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(54) **PROBE FOR ULTRASONIC DIAGNOSTIC APPARATUS AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Jin Woo Jung**, Seoul (KR); **Jeong Cheol Seo**, Gwangju-si (KR); **Jae Yk Kim**, Seoul (KR)

(73) Assignee: **SAMSUNG MEDISON CO., LTD.**, Hongcheon-Gun, Gangwon-Do (KR)

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A61B 5/05 (2006.01)
B06B 1/06 (2006.01)
G10K 11/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B06B 1/0622*** (2013.01); *Y10T 29/49005* (2015.01); ***G10K 11/004*** (2013.01)

(58) **Field of Classification Search**
USPC 600/407, 437–475
See application file for complete search history.

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Primary Examiner — Mark Remaly
(74) *Attorney, Agent, or Firm* — McDermott Will & Emery LLP

(57) **ABSTRACT**

A probe for an ultrasonic diagnostic apparatus includes a backing layer including backing members, a first connector bonded between the backing members and including electrodes spaced from each other in an arrangement direction, and a piezoelectric member electrically connected to the electrodes. A method of manufacturing the same is also disclosed. The piezoelectric member is connected to the first connector or to first and second connectors via an electrode layer instead of using a complicated and laborious soldering operation, thereby enabling easy connection between the piezoelectric member and the connector while preventing deterioration in performance caused by defective connection therebetween and deterioration in performance of the piezoelectric member caused by heat during manufacturing operation.

