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

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See application file for complete search history.

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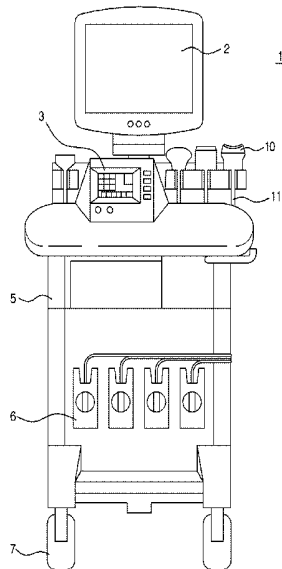
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(57) **ABSTRACT**

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.

18 Claims, 6 Drawing Sheets



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8/4461 (2013.01)

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FIG. 1

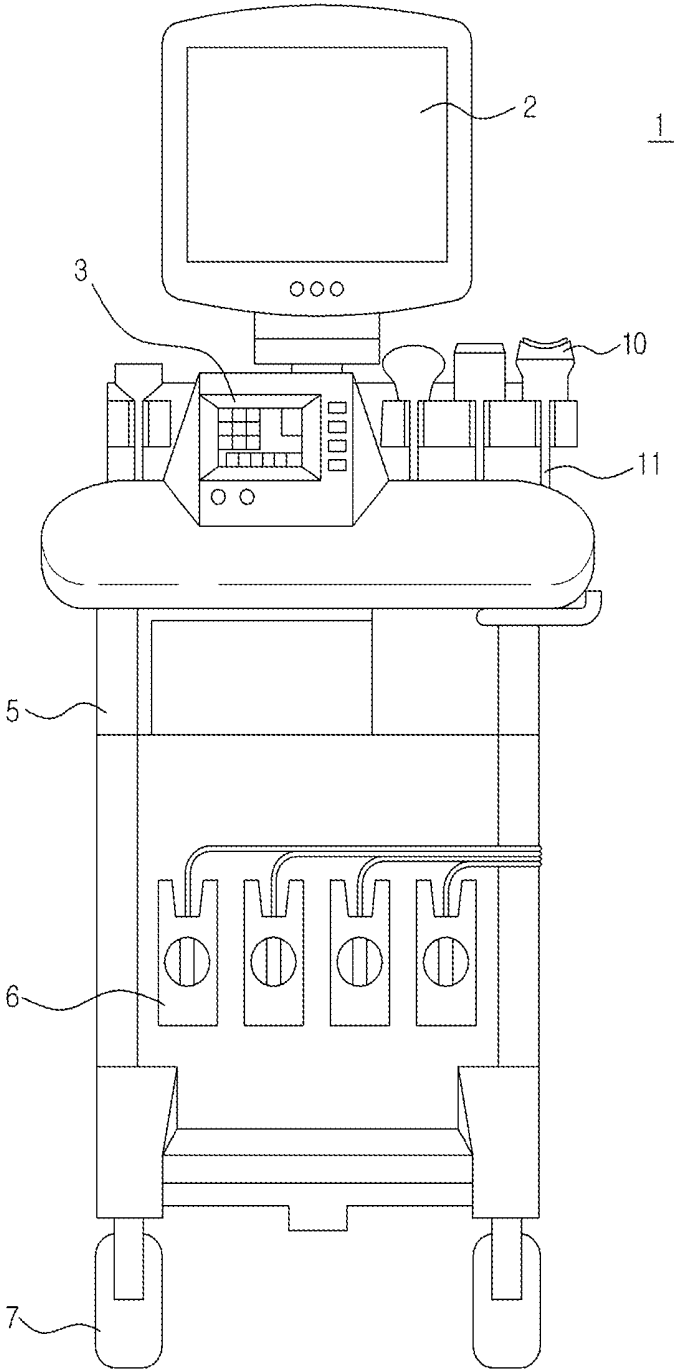


FIG. 2

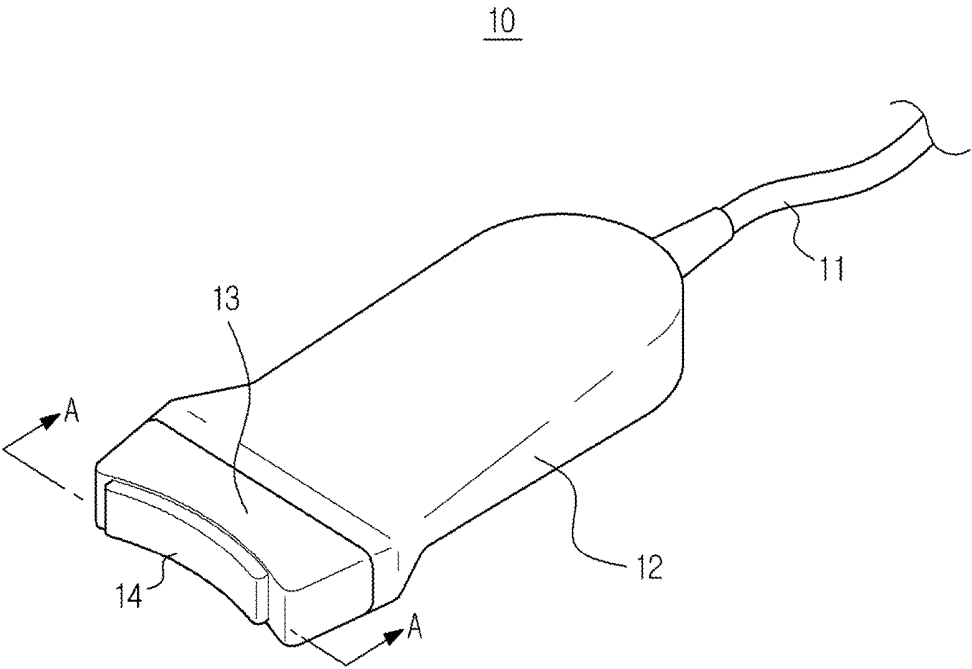


FIG. 3

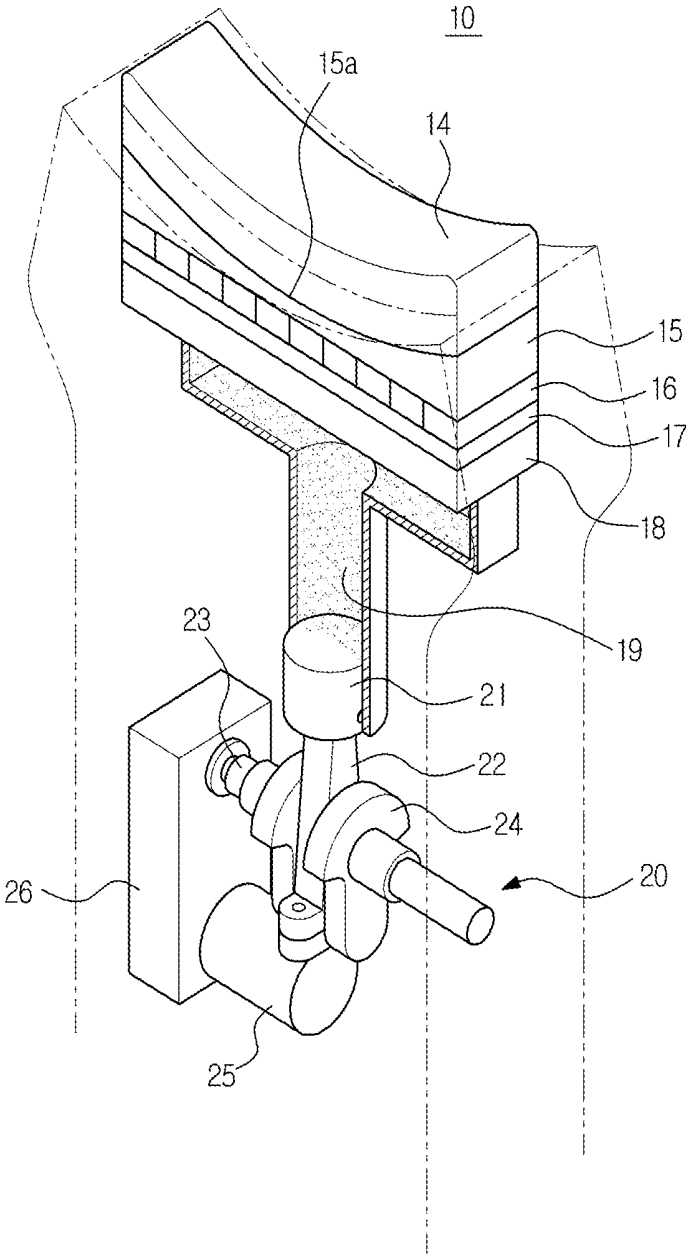


FIG. 4

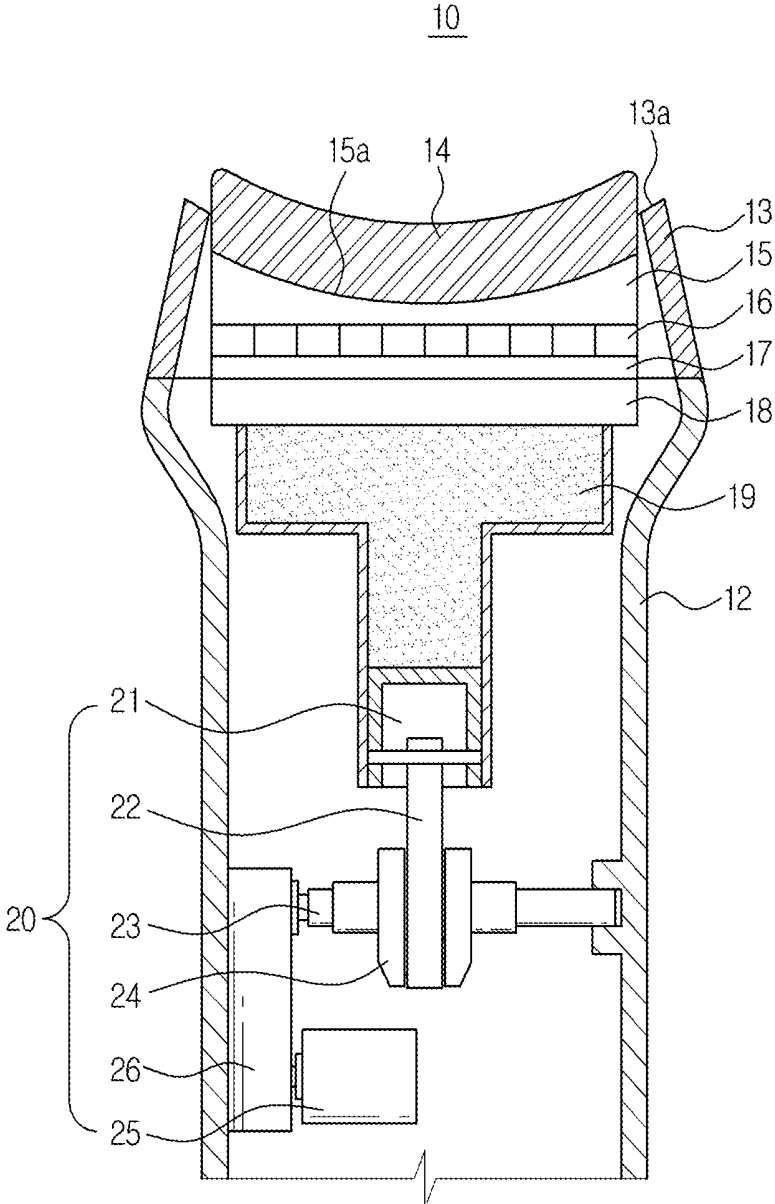


FIG. 5

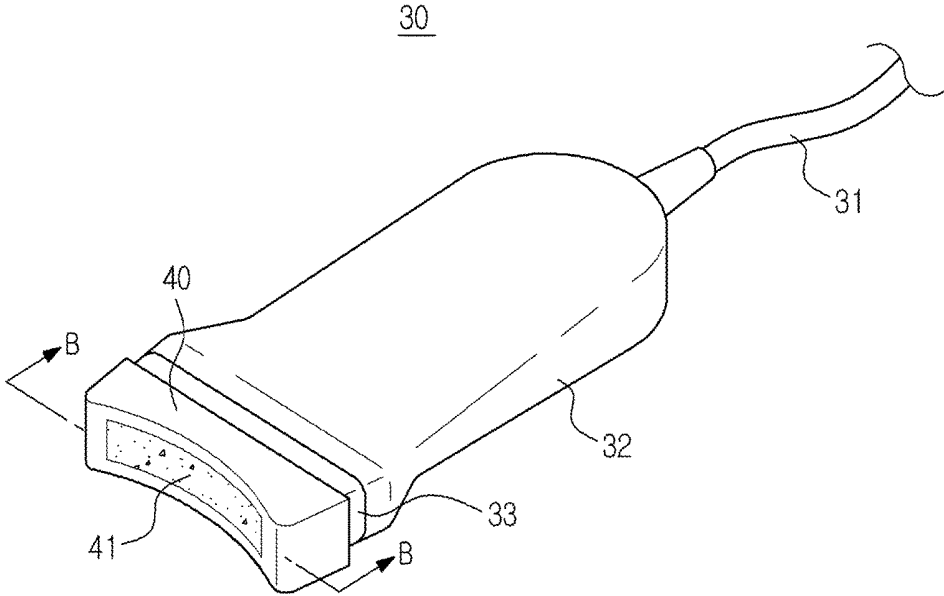
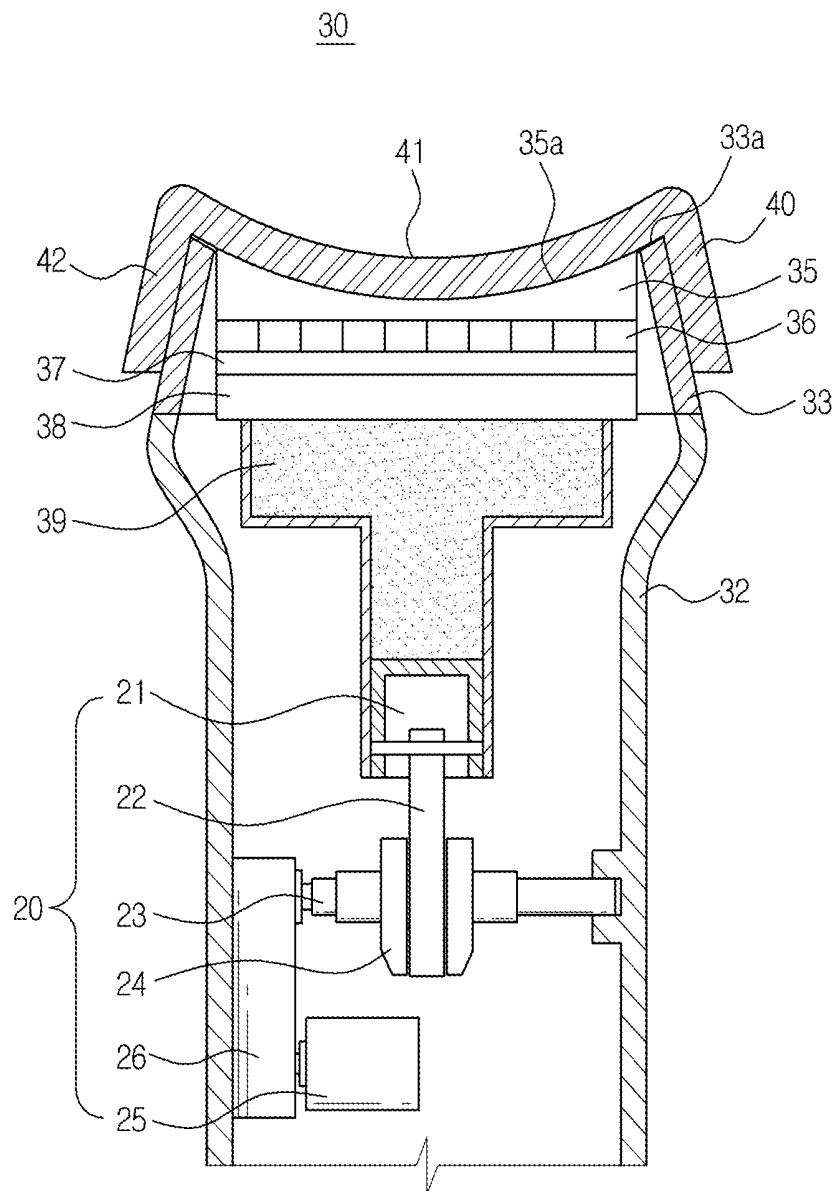


FIG. 6



PROBE FOR ULTRASONIC DIAGNOSTIC APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

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

1. Field

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.

2. Description of the Related Art

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.

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.

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.

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.

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.

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.

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

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.

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.

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.

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.

The moving layer may include compressed gas.

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

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.

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.

