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(54) TRANSDUCER ASSEMBLY FOR ULTRASOUND PROBES

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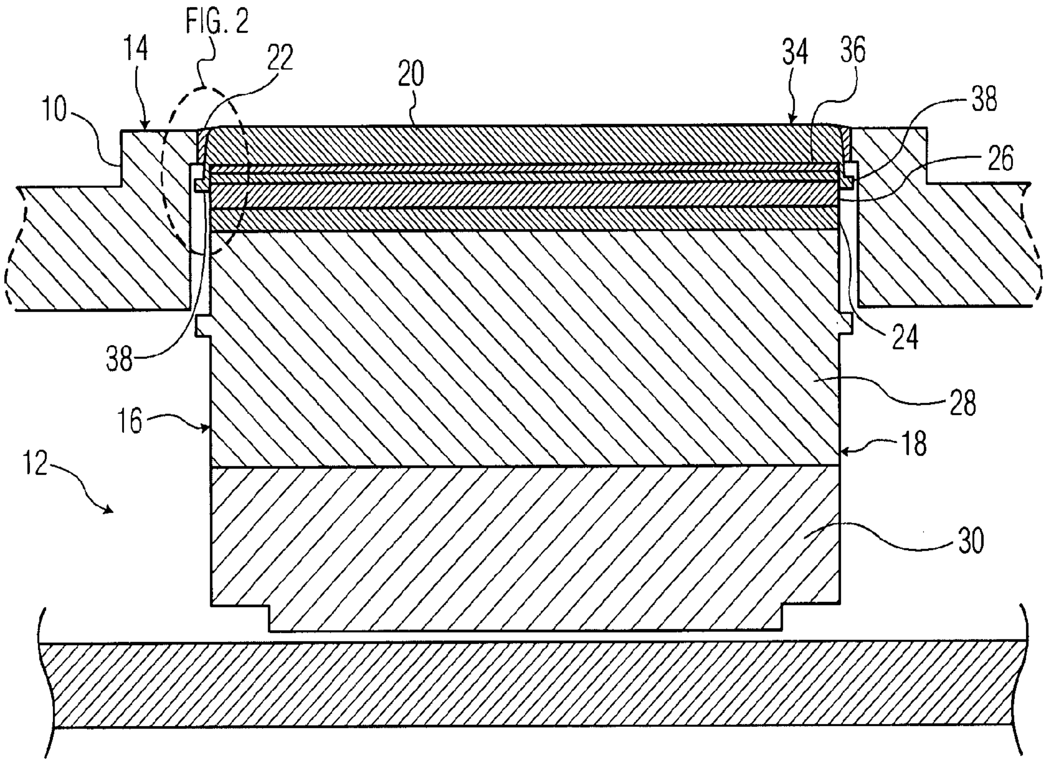
(57) ABSTRACT

Transducer assembly for an ultrasound probe including a transducer array having transducer elements and an acoustic window attached directly to the transducer array such that the transducer array and the acoustic window form an integral unit. The acoustic window includes a layer of elastomer optionally covered on upper and lower surfaces by impervious polymer layers. An ultrasound probe, such as a transesophageal echocardiographic probe, a transnasal probe, a transthoracic probe, an intracavity probe and an intraoperative probe, including the transducer assembly in a cavity of the housing or nose is also disclosed.