9 Claims, 12 Drawing Sheets

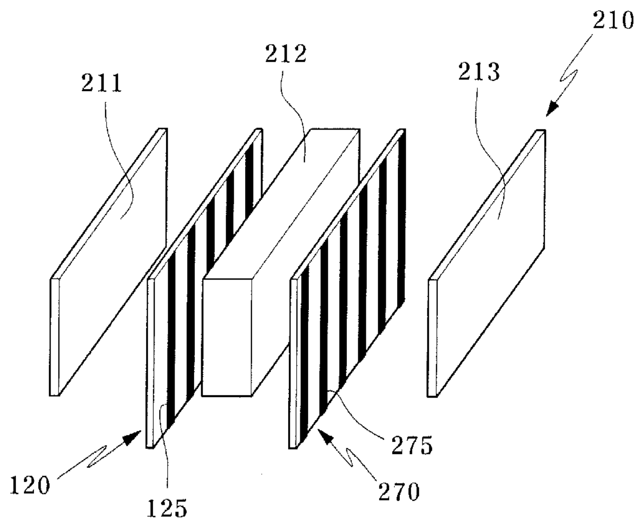


Fig. 1

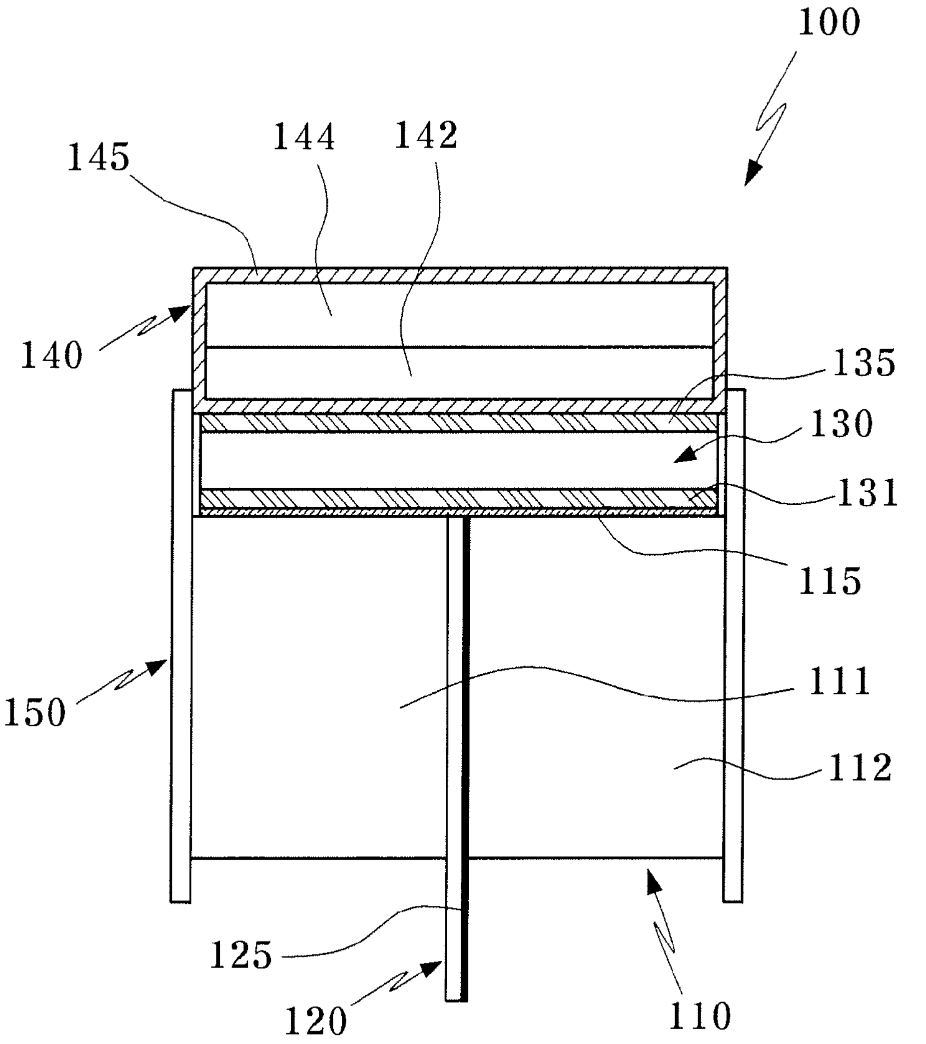


Fig. 2

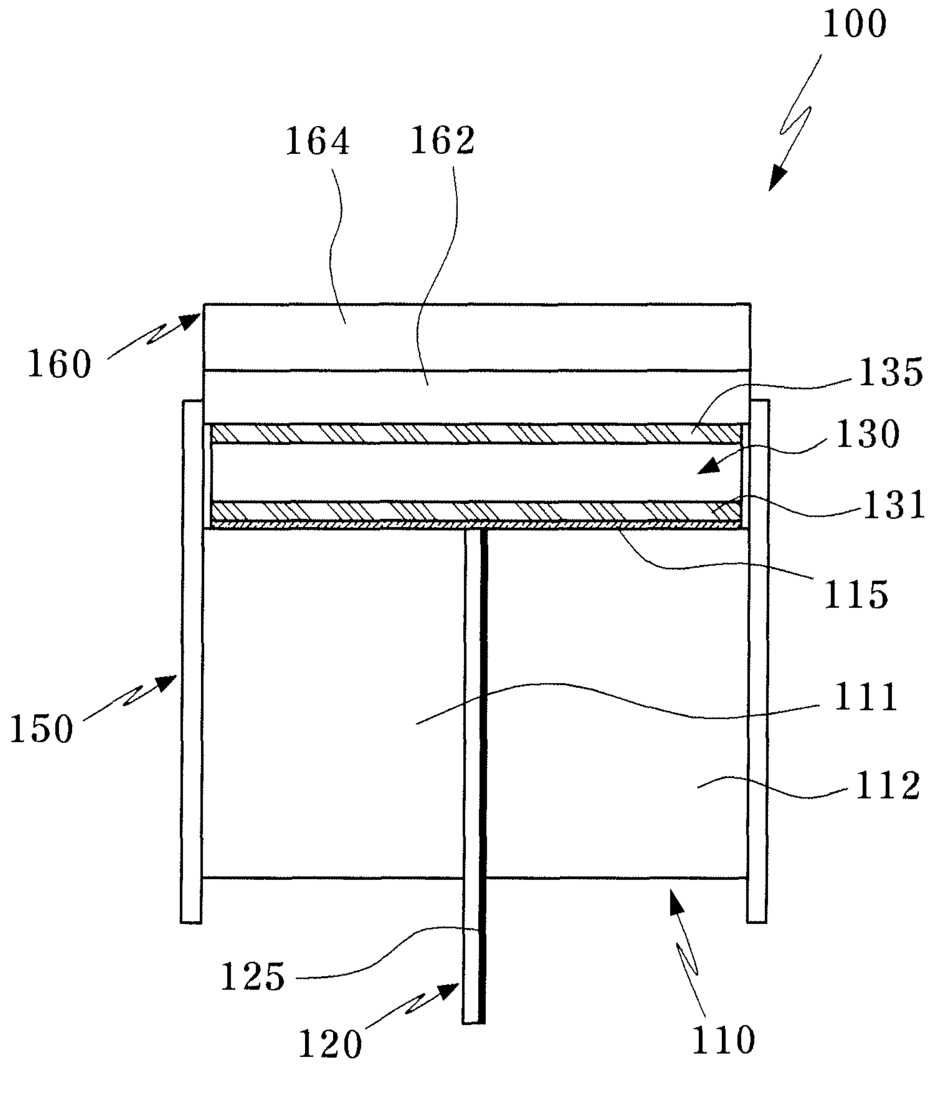


Fig. 3

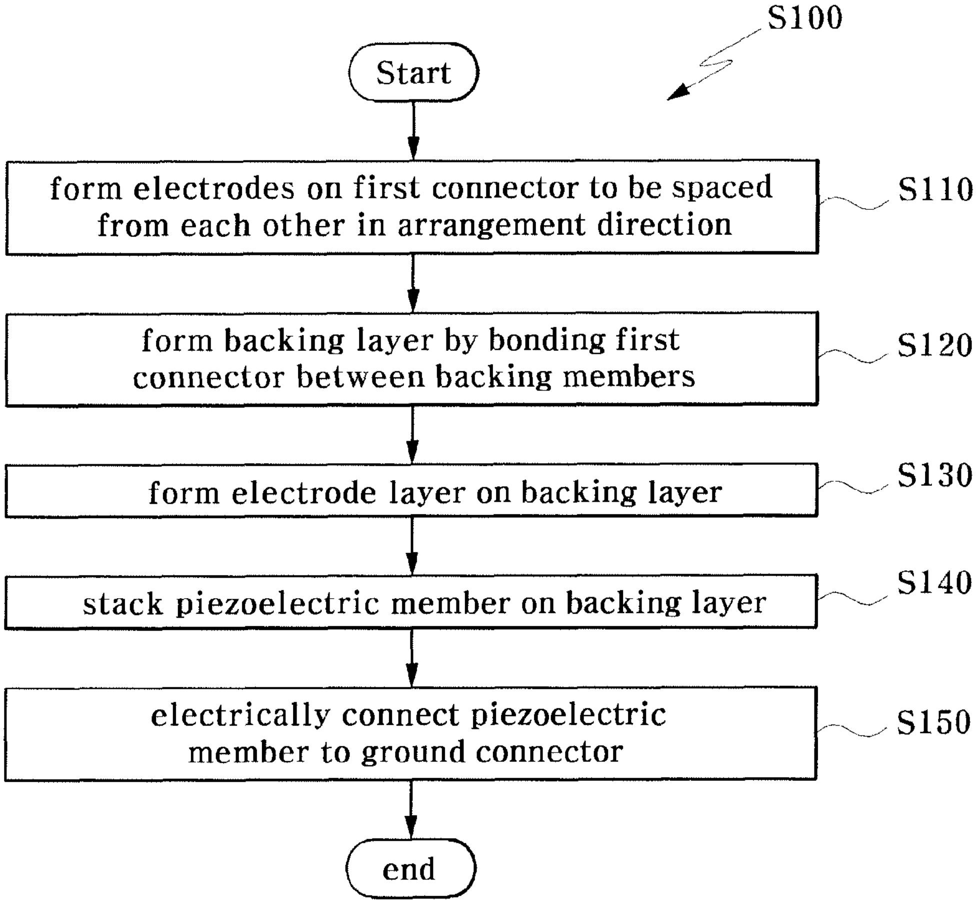

S100
Start
form electrodes on first connector to be spaced from each other in arrangement direction
S110
form backing layer by bonding first connector between backing members
S120
form electrode layer on backing layer
S130
stack piezoelectric member on backing layer
S140
electrically connect piezoelectric member to ground connector
S150
end