The pad may be integrally attached to the sound lens.

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

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.

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.

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

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.

The cover portion may include a flexible material.

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.

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.

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

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.

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.

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.

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.

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

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:

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

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.

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

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

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.

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

DETAILED DESCRIPTION

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.

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.

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.

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.

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.

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**.

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.

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.

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.

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.

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.

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.

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 an resultant image.

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.

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.

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.

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**.

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.

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.

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

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.

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**.

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**.

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.

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**.

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.

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**.

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.

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.

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.

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.

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.

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 an ultrasonic diagnostic apparatus, 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 backing 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 from the piezoelectric object to a subject by matching a sound impedance of the piezoelectric object with a sound impedance of the subject;

a single acoustic 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;

a moving layer which is provided at a rear surface of the backing layer and which changes a radius of curvature of the acoustic lens, and

a driving member which causes the moving layer to move, wherein the moving layer comprises a liquid and a film surrounding the liquid, and

wherein the single acoustic lens includes a concave portion which facilitates performance of a diagnosis along a curved surface of the subject, and has a varying radius of curvature.

2. The probe for an ultrasonic diagnostic apparatus of claim 1, further comprising:

a cover portion which is provided at a front surface of the acoustic lens and which is configured to make 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 acoustic lens.

3. The probe for an ultrasonic diagnostic apparatus of claim 2, 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 is configured to make contact with the skin of the subject.

4. The probe for an ultrasonic diagnostic apparatus of claim 3, wherein the pad is integrally attached to the acoustic lens.

5. The probe for an ultrasonic diagnostic apparatus of claim 3, wherein the pad is provided at an outer side of a base member that is detachably mounted to the cover portion.

6. The probe for an ultrasonic diagnostic apparatus of claim 1, wherein the driving member includes a piston located on a rear surface of the moving layer and configured to move the moving layer.

7. The probe for an ultrasonic diagnostic apparatus of claim 6, wherein each of a radius of curvature of the piezoelectric object and a radius of curvature of the backing

layer varies as the moving layer is moved by using the piston, and the concave portion flattens as the moving layer is moved.

8. The probe for an ultrasonic diagnostic apparatus of claim 6, wherein the driving member further includes a motor which is coupled to the piston and which drives the piston in a full automatic manner.

9. The probe for an ultrasonic diagnostic apparatus of claim 8, wherein each of a radius of curvature of the piezoelectric object and a radius of curvature of the backing 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.

10. The probe for an ultrasonic diagnostic apparatus of claim 2, wherein the cover portion includes a flexible material.

11. An ultrasonic diagnostic apparatus comprising a probe including a cover portion in contact with a subject and a transducer which is disposed on a rear surface of the cover portion and having a piezoelectric object, an acoustic matching layer, a single acoustic lens, and a backing layer which are configured to inter-convert an electrical signal and a sound signal,

wherein the probe comprises:

a concave portion disposed to be inwardly recessed on a surface of the transducer in contact with the cover portion and configured to diagnose the subject along a curved surface of the subject; and

a moving layer disposed on a rear surface of the transducer and configured to change a radius of curvature of a portion of the single acoustic lens which is configured to make contact with the subject,

wherein the moving layer comprises a liquid and a film surrounding the liquid.

12. The ultrasonic diagnostic apparatus of claim 11, 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 is configured to make contact with a skin of the subject.

13. The ultrasonic diagnostic apparatus of claim 11, further comprising:

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

14. The ultrasonic diagnostic apparatus of claim 13, 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 is configured to make contact with a skin of the subject.

15. The ultrasonic diagnostic apparatus of claim 11, 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.

16. The ultrasonic diagnostic apparatus of claim 11, further comprising:

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

17. The ultrasonic diagnostic apparatus of claim 16, 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.

18. A probe for an ultrasonic diagnostic apparatus, 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; 5
 - a backing 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 10 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;
 - a single acoustic lens which is provided at a front surface 15 of the acoustic matching layer and which concentrates the generated ultrasonic wave and radiates the concentrated ultrasonic wave toward the subject;
 - a concave portion disposed on the sound lens and configured to diagnose the subject along a curved surface 20 of the subject; and
 - a moving layer disposed on a rear surface of the backing layer and configured to change radius of curvature of the single acoustic lens,
- wherein the moving layer comprises a liquid and a film 25 surrounding the liquid.

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摘要(译)

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