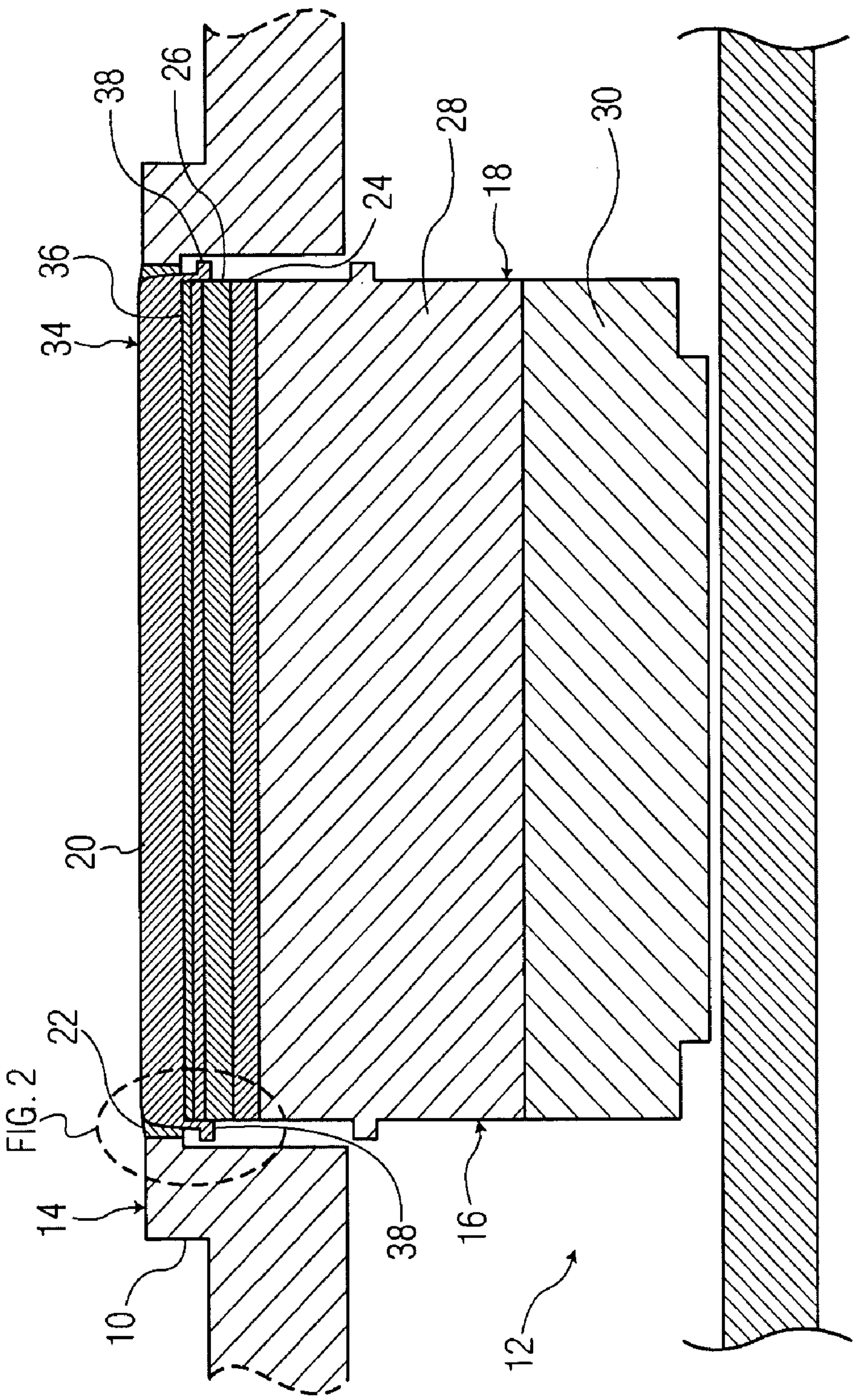


FIG. 1

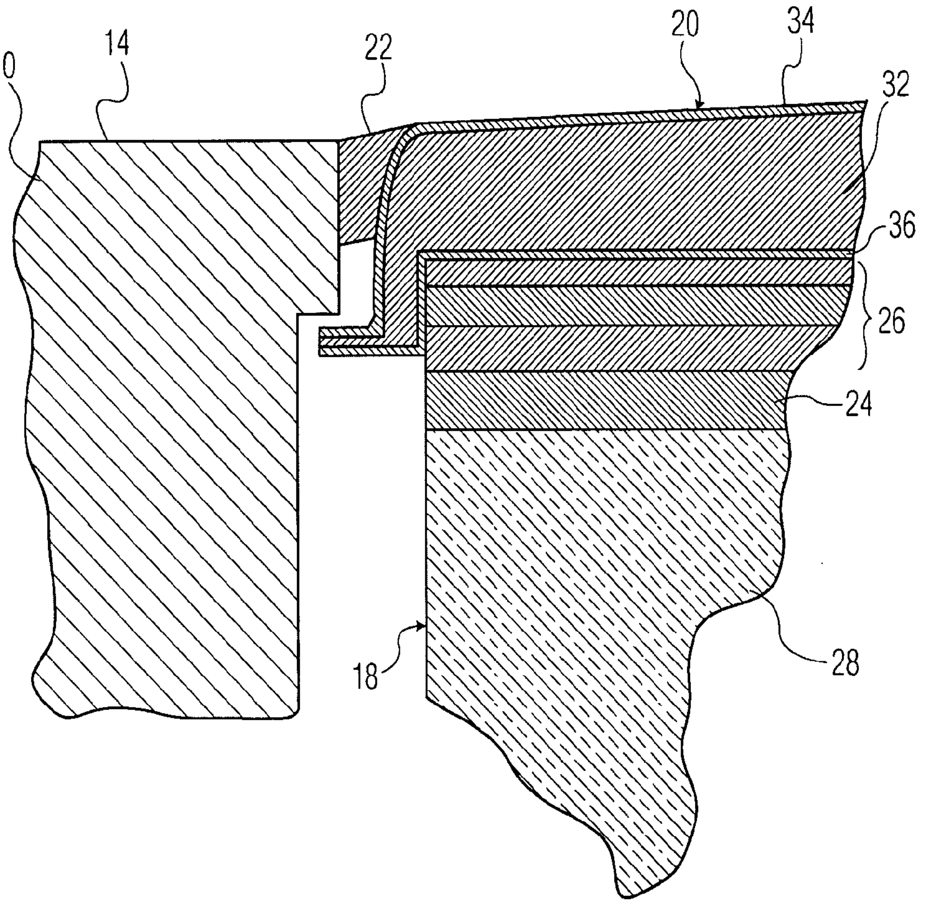


FIG. 2

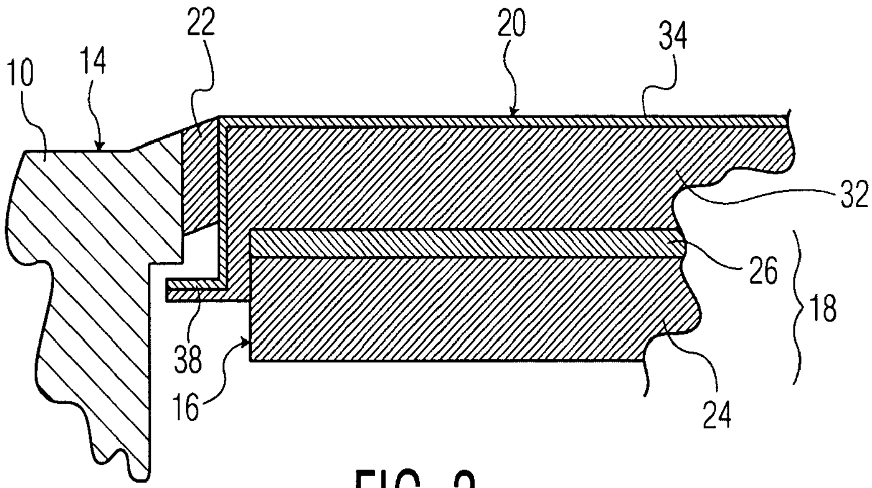