Fig. 4

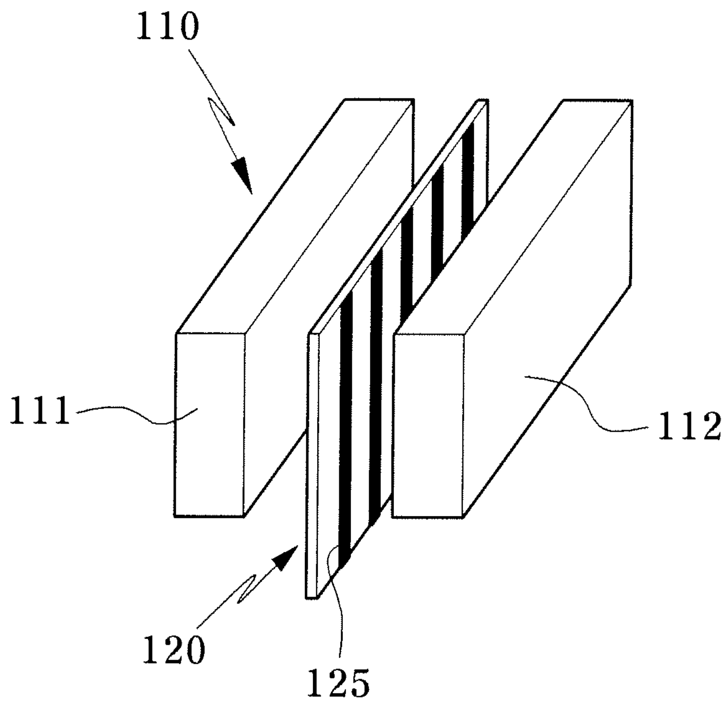


Fig. 5

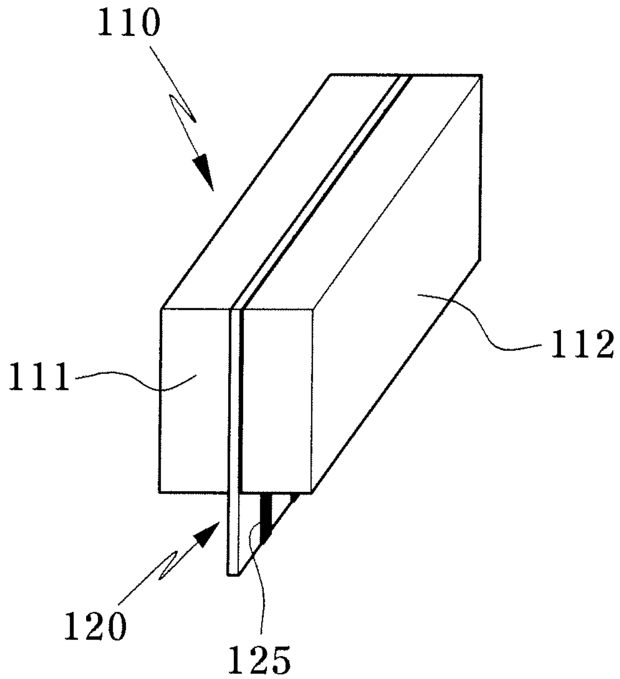


Fig. 6

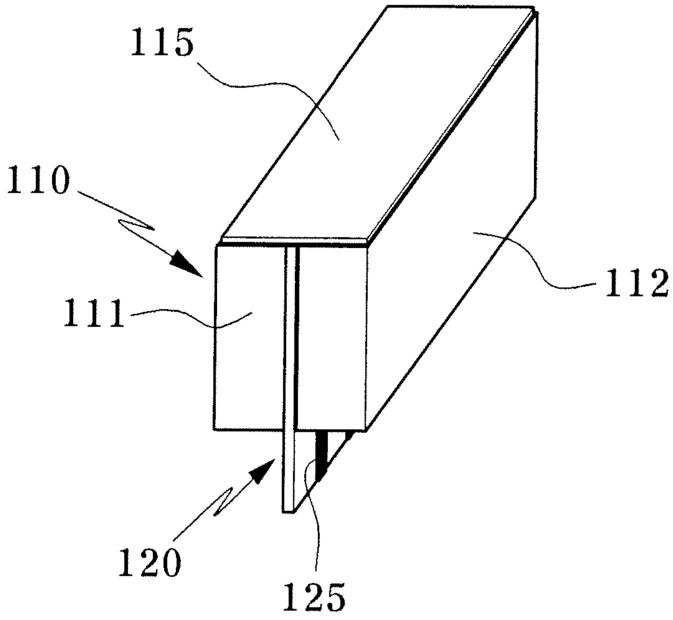

115
110
111
112
120
125

Fig. 7

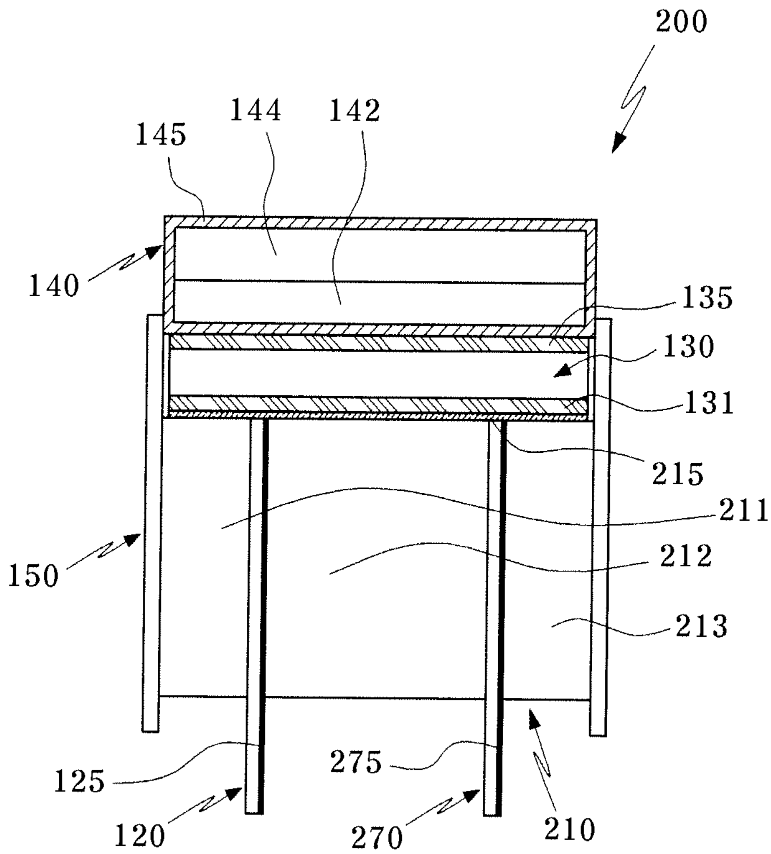

200
145
144
142
140
135
130
131
215
211
150
212
213
125
275
120
270
210

Fig. 8

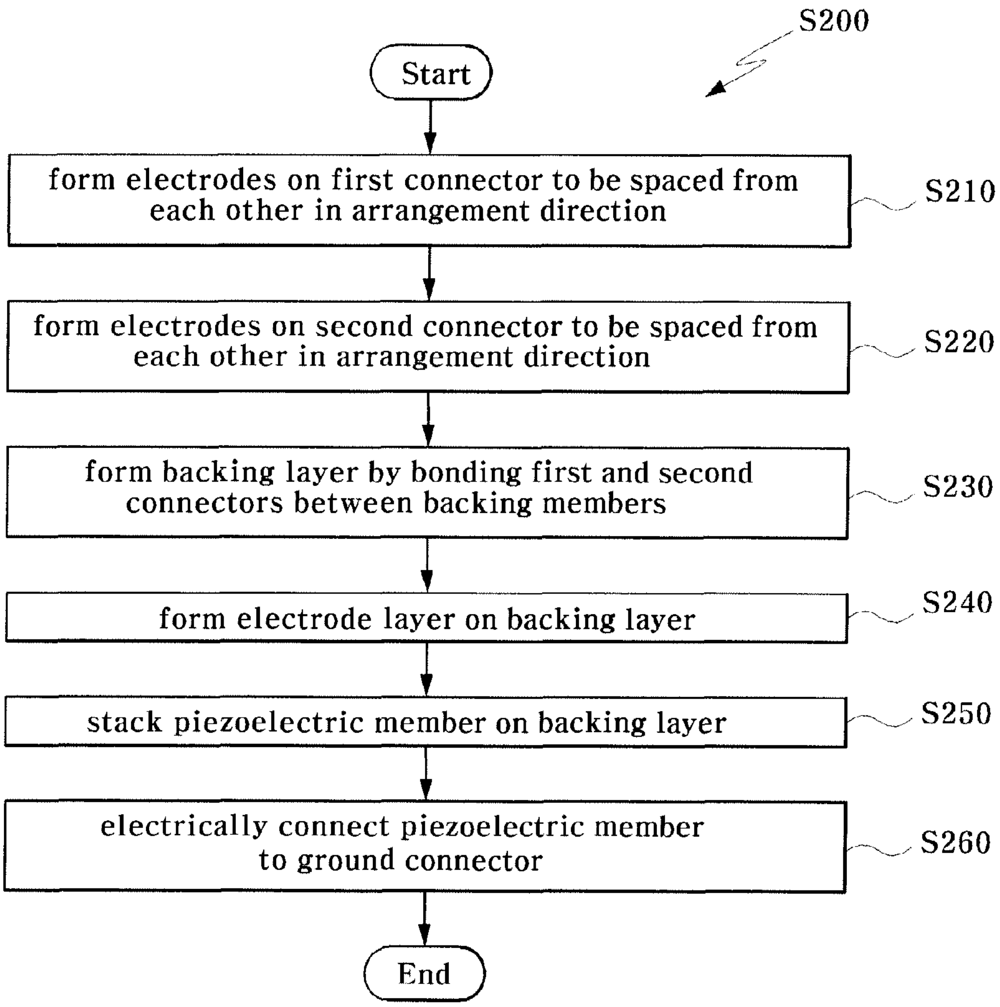

S200
Start
form electrodes on first connector to be spaced from each other in arrangement direction
S210
form electrodes on second connector to be spaced from each other in arrangement direction
S220
form backing layer by bonding first and second connectors between backing members
S230
form electrode layer on backing layer
S240
stack piezoelectric member on backing layer
S250
electrically connect piezoelectric member to ground connector
S260
End

