMZT single crystal which is made of the solid solution of magnesium niobate and titanate.

[0051] In a case of the electrode portions (not shown) formed at both sides of the piezoelectric object 17, the electrode portions may be formed by using a metal which has a relatively high conductivity, such as, for example, at least one of gold, silver, and copper, or by using graphite.

[0052] The acoustic matching layer 16 is installed at a front portion of the piezoelectric object 17. The acoustic matching layer 16 matches the sound impedance of the piezoelectric object 17 with the sound impedance of the subject, so that the ultrasonic wave signal generated by the piezoelectric object 17 may be efficiently delivered to the subject. Accordingly, the acoustic matching layer 16 is configured to have a median sound impedance value with respect to the sound impedance of the piezoelectric object 17 and the sound impedance of the subject.

[0053] The acoustic matching layer 16 may be formed by using a glass material or a resin material. The acoustic matching layer 16 may include a plurality of acoustic matching layers which have different respective materials so that the sound impedance may be gradually changed from the sound impedance of the piezoelectric object 17 to the sound impedance of the subject.

[0054] The sound absorbing layer 18 is disposed at a rear portion of the piezoelectric object 17. The sound absorbing layer 18 restrains a free vibration of the piezoelectric object 17 in order to reduce the width of the pulse of the ultrasonic

wave, and blocks the ultrasonic wave which would otherwise be transmitted to a rear portion of the piezoelectric object 17, thereby preventing a distortion of a resultant image.

[0055] A printed circuit board (PCB) (not shown) may be positioned in between the sound absorbing layer 18 and the piezoelectric object 17. The PCB is provided in order to reciprocally change the electrical signal and the ultrasonic wave signal generated by the electrode portion (not shown). The PCB may be arranged vertically with respect to a side surface of the piezoelectric object 17 having a largest surface area, and the sound absorbing layer 18 may be arranged such that the PCB and the sound absorbing layer 18 are stacked up against each other. The PCB may further include a structure, such as, for example, a flexible printed circuit board (FPCB) which is provided in conjunction with a signal, which structure is capable of supplying electrical energy.

[0056] The sound lens 15 is disposed at a front portion of the acoustic matching layer 16. The sound lens 15 is configured to concentrate the ultrasonic wave signal, which proceeds to a front of the sound lens 15, to a particular position. The sound lens 15 includes a concave portion 15a which facilitates performance of a diagnosis along a curved surface of the subject.

[0057] The cover portion 13 may also be provided with a concave portion 13a which has a same shape as a shape of the concave portion 15a of the sound lens 15. However, in a case in which the cover portion 13 is formed by using a flexible material, the cover portion 13 does not need to be provided with the concave portion 13a, because the flexibility of the material ensures that the probe 10 remains fully capable of facilitating performance of a diagnosis on the surface of the subject.

[0058] In addition, at a rear surface of the sound absorbing layer 18, a moving layer 19 which changes the radius of curvature of the sound lens 15 with respect to making contact with the subject is provided. At a rear of the moving layer 19, a driving member 20 is provided, which driving member 20 causes the moving layer 19 to move in order to change the radius of curvature of the sound lens 15.

[0059] The moving layer 19 may be provided, for example, as pressured gas. The moving layer 19 may be formed by using a liquid, and in this case as such, the moving layer 19 includes a film which surrounds the liquid. The film which is included within the moving layer 19 may be formed by using a thin film so that the shape of the moving layer 19 may be changed. In addition, the liquid which is surrounded by the film may be formed by using an oil film having viscosity and flexibility.

[0060] The driving member 20, which is positioned at a rear portion of the moving layer 19, may include a piston 21 which causes the moving layer 19 to move. The piston 21 is connected to a control member, such as a lever (not shown) which is provided at an outer side of the case 12, so that an administrator may manually control the position of the piston 21, and accordingly, the moving layer 19 may be moved. Each of a radius of a curvature of the piezoelectric object 17 and a radius of a curvature of the sound absorbing layer 18 varies as the moving layer 19 is moved by the piston 21, and accordingly, a radius of a curvature of the sound lens 15 also varies. Thus, the shape of the concave portion 15A may flatten, such that a concave-type probe may be deformed to be shaped similarly as a linear-type probe.

[0061] In addition, the piston 21 may be operated in a full automatic manner by being connected to a motor 25. In this

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摘要(译)

提供一种用于超声诊断设备的探针，其用于对受试者进行测试。探头包括形成探头外部的壳体，设置在壳体内部并产生超声波的压电物体，设置在压电物体后表面上的吸声层，防止超声波被输送到压电物体的后部，声匹配层通过使压电物体的声阻抗与物体的声阻抗相匹配而将产生的超声波输送到物体，以及声透镜集中产生的超声波并将集中的超声波辐射到受试者。