Fig. 9

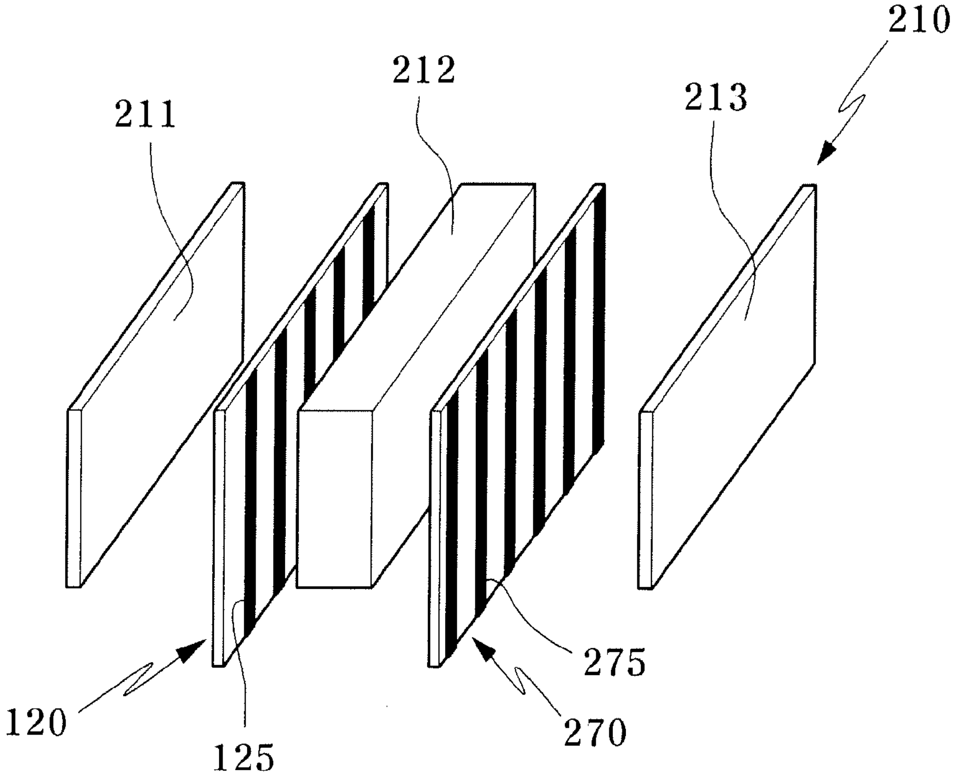


Fig. 10

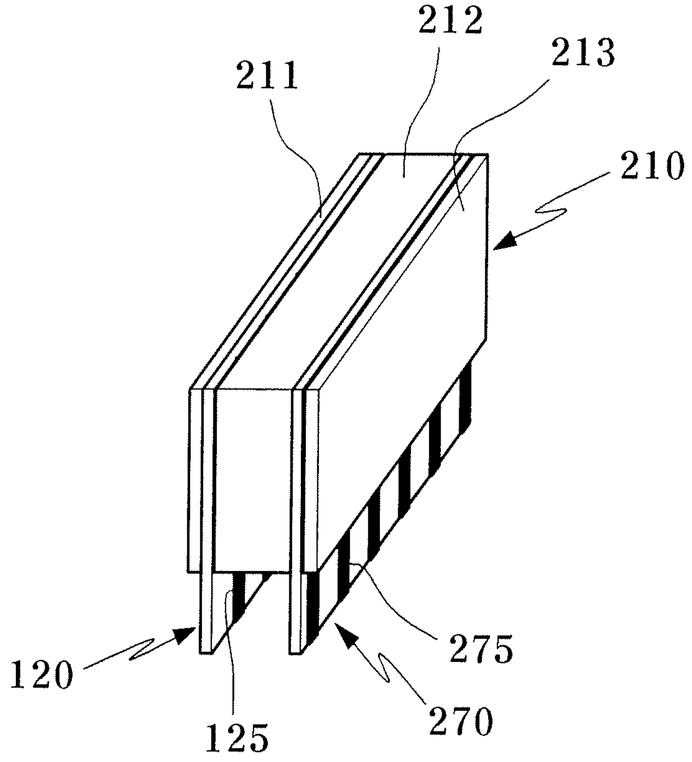


Fig. 11

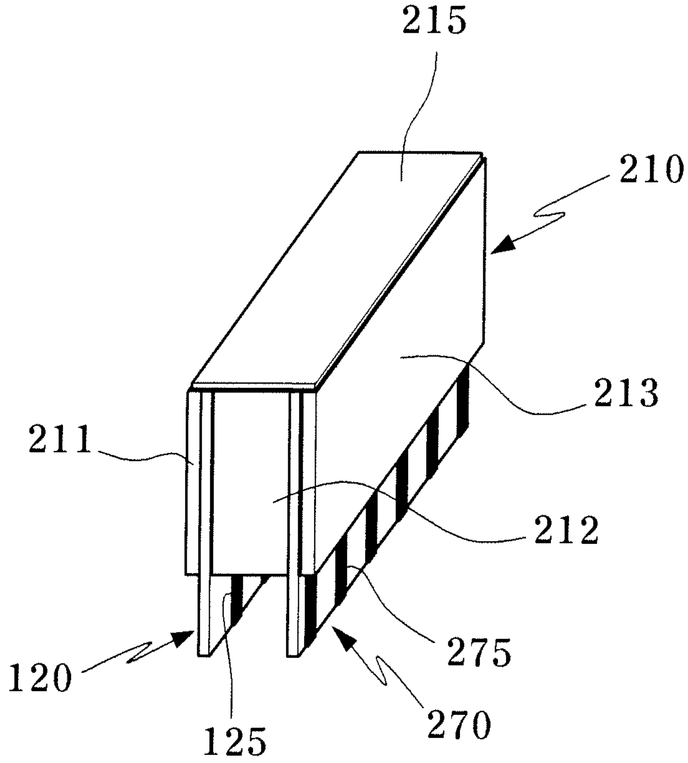


Fig. 12

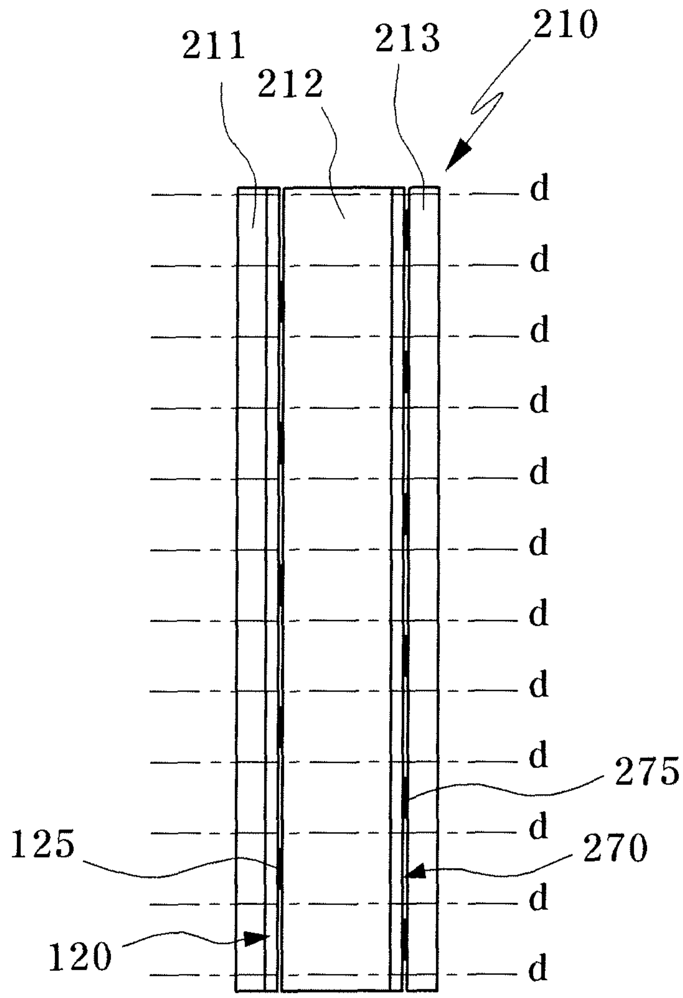
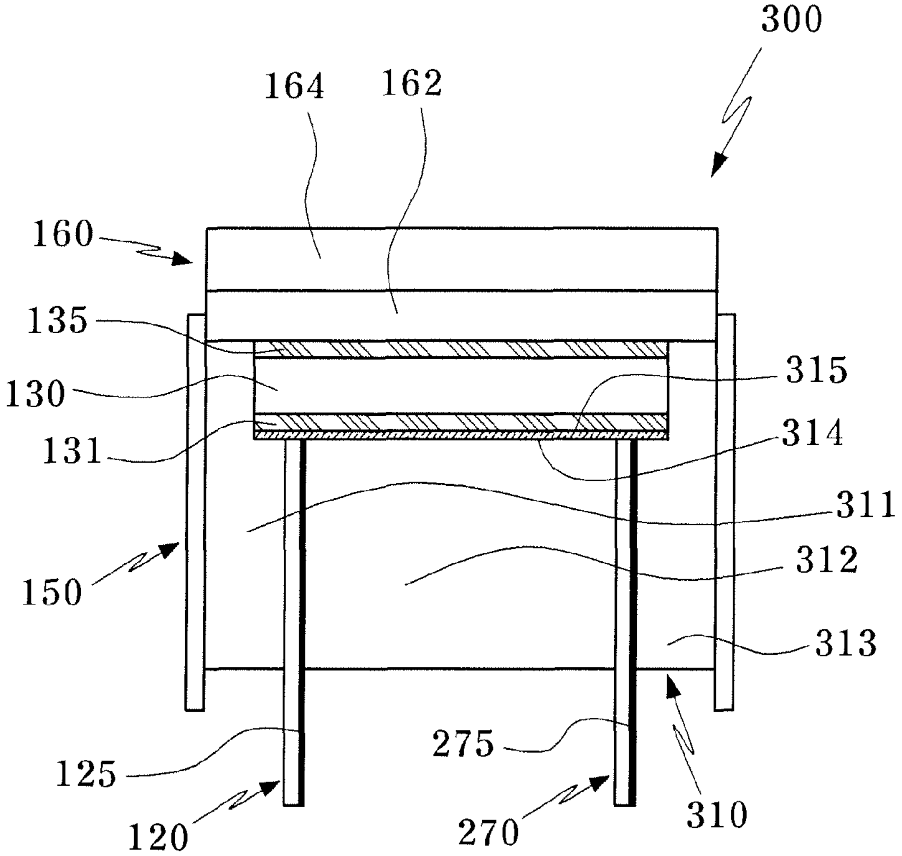
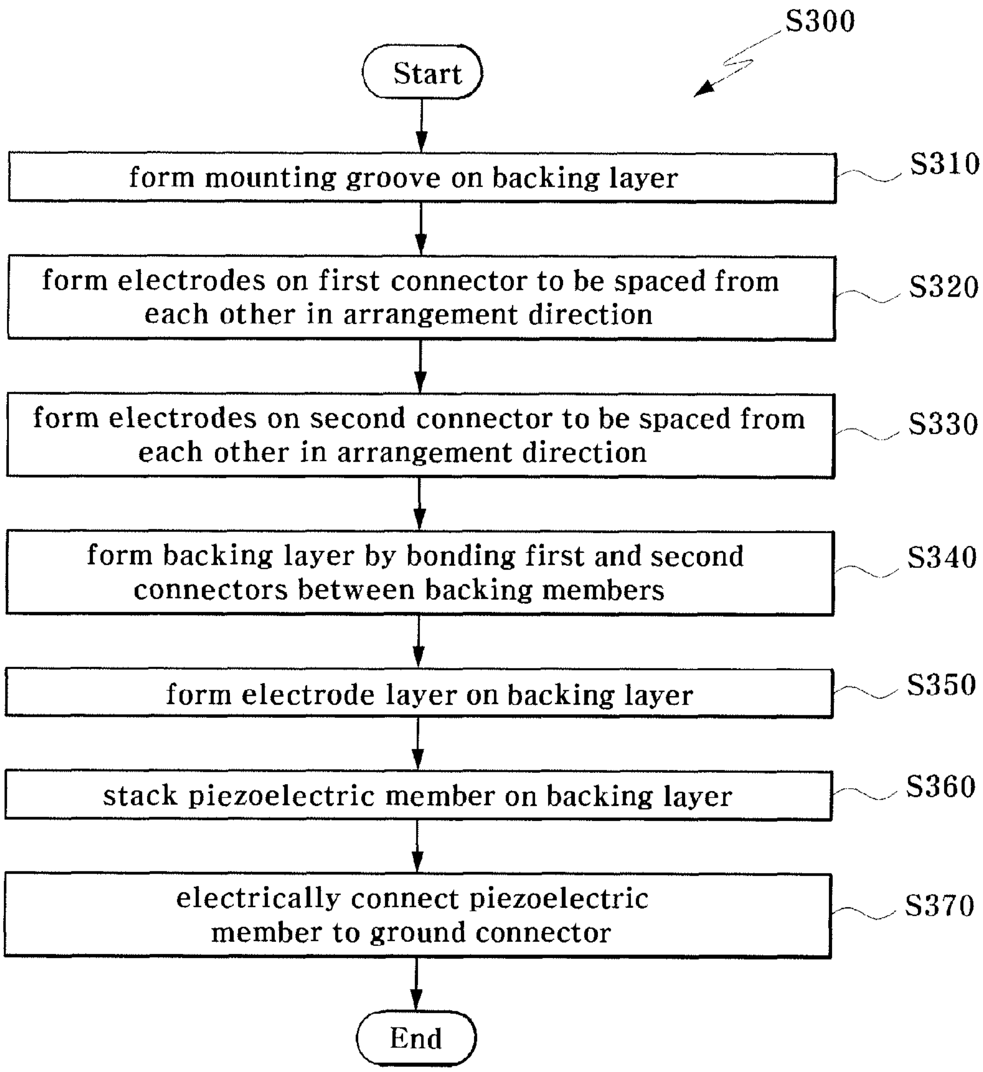


Fig. 13



300
164
162
160
135
315
130
314
131
311
150
312
313
275
125
310
270
120

Fig. 14


S300
Start
form mounting groove on backing layer
S310
form electrodes on first connector to be spaced from each other in arrangement direction
S320
form electrodes on second connector to be spaced from each other in arrangement direction
S330
form backing layer by bonding first and second connectors between backing members
S340
form electrode layer on backing layer
S350
stack piezoelectric member on backing layer
S360
electrically connect piezoelectric member to ground connector
S370
End

PROBE FOR ULTRASONIC DIAGNOSTIC APPARATUS AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from Korean Patent Application No. 10-2009-0023013 filed on Mar. 18, 2009, the entire subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to probes and, more particularly, to a probe for an ultrasonic diagnostic apparatus that generates internal images of a patient body using ultrasound waves, and a method of manufacturing the same.

2. Description of the Related Art

Generally, an ultrasonic diagnostic apparatus refers to a non-invasive apparatus that irradiates an ultrasound signal from a surface of a patient body towards a target internal organ beneath the body surface and obtains an image of a monolayer or blood flow in soft tissue from information in the reflected ultrasound signal (ultrasound echo-signal). The ultrasonic diagnostic apparatus has been widely used for diagnosis of the heart, the abdomen, the urinary organs, and in obstetrics and gynecology due to various merits such as small size, low price, real-time image display, and high stability through elimination of radiation exposure, as compared with other image diagnostic systems, such as X-ray diagnostic systems, computerized tomography scanners (CT scanners), magnetic resonance imagers (MRIs), nuclear medicine diagnostic apparatuses, and the like.

The ultrasonic diagnostic apparatus includes a probe which transmits an ultrasound signal to a patient body and receives the ultrasound echo-signal reflected therefrom to obtain the ultrasound image of the patient body.

The probe includes a transducer, a case with an open upper end, a cover coupled to the open upper end of the case to directly contact the body surface of the patient, and the like.

The transducer includes a piezoelectric layer in which a piezoelectric material converts electrical signals into sound signals or vice versa while vibrating, a sound matching layer reducing a difference in sound impedance between the piezoelectric layer and a patient body to allow as much of the ultrasound waves generated from the piezoelectric layer as possible to be transferred to the patient body, a lens layer focusing the ultrasound waves, which travel in front of the piezoelectric layer, onto a predetermined point, and a backing layer blocking the ultrasound waves from traveling in a rearward direction of the piezoelectric layer to prevent image distortion.

The piezoelectric layer includes a piezoelectric member and electrodes provided to upper and lower ends of the piezoelectric member, respectively. Further, a printed circuit board (PCB) is bonded to the piezoelectric layer. The PCB is provided with wiring electrodes that are connected to the electrodes of the piezoelectric layer to transfer signals from the piezoelectric member. The PCB is connected to the piezoelectric layer by connecting the wiring electrodes of the PCB and the electrodes of the piezoelectric layer.

In fabrication of the probe, connection of the wiring electrodes of the PCB to the electrodes of the piezoelectric layer is a laborious operation, which increases fabrication time and causes deterioration in performance of the probe due to low durability and non-uniformity of a connected part therebetween. Therefore, there is a need to provide a probe for an ultrasonic diagnostic apparatus that overcomes such problems.

SUMMARY OF THE INVENTION

The present invention is conceived to solve the problems of the related art as described above, and an aspect of the present invention is to provide an improved probe for an ultrasonic diagnostic apparatus configured to allow easy manufacture of the probe while preventing deterioration in performance caused by defective connection between a piezoelectric layer and a PCB, and a method of manufacturing the same.

In accordance with one aspect of the invention, a probe for an ultrasonic diagnostic apparatus includes: a backing layer including backing members; a first connector bonded between the backing members and including electrodes spaced from each other in an arrangement direction; and a piezoelectric member electrically connected to the electrodes.

The first connector may be disposed in a height direction of the backing members.

The first connector may include a flexible printed circuit board (FPCB).

The backing layer may include an electrode layer electrically connected to the electrodes.

The electrode layer may be formed on a surface of the backing layer.

The backing layer may be formed with a mounting groove, and the piezoelectric member may be inserted into the mounting groove.

The probe may further include a second connector bonded between the backing members and including electrodes spaced from each other in the arrangement direction.

The second connector may be disposed in the height direction of the backing members such that the electrodes of the first connector alternate with the electrodes of the second connector.

The electrodes of the first and second connectors may be signal electrodes.

In accordance with another aspect of the invention, a method of manufacturing a probe for an ultrasonic diagnostic apparatus includes: forming electrodes on a first connector to be spaced from each other in an arrangement direction; forming a backing layer by bonding the first connector between backing members; and stacking a piezoelectric member on the backing layer to be electrically connected to the electrodes.

The method may further include forming an electrode layer on the backing layer to be electrically connected to the piezoelectric member and the electrodes after forming the backing layer.

The forming a backing layer may include disposing the first connector in a height direction of the backing members.

In accordance with a further aspect of the invention, a method of manufacturing a probe for an ultrasonic diagnostic apparatus includes: forming electrodes on a first connector to be spaced from each other in an arrangement direction; forming electrodes on a second connector to be spaced from each other in the arrangement direction; forming a backing layer by bonding the first and second connectors between backing members; and stacking a piezoelectric member on the backing layer to be electrically connected to the electrodes of the first and second connectors.

The method may further include forming an electrode layer on the backing layer to be electrically connected to the piezoelectric member and the electrodes of the first and second connectors after forming the backing layer.

The forming a backing layer may include disposing the second connector in a height direction of the backing members such that the electrodes of the first connector alternate with the electrodes of the second connector.

The method may further include forming a mounting groove on the backing layer, wherein the stacking a piezoelectric member on the backing layer includes inserting the piezoelectric member into the mounting groove.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages of the invention will become apparent from the following description of embodiments given in conjunction with the accompanying drawings, in which:

FIGS. **1** and **2** are schematic views of a probe for an ultrasonic diagnostic apparatus according to a first embodiment of the present invention;

FIG. **3** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the first embodiment of the invention;

FIGS. **4** and **5** are views of a process of forming a backing layer of the probe according to the first embodiment of the invention;

FIG. **6** is a view of a process of forming an electrode layer on the backing layer of the probe according to the first embodiment of the invention;

FIG. **7** is a schematic view of a probe for an ultrasonic diagnostic apparatus according to a second embodiment of the present invention;

FIG. **8** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the second embodiment of the invention;

FIGS. **9** and **10** are views of a process of forming a backing layer of the probe according to the second embodiment of the invention;

FIG. **11** is a view of a process of forming an electrode layer on the backing layer of the probe according to the second embodiment of the invention;

FIG. **12** is a view showing a separated state of the backing layer of the probe according to the second embodiment of the invention;

FIG. **13** is a schematic view of a probe for an ultrasonic diagnostic apparatus according to a third embodiment of the present invention; and

FIG. **14** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENT

Exemplary embodiments of the invention will now be described in detail with reference to the accompanying drawings. It should be noted that the drawings are not to precise scale and may be exaggerated in thickness of lines or size of components for descriptive convenience and clarity only. Furthermore, terms used herein are defined by taking functions of the invention into account and can be changed according to the custom or intention of users or operators. Therefore, definition of the terms should be made according to overall disclosures set forth herein.

FIGS. **1** and **2** are schematic views of a probe for an ultrasonic diagnostic apparatus according to a first embodiment of the present invention.

Referring to FIG. **1**, a probe **100** for an ultrasonic diagnostic apparatus according to this embodiment includes a backing layer **110**, a first connector **120**, and a piezoelectric member **130**.

The backing layer **110** is disposed behind the piezoelectric member **130** described below. The backing layer **110** reduces a pulse width of an ultrasound wave by suppressing free vibration of the piezoelectric member **130** and prevents image distortion by blocking unnecessary propagation of the ultrasound wave in the rearward direction of the piezoelectric member **130**.

The backing layer **110** includes multiple backing members **111**, **112** and is formed by bonding the backing members **111**, **112** to each other. The backing layer **110** may be formed of a material containing a rubber to which epoxy, tungsten powder, and the like are added.

The first connector **120** includes an insulation part (reference numeral omitted) and electrodes **125**. The multiple electrodes **125** are disposed on the insulation part to be separated from each other in an "arrangement direction." Herein, the term "arrangement direction" refers to a direction in which piezoelectric members are arranged in an array. In other words, the electrodes **125** are spaced from each other in the arrangement direction of piezoelectric members **130** which are arranged in an array (see FIG. **4**).

In this embodiment, each of the electrodes **125** of the first connector **120** is a signal electrode that is electrically connected to a first electrode **131** of the piezoelectric member **130** described below.

The first connector **120** including the electrodes **125** is bonded between the backing members **111**, **112**. According to this embodiment, the first connector **120** is inserted and bonded between two backing members **111**, **112**.

The first connector **120** is disposed in a "height direction of the backing members **111**, **112**." The backing members **111**, **112** are bonded to opposite sides of the first connector **120**, thereby forming the backing layer **110**. Herein, the term "height direction of the backing members **111**, **112**" refers to a direction perpendicular to a direction in which an electrode layer **115** is formed (see FIG. **4**).

One end of the first connector **120** bonded between the backing members **111**, **112** is exposed on a front side of the backing layer **110** adjacent to the piezoelectric member **130**, and the other end thereof extends through a rear side of the backing layer **110**. As such, since the one end of the first connector **120** is exposed on the front side of the backing layer **110**, the electrodes **125** of the first connector **120** are exposed on the front side of the backing layer **110**.

The first connector **120** may include a flexible printed circuit board (FPCB), a printed circuit board (PCB) or any configuration capable of supplying signals or electricity.

The backing layer **110** includes the electrode layer **115**. The electrode layer **115** is formed on the backing layer **110** to be disposed between the backing layer **110** and the piezoelectric member **130**. The electrode layer **115** is electrically connected to the electrodes **125**.

According to this embodiment, the electrode layer **115** is formed on a surface of the backing layer **110**. Specifically, the electrode layer **115** may be formed on the front surface of the backing layer **110** adjacent to the piezoelectric member **130**. The electrode layer **115** may be formed of a highly electrically conductive material by deposition, sputtering, plating, spraying or the like.

The piezoelectric member **130** is electrically connected to the electrodes **125**. The piezoelectric member **130** generates ultrasound waves using a resonance phenomenon and may be formed of a ceramic of lead zirconate titanate (PZT), a PZNT single crystal made of a solid solution of lead zinc niobate and lead titanate, a PZMT single crystal made of a solid solution of lead magnesium niobate and lead titanate, or the like.

The piezoelectric member **130** is formed with first and second electrodes **131**, **135**. One of the first and second electrodes **131**, **135** is disposed on one side of the piezoelectric member **130** and the other electrode is disposed on the other side thereof. Here, the first electrode **131** is electrically connected to the electrode layer **115**.

The first and second electrodes **131**, **135** may be formed of a highly electrically conductive metal. Here, one of the first and second electrodes **131**, **135** serves as a positive pole or signal electrode of the piezoelectric member **130**, and the other serves as a negative pole or ground electrode of the piezoelectric member **130**.

The first and second electrodes **131**, **135** are separated from each other to allow the signal electrode and the ground electrode to be separated from each other. In this embodiment, the first and second electrodes **131**, **135** are illustrated as serving as the positive and negative poles, respectively.

According to this embodiment, the piezoelectric member **130** is electrically connected to the electrodes **125** via the electrode layer **115** and the first electrode **131** which are electrically connected to each other.

The piezoelectric member **130** may be composed of a plurality of piezoelectric members **130** arranged in an array to provide multiple channels. The electrode layer **115** may also be composed of a plurality of electrode layers **115** arranged side by side in an array so as to correspond to the piezoelectric members **130** arranged in an array. Therefore, the piezoelectric members **130** and the electrode layers **115** are correspondingly connected to the electrodes **125** spaced from each other in the arrangement direction.

According to this embodiment, the probe **100** may further include a sound matching layer **140** and a ground connector **150**.

The sound matching layer **140** is disposed in front of the piezoelectric member **130**. The sound matching layer **140** allows ultrasound signals generated from the piezoelectric member **130** to be efficiently transferred to a target by matching sound impedances of the piezoelectric member **130** and the target. The sound matching layer **140** is configured to have an intermediate value between the sound impedance of the piezoelectric member **130** and the sound impedance of the target.

The sound matching layer **140** may be formed of a glass or resin material, and includes a first sound matching layer **142** and a second sound matching layer **144**, which are formed of different materials to allow the sound impedance of the sound matching layer **140** to be changed stepwise from the piezoelectric member **130** to the target.

The sound matching layer **140** further includes an electrode part **145**. The electrode part **145** may be formed to partially or entirely surround the sound matching layer **140**. When the electrode part **145** is formed to partially surround the sound matching layer **140**, the electrode part **145** surrounds the first sound matching layer **142** adjacent to the piezoelectric member **130**.

Like the electrode layer **115**, the electrode part **145** may be formed of a highly electrically conductive material by deposition, sputtering, plating, spraying or the like.

The electrode part **145** is electrically connected to a second electrode **135** of the piezoelectric member **130**. As a result, the piezoelectric member **130** is electrically connected to the electrode part **145**.

The ground connector **150** is electrically connected to the electrode part **145**. As in the first connector **120**, the ground connector **150** may include a flexible printed circuit board (FPCB), a printed circuit board, or any configuration capable of supplying signals or electricity. The ground connector **150** may be connected to the electrode part **145** by a soldering material such as lead, an anisotropic conductor, and the like. As such, the ground connector **150** is electrically connected to the second electrode **135** of the piezoelectric member **130** via connection with the electrode part **145**.

According to this embodiment, connection between the piezoelectric member **130** and the ground connector **150** is illustrated as being obtained through the electrode part **145** formed on the sound matching layer **140**. However, the invention is not limited to this configuration, and the connection between the piezoelectric member **130** and the ground connector **150** may be embodied in various ways.

For example, referring to FIG. **2**, a sound matching layer **160** including the first and second sound matching layers **162**, **164** is directly connected to the piezoelectric member **130**. In other words, the sound matching layer **160** is formed of an electrically conductive material, such as graphite, gold, silver or copper, and is electrically connected to the second electrode **135** of the piezoelectric member **130**.

The sound matching layer **160** may be entirely or partially formed of the electrically conductive material. When the sound matching layer **160** is partially formed of the electrically conductive material, the first sound matching layer **162** adjacent to the piezoelectric member **130** may be formed of the electrically conductive material.

Although not shown in the drawings, the probe **100** according to this embodiment may further include a lens layer disposed in front of the sound matching layer **140** to focus forwardly traveling ultrasound waves on a predetermined point.

The probe **100** for an ultrasonic diagnostic apparatus according to this embodiment may be a linear type probe having a linear surface or a convex type probe having a convexly rounded surface or a phased array probe.

FIG. **3** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the first embodiment of the invention, FIGS. **4** and **5** are views of a process of forming the backing layer of the probe according to the first embodiment of the invention, and FIG. **6** is a view of a process of forming the electrode layer on the backing layer of the probe according to the first embodiment of the invention.

Referring to FIGS. **1** to **6**, the method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the first embodiment will now be described.

In the method S**100** according to this embodiment, firstly, electrodes **125** are formed on a first connector **120**, as shown in FIG. **4**, in S**110**.

The respective electrodes **125** are formed in the height direction of backing members **111**, **112** and are spaced from each other in the arrangement direction in which piezoelectric members **130** are arranged.

In this embodiment, the first connector **120** includes, but is not limited to, a flexible printed circuit board (FPCB). The first connector **120** may include a printed circuit board or any configuration capable of supplying signals or electricity as well as the flexible printed circuit board (FPCB).

With the electrodes **125** formed on the first connector **120**, the first connector **120** is bonded between backing members **111**, **112** to form a backing layer **110**, as shown in FIG. **5**, in S**120**.

For this purpose, the backing members **111**, **112** are formed of a material including a rubber to which epoxy resin, tungsten powder, and the like are added. Then, with the first connector **120** disposed between the backing members **111**, **112** in the height direction, the backing members **111**, **112** are bonded to opposite sides of the first connector **120**, thereby completing formation of the backing layer **110**.

One end of the first connector **120** bonded between the backing members **111**, **112** is exposed on the front side of the backing layer **110** adjacent to the piezoelectric member **130**, and the other end thereof extends through the rear side of the backing layer **110**.

Since the one end of the first connector **120** is exposed on the front side of the backing layer **110**, the electrodes **125** of the first connector **120** are exposed one the front side of the backing layer **110**.

After the backing layer **110** is formed, an electrode layer **115** is formed on the backing layer **110** to be electrically connected to the piezoelectric member **130** and the electrodes **125** in S**130**.

According to this embodiment, the electrode layer **115** is formed on a surface of the backing layer **110**. Specifically, the electrode layer **115** may be formed on the front surface of the backing layer **110** adjacent to the piezoelectric member **130**. The electrode layer **115** may be formed of a highly electrically conductive material by deposition, sputtering, plating, spraying or the like.

With this configuration of the electrode layer **115**, the rear side of the electrode layer **115** adjoining the surface of the backing layer **110** is electrically connected to the electrodes **125** of the first connector **120**.

After the electrode layer **115** is formed on the backing layer **110**, the piezoelectric member **130** is stacked on the backing layer **110** to be electrically connected to the electrodes **125** in S**140**.

By this process, a first electrode **131** of the piezoelectric member **130** is electrically connected to the electrode layer **115**. As such, since the electrode layer **115** connected to the first electrode **131** is electrically connected to the electrodes **125** of the first connector **120**, the piezoelectric member **130** is electrically connected to the electrodes **125** via the electrode layer **115** and the first electrode **131** which are electrically connected to each other.

According to this embodiment, the piezoelectric member **130** may be divided into multiple piezoelectric members **130** spaced a predetermined distance from each other and arranged side by side in an array, so that the multiple piezoelectric members **130** can be used as multiple channels corresponding to the multiple electrodes **125** formed on the first connector **120**, respectively.

The electrode layer **115** may also be divided into multiple electrode layers, which are arranged side by side in an array so as to correspond one-to-one to first electrodes **131** formed on the multiple piezoelectric members **130**.

According to this embodiment, stacks of the backing layer **110** and the piezoelectric member **130** are diced by a dicing machine (not shown). Dicing is performed to a depth such that the electrode layer **115** can be reliably divided into the multiple electrode layers.

By dicing, the piezoelectric member **130** is divided into the multiple piezoelectric members **130** spaced a predetermined distance from each other, such that first and second electrodes **131**, **135** formed on each of the piezoelectric members **130** can be electrically completely separated from first and second electrodes **131**, **135** formed on other piezoelectric members **130** adjacent thereto.

When the electrode layer **115** is divided into the multiple electrode layers **115** by dicing, each of the electrodes layers **115** is electrically completely separated from other electrode layers **115** adjacent thereto such that only one divided electrode layer **115** is connected to a first electrode **131** of one piezoelectric member **130**.

In this embodiment, the electrode layer **115** is illustrated as being diced together with the piezoelectric member **130** to correspond to the first electrode **131** of the piezoelectric member **130**. However, the invention is not limited thereto. Alternatively, the electrode layer **115** may be subjected to a patterning process to correspond to the first electrode **131** by optical etching, etching or the like before the piezoelectric member **130** is stacked on the backing layer **110**.

After the piezoelectric member **130** is stacked on the backing layer **110**, the piezoelectric member **130** is electrically connected to a ground connector **150**, as shown in FIG. **1**, in S**150**.

The ground connector **150** may be electrically connected to the piezoelectric member **130** via electrical connection between the second electrode **135** and an electrode part **145** formed on a sound matching layer **140**. Alternatively, the ground connector **150** may be electrically connected to the piezoelectric member **130** via electrical connection between the second electrode **135** and a sound matching layer **140**, which is made of an electrically conductive material, as shown in FIG. **2**.

The method S**100** of manufacturing a probe for an ultrasonic diagnostic apparatus is not limited to the sequence described above. The processes of the method may be performed in a different sequence or at the same time.

According to the embodiment, in manufacture of the probe **100** for an ultrasonic diagnostic apparatus, the piezoelectric member **130** is connected to the first connector **120** via the electrode layer **115** instead of using a complicated and laborious soldering operation, thereby enabling easy connection between the piezoelectric member **130** and the first connector **120** while preventing deterioration in performance caused by defective connection therebetween and in performance of the piezoelectric member **130** caused by heat during manufacture.

Further, according to the embodiment, the first connector **120** is bonded between the backing members **111**, **112**, instead of being disposed between a backing layer **110** and the piezoelectric member **130**, to be electrically connected to the piezoelectric member **130** via the electrode layer **115**, thereby preventing deterioration in performance caused by defective connection between the piezoelectric member **130** and the first connector **120** and preventing damage of the first connector **120** caused by bending.

Further, according to the embodiment, individual formation and maintenance of the backing layer **110** can be achieved by bonding the first connector **120** to the backing members **111**, **112** and forming the electrode layer **115** thereon, so that the backing layer **110** can be prepared in desired shapes and dimensions so as to be easily assembled to other components, thereby enabling easy manufacture of the probe at lower cost while enhancing uniformity of final products.

FIG. **7** is a schematic view of a probe for an ultrasonic diagnostic apparatus according to a second embodiment of the invention.

For descriptive convenience, the same or similar components to those of the above embodiment will be denoted by the same reference numerals as those of the above embodiment, and a detailed description thereof will be omitted herein.

Referring to FIG. **7**, a probe **200** for an ultrasonic diagnostic apparatus according to the second embodiment includes a backing layer **210**, a first connector **120**, a second connector **270**, a piezoelectric member **130**, a sound matching layer **140**, and a ground connector **150**.

The backing layer **210** is disposed behind the piezoelectric member **130**. The backing layer **210** includes multiple backing members **211**, **212**, **213** and is formed by bonding the backing members **211**, **212**, **213** to each other. The backing layer **210** may be formed of a material containing a rubber to which epoxy, tungsten powder, and the like are added.

The first connector **120** is bonded between the backing members **211**, **212**. According to this embodiment, the first connector **120** is inserted and bonded between two backing members **211**, **212** among the three backing members **211**, **212**, **213**. The first connector **120** is disposed in the height direction of the backing members **211**, **212**, **213**. The backing members **211**, **212** are bonded to opposite sides of the first connector **120**, respectively.

One end of the first connector **120** bonded between the backing members **211**, **212** is exposed on a front side of the backing layer **210** adjacent to the piezoelectric member **130**, and the other end thereof extends through a rear side of the backing layer **210**. As such, since the one end of the first connector **120** is exposed on the front side of the backing layer **210**, electrodes **125** of the first connector **120** are exposed on the front side of the backing layer **210**.

The second connector **270** includes an insulation part (reference numeral omitted) and electrodes **275**. The multiple electrodes **275** are disposed on the insulation part to be spaced from each other in the arrangement direction. According to this embodiment, the second connector **270** is inserted and bonded between the two backing members **212**, **213**. The second connector **270** is disposed in the height direction of the backing members **211**, **212**, **213**. The backing members **212**, **213** are bonded to opposite sides of the second connector **270**, respectively.

One end of the second connector **270** bonded between the backing members **212**, **213** is exposed on the front side of the backing layer **210** adjacent to the piezoelectric member **130**, and the other end thereof extends through the rear side of the backing layer **210**. As such, since the one end of the second connector **270** is exposed on a front side of the backing layer **210**, the electrodes **275** of the second connector **270** are exposed from the backing layer **210**.

As in the first electrode **120**, the second connector **270** may include a flexible printed circuit board (FPCB), a printed circuit board or any configuration capable of supplying signals or electricity.

According to this embodiment, the first connector **120** is spaced from the second connector **270** by a width occupied by the backing member **212**, and the electrodes **275** of the second connector **270** are disposed to alternate with the electrodes **125** of the first connector **120**.

Each of the electrodes **125**, **275** of the first and second connectors **120**, **270** is a signal electrode that is electrically connected to a first electrode **131** of the piezoelectric member **130**.

The backing layer **210** includes an electrode layer **215**. The electrode layer **215** is formed on the backing layer **210** to be disposed between the backing layer **210** and the piezoelectric member **130**. The electrode layer **215** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270**.

The piezoelectric member **130** may be composed of a plurality of piezoelectric members **130** arranged in an array to provide multiple channels. Accordingly, the electrode layer **215** may also be composed of a plurality of electrode layers **215** arranged side by side in an array so as to correspond to the piezoelectric members **130** arranged in an array. The piezoelectric members **130** and the electrode layers **215** are correspondingly connected to the electrodes **125**, **275** spaced from each other in the arrangement direction.

The sound matching layer **140** is provided with an electrode part **145**, which is electrically connected to the ground connector **150**. In this embodiment, connection between the piezoelectric member **130** and the ground connector **150** is illustrated as being embodied by the electrode part **145** formed on the sound matching layer **140**. However, the invention is not limited thereto and the connection between the piezoelectric member **130** and the ground connector **150** can be realized in various manners.

FIG. **8** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the second embodiment of the invention, FIGS. **9** and **10** are views of a process of forming the backing layer of the probe according to the second embodiment of the invention, and FIG. **11** is a view of a process of forming the electrode layer on the backing layer of the probe according to the second embodiment of the invention.

Referring to FIGS. **7** to **11**, the method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the second embodiment will now be described.

In the method S**200** according to this embodiment, firstly, electrodes **125** are formed on a first connector **120** in S**210**, and electrodes **275** are formed on a second connector **270** in S**220**, as shown in FIG. **9**.

Here, the respective electrodes **125**, **275** of the first and second connectors **120**, **270** are formed in the height direction of the backing members **211**, **212**, **213** and are spaced from each other in the arrangement direction of piezoelectric members **130** arranged in an array.

With the electrodes **125**, **275** formed on the first and second connectors **120**, **270**, respectively, the first and second connectors **120**, **270** are bonded between the backing members **211**, **212**, **213** to form a backing layer **210** in S**230**.

For this purpose, the backing members **211**, **212**, **213** are formed of a material including a rubber to which epoxy resin, tungsten powder, and the like are added. Then, with the first connector **120** disposed between the backing members **211**, **212** in the height direction, the backing members **211**, **212** are bonded to opposite sides of the first connector **120**.

Further, with the second connector **270** disposed between the backing members **212**, **213** in the height direction, the backing members **212**, **213** are bonded to opposite sides of the second connector **270**, thereby completing formation of the backing layer **210**.

One end of each of the first and second connectors **120**, **270** bonded between the backing members **211**, **212**, **213** is exposed on a front side of the backing layer **210** adjacent to the piezoelectric member **130**, and the other end thereof extends through the rear side of the backing layer **210**.

Since the one end of each of the first and second connectors **120**, **270** is exposed on the front side of the backing layer **210**, the electrodes **125**, **275** of the first and second connectors **120**, **270** are exposed on the front side of the backing layer **210**.

According to this embodiment, when forming the backing layer **210**, the first and second connectors **120**, **270** may be disposed in the height direction of the backing members **211**, **212**, **213**, such that the electrodes **275** of the second connector **270** alternate with the electrodes **125** of the first connector **120**.

After the backing layer **210** is formed, an electrode layer **215** is formed on the backing layer **210** to be electrically connected to the piezoelectric member **130** and the electrodes **125**, **275** of the first and second connectors **120**, **270**, as shown in FIG. **11**, in S**240**.

With this configuration of the electrode layer **215**, the rear side of the electrode layer **215** adjoining the surface of the backing layer **210** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270**.

After the electrode layer **215** is formed on the backing layer **210**, the piezoelectric member **130** is stacked on the backing layer **210** to be electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270** in S**250**.

By this process, a first electrode **131** of the piezoelectric member **130** is electrically connected to the electrode layer **215**. As such, since the electrode layer **215** connected to the first electrode **131** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270**, the piezoelectric member **130** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270** via the electrode layer **215** and the first electrode **131** which are electrically connected to each other.

As in the above embodiment, the piezoelectric member **130** of this embodiment may be divided into multiple piezoelectric members **130** spaced a predetermined distance from each other and arranged side by side in an array, so that the multiple piezoelectric members can be used as multiple channels corresponding to the multiple electrodes **125**, **275** formed on the first and second connectors **120**, **270**.

The electrode layer **215** may also be divided into multiple electrode layers, which are arranged side by side in an array so as to correspond one-to-one to the first electrodes **131** formed on the multiple piezoelectric members **130**.

According to this embodiment of the invention, stacks of the backing layer **210** and the piezoelectric member **130** are diced by a dicing machine (not shown). Dicing is performed to a depth such that the electrode layer **215** can be reliably divided into the multiple electrode layers.

By dicing, the piezoelectric member **130** is divided into the multiple piezoelectric members **130** spaced a predetermined distance from each other, such that first and second electrodes **131**, **135** formed on each of the piezoelectric members **130** can be electrically completely separated from first and second electrodes **131**, **135** formed on other piezoelectric members **130** adjacent thereto.

When the electrode layer **215** is divided into the multiple electrode layers **215** by dicing, each of the electrodes layers **215** is electrically completely separated from other electrode layers adjacent thereto such that one divided electrode layer **215** can be connected to a first electrode **131** formed on one piezoelectric member **130**.

FIG. **12** is a view showing a separated state of the backing layer of the probe according to the second embodiment of the invention.

Referring to FIG. **12**, separation between the backing layer and the first and second connectors by dicing will be described. In FIG. **12**, the electrode layer is omitted.

In FIG. **12**, by dicing the stacks of the backing layer **210** and the piezoelectric member **130** (see FIG. **7**), the backing layer **210**, the electrode layer **215** (see FIG. **7**), and the first and second connectors **120**, **270** electrically connected to the electrode layer **215** are divided as follows.

When the electrode layer **215** is divided into the multiple electrode layers **215** by dicing, each of the electrodes layers **215** is electrically completely separated from other electrode layers **215** adjacent thereto. Here, only one of the electrode **125** of the first connector **120** and the electrode **275** of the second connector **270** is connected to one electrode layer **115**.

For this purpose, when the electrode layer **215** is divided by dicing, portions of the first connector **120** corresponding to center lines between the respective electrodes **125** of the first connector **120** disposed in the arrangement direction are divided and portions of the second connector **270** corresponding center lines between the respective electrodes **275** of the second connector **270** disposed in the arrangement direction are divided.

According to this embodiment, since the electrodes **125** of the first connector **120** are disposed to alternate with the electrodes **275** of the second connector **270**, the respective dividing lines (d) formed on the electrode layer **215** to divide the electrode layer **215** by dicing are formed between the respective electrodes **125** of the first connector **120** and between the respective electrodes **275** of the second connector **270** disposed to alternate with the respective electrodes **125** of the first connector **120**.

As a result, only one of the electrode **125** of the first connector **120** and the electrode **275** of the second connector **270** can be connected to one electrode layer **215**.

After the piezoelectric member **130** is stacked on the backing layer **210**, a sound matching layer **140** is stacked on the piezoelectric member **130** and the piezoelectric member **130** is electrically connected to a ground connector **150**, as shown in FIG. **7**, in S**260**. This operation is similar to that of the above embodiment, and a detailed description thereof will be omitted herein.

The method S**200** of manufacturing a probe for an ultrasonic diagnostic apparatus is not limited to the sequence described above. The processes of the method may be performed in a different sequence or at the same time.

According to the embodiment, in manufacture of the probe **200** for an ultrasonic diagnostic apparatus, the piezoelectric member **130** is electrically connected to the first and second connectors **120**, **270**, that is, multiple connectors **120**, **270**, so that a distance between the first and second connectors **120**, **270** and the ground connector **150** can be decreased.

As a result, the probe **200** according to this embodiment has a narrow space between the electrodes **125**, **275** of the first and second connectors **120**, **270**, that is, signal electrodes, and the electrode of the ground connector **150**, that is, a ground electrode, thereby reducing noise.

Further, according to the embodiment, the multiple connectors **120**, **270** are bonded in the backing layer **210** and the electrodes **125** of the first connector **120** are disposed to alternate with the electrodes **275** of the second connector **270**, so that the respective components of the probe **200** divided by dicing may have sufficient strength and be arranged at a narrower pitch to have a high density and a small size.

FIG. **13** is a schematic view of a probe for an ultrasonic diagnostic apparatus according to a third embodiment of the present invention.

For descriptive convenience, the same or similar components to those of the above embodiment will be denoted by the same reference numerals as those of the above embodiment, and a detailed description thereof will be omitted herein.

Referring to FIG. **13**, a probe **300** for an ultrasonic diagnostic apparatus according to the third embodiment includes a backing layer **310**, a first connector **120**, a second connector **270**, a piezoelectric member **130**, a sound matching layer **160**, and a ground connector **150**.

The backing layer **310** is disposed behind the piezoelectric member **130**. The backing layer **310** includes multiple backing members **311**, **312**, **313** and is formed by bonding the backing members **311**, **312**, **313**, the first connector **120** and the second connector **270** to each other.

According to this embodiment, a mounting groove **314** is formed on the backing layer **310**. The mounting groove **314** is formed on the front side of the backing layer **310** adjacent to the piezoelectric member **130**. The piezoelectric member **130** is inserted into the mounting groove **314**. The mounting groove **314** is depressed into the backing layer **310** in a shape corresponding to the piezoelectric member **130** to allow the piezoelectric member **130** to be inserted into the backing layer **310**.

The backing layer **310** includes an electrode layer **315**. The electrode layer **315** is formed on the backing layer **310** and is disposed between the backing layer **310** and the piezoelectric member **130**. Specifically, the electrode layer **315** may be formed on the mounting groove **314** and disposed to be electrically connected to electrodes **125**, **275** of the first and second connectors **120**, **270**.

The sound matching layer **160** is disposed in front of the piezoelectric member **130**. The sound matching layer **160** is stacked on a plane constituted by the backing layer **310** and the piezoelectric member **130** inserted into the mounting groove **314** of the backing layer **310**.

The sound matching layer **160** includes first and second sound matching layers **162**, **164** and is directly connected to the piezoelectric member **130**. The sound matching layer **160** is formed of an electrically conductive material, such as graphite, gold, silver or copper, and is electrically connected to the second electrode **135** of the piezoelectric member **130**.

The sound matching layer **160** may be entirely or partially formed of the electrically conductive material. When the sound matching layer **160** is partially formed of the electrically conductive material, the first sound matching layer **162** adjacent to the piezoelectric member **130** may be formed of the electrically conductive material.

In this embodiment, connection between the piezoelectric member **130** and the ground connector **150** is illustrated as being obtained by the first sound matching layer **162** of the sound matching layer **160**. However, the invention is not limited thereto and the connection therebetween can be realized in various manners.

FIG. **14** is a flowchart of a method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the third embodiment of the present invention.

Referring to FIGS. **13** to **14**, the method of manufacturing the probe for an ultrasonic diagnostic apparatus according to the third embodiment will now be described.

In the method S**300** according to this embodiment, firstly, a mounting groove **314** is formed on a backing layer **310** in S**310**.

For example, in order to form the mounting groove **314** on backing members **311**, **312**, **313** formed of a material including a rubber to which epoxy resin, tungsten powder, and the like are added, the backing members **311**, **313** are formed to have steps at both sides of the backing member **312** interposed between the backing members **311**, **313**. The backing members **311**, **313** are disposed adjacent to the backing layer **312** by forming lower step sections to be coplanar with the backing layer **312** interposed between the backing members **311**, **313**.

Then, electrodes **125** are formed on a first connector **120** in S**320**, and electrodes **275** are formed on a second connector **270** in S**330**.

Here, the respective electrodes **125**, **275** of the first and second connectors **120**, **270** are formed in the height direction of the backing members **311**, **312**, **313** and are spaced from each other in the arrangement direction of piezoelectric members **130** arranged in an array.

With the electrodes **125**, **275** formed on the first and second connectors **120**, **270**, respectively, the first and second connectors **120**, **270** are bonded between backing members **311**, **312**, **313** to form a backing layer **310** in S**340**.

For this purpose, with the first connector **120** disposed between the backing members **311**, **312** in the height direction, the backing members **311**, **312** are bonded to opposite sides of the first connector **120**. Further, with the second connector **270** disposed between the backing members **312**, **313** in the height direction, the backing members **312**, **313** are bonded to opposite sides of the second connector **270**, thereby completing formation of the backing layer **310**.

One end of each of the first and second connectors **120**, **270** bonded between the backing members **311**, **312**, **313** is exposed on the front side of the backing layer **310** adjacent to the piezoelectric member **130**, and the other end thereof extends through the rear side of the backing layer **310**.

Since the one end of each of the first and second connectors **120**, **270** is exposed on the front side of the backing layer **310**, the electrodes **125**, **275** of the first and second connectors **120**, **270** are exposed on the front side of the backing layer **310** through the mounting groove **314**.

After the backing layer **310** is formed, an electrode layer **315** is formed on the backing layer **310** to be electrically connected to the piezoelectric member **130** and the electrodes **125**, **275** of the first and second connectors **120**, **270** in S**350**. The electrode layer **315** may be formed on the mounting groove **314**.

With this configuration of the electrode layer **315**, the rear side of the electrode layer **315** adjoining the surface of the mounting groove **314** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270**.

After the electrode layer **315** is formed on the backing layer **310**, the piezoelectric member **130** is stacked on the backing layer **310** by inserting the piezoelectric member **130** into the mounting groove **314** to be electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270** in S**360**.

By this process, a first electrode **131** of the piezoelectric member **130** is electrically connected to the front side of the electrode layer **315**. As such, since the electrode layer **315** connected to the first electrode **131** is electrically connected at the rear side thereof to the electrodes **125**, **275** of the first and second connectors **120**, **270**, the piezoelectric member **130** is electrically connected to the electrodes **125**, **275** of the first and second connectors **120**, **270** via the electrode layer **315** and the first electrode **131** which are electrically connected to each other.

As in the above embodiment, after the piezoelectric member **130** is stacked on the backing layer **310**, a sound matching layer **160** is stacked on the piezoelectric member **130** and the piezoelectric member **130** is electrically connected to a ground connector **150** in S**370**. This operation is similar to that of the above embodiment, and a detailed description thereof will be omitted herein.

The method S**300** of manufacturing a probe for an ultrasonic diagnostic apparatus is not limited to the sequence described above. The processes of the method may be performed in a different sequence or at the same time.

According to this embodiment of the invention, in the probe **300** for an ultrasonic diagnostic apparatus, the mounting groove **314** is formed on the backing members **311**, **312**, **313** such that the piezoelectric member **130** can be inserted into the mounting groove to reduce the size of the probe and allow easy connection between the piezoelectric member **130** and the first and second connectors **120**, **270** while ensuring an enhanced support structure of the piezoelectric member **130**, thereby preventing defective connection and deterioration in performance of the probe caused thereby.

As apparent from the description, according to one embodiment of the invention, a piezoelectric member is joined to a first connector or to first and second connectors via an electrode layer instead of using a complicated and laborious soldering operation in manufacture of the probe, thereby enabling easy connection between the piezoelectric member and the connector while preventing deterioration in performance caused by defective connection therebetween and deterioration in performance of the piezoelectric member caused by heat during manufacture.

Further, according to one embodiment of the invention, the first connector or the first and second connectors are bonded between backing members, instead of being disposed between a backing layer and the piezoelectric member, to be electrically connected to the piezoelectric member via the electrode layer, thereby preventing deterioration in performance caused by defective connection between the piezoelectric member and the first or second connector and preventing damage of the first and second connectors caused by bending.

Further, according to one embodiment of the invention, individual formation and maintenance of the backing layer can be achieved by bonding the first and second connectors to the backing members and forming the electrode layer thereon, so that the backing layer can be prepared in desired shapes and dimensions so as to be easily assembled to other components, thereby enabling easy manufacture of the probe at lower cost while enhancing uniformity of final products.

Further, according to one embodiment of the invention, the probe has a narrow space between signal electrodes and ground electrodes, thereby reducing noise.

Further, according to one embodiment of the invention, electrodes of the first connector alternate with those of the second connector, so that respective components divided by dicing have sufficient strength at a narrower pitch to have a high density and a small size.

Further, according to one embodiment of the invention, the piezoelectric member is inserted into a mounting groove formed on the backing layer, thereby enabling size reduction and easy connection between the piezoelectric member and the first and second connectors while providing a more rigid support structure to the piezoelectric member to prevent deterioration in performance caused by defective connection therebetween.

In understanding the scope of the invention, the terms “part” or “member” when used in the singular can have the dual meaning of a singular part or a plurality of parts unless otherwise stated. Further, the use of articles “a,” “an” and “the” in the context of describing the invention, especially in the context of the embodiments, are to be construed to cover both the singular and the plural unless otherwise indicated herein or clearly contradicted by context.

Although some embodiments have been provided to illustrate the invention in conjunction with the drawings, it will be apparent to those skilled in the art that the embodiments are given by way of illustration only, and that various modifications and equivalent embodiments can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention should be limited only by the accompanying claims.

What is claimed is:

1. A probe for an ultrasonic diagnostic apparatus, comprising:

a backing layer including backing members;

a first connector bonded between the backing members in a height direction, and including first connector electrodes spaced from each other in an arrangement direction;

a second connector bonded between the backing members in the height direction, and including second connector electrodes spaced from each other in the arrangement direction; and

a piezoelectric member electrically connected to the first connector electrodes and the second connector electrodes, wherein:

the second connector is disposed such that the first connector electrodes alternate with the second connector electrodes in the arrangement direction, whereby the first connector electrodes do not overlap the second connector electrodes in the height direction, and

the first connector and the second connector are separated from each other.

2. The probe according to claim **1**, wherein the first connector comprises a flexible printed circuit board (FPCB).

3. The probe according to claim **1**, wherein the backing layer comprises an electrode layer electrically connected to the first connector electrodes and the second connector electrodes.

4. The probe according to claim **3**, wherein the electrode layer is disposed on a surface of the backing layer.

5. The probe according to claim **1**, wherein the backing layer has a mounting groove and the piezoelectric member is disposed in the mounting groove.

6. The probe according to claim **1**, wherein the first connector electrodes and the second connector electrodes are signal electrodes.

7. A method of manufacturing a probe for an ultrasonic diagnostic apparatus, comprising:

forming first connector electrodes spaced from each other in an arrangement direction on a first connector;

forming second connector electrodes spaced from each other in the arrangement direction on a second connector;

forming a backing layer by bonding the first and second connectors between backing members in a height direction; and

stacking a piezoelectric member on the backing layer such that the piezoelectric member is electrically connected to the first connector electrodes and the second connector electrodes,

wherein the forming a backing layer comprises disposing the second connector such that the first connector electrodes alternate with the second connector electrodes in the arrangement direction, whereby the first connector electrodes do not overlap the second connector electrodes in the height direction, and

the first connector and the second connector are separated from each other.

8. The method according to claim **7**, further comprising:

after forming the backing layer, forming an electrode layer on the backing layer such that the electrode layer is electrically connected to the piezoelectric member, the first connector electrodes and the second connector electrodes.

9. The method according to claim **7**, further comprising:

forming a mounting groove on the backing layer,

wherein the stacking a piezoelectric member on the backing layer comprises inserting the piezoelectric member into the mounting groove.

* * * * *

专利名称(译)	用于超声诊断设备的探针及其制造方法		
公开(公告)号	US9073086	公开(公告)日	2015-07-07
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[标]申请(专利权)人(译)	郑进永WOO SEO郑澈 KIM JAE YK		
申请(专利权)人(译)	JUNG，JIN WOO SEO，郑澈 KIM，JAE YK		
当前申请(专利权)人(译)	三星MEDISON CO.，LTD.		
[标]发明人	JUNG JIN WOO SEO JEONG CHEOL KIM JAE YK		
发明人	JUNG, JIN WOO SEO, JEONG CHEOL KIM, JAE YK		
IPC分类号	A61B5/05 B06B1/06 G10K11/00 A61B8/00 G01N29/24 G01S7/521 G01S15/89 H01L41/08 H01L41/09 H01L41/18 H01L41/187 H01L41/22 H01L41/29		
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摘要(译)

一种用于超声诊断设备的探头，包括：背衬层，包括背衬构件;第一连接器，结合在背衬构件之间并包括在排列方向上彼此间隔开的电极;以及压电构件，电连接到电极。还公开了一种制造该方法的方法。压电构件经由电极层连接到第一连接器或第一连接器和第二连接器，而不是使用复杂且费力的焊接操作，从而能够容易地连接压电构件和连接器，同时防止由于它们之间的连接不良而导致的性能劣化。并且在制造操作期间由热引起的压电构件的性能劣化。