FIG. 3

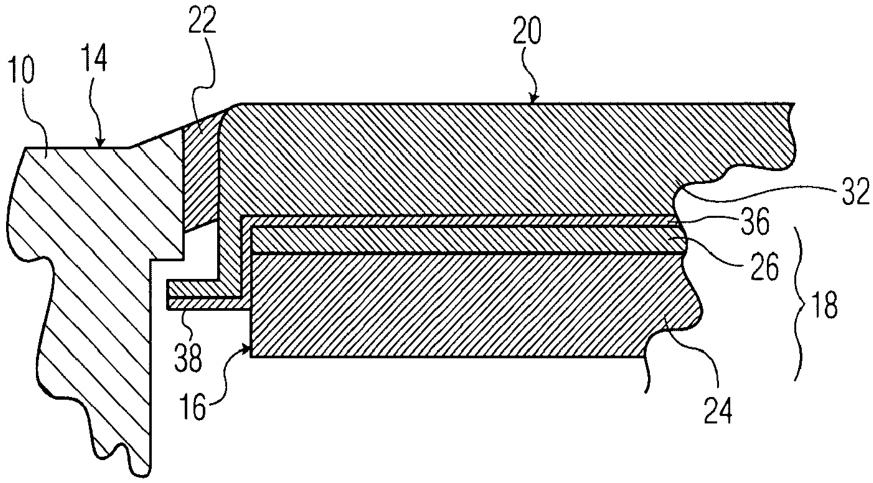


FIG. 4

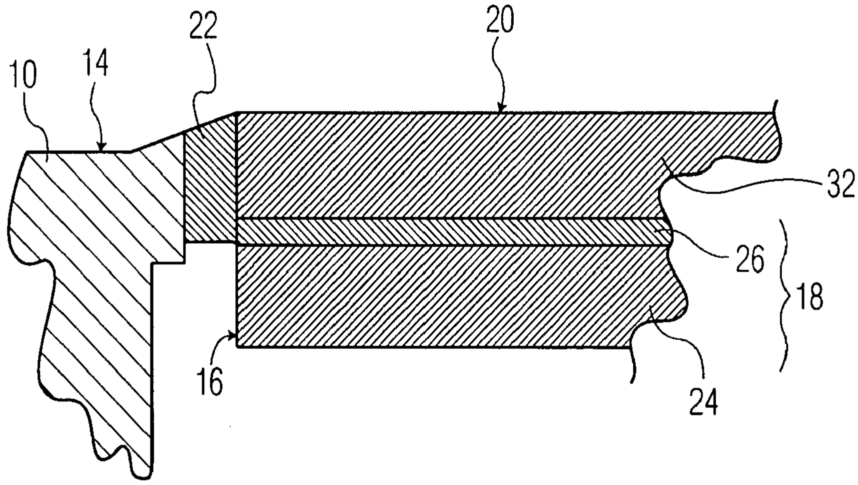


FIG. 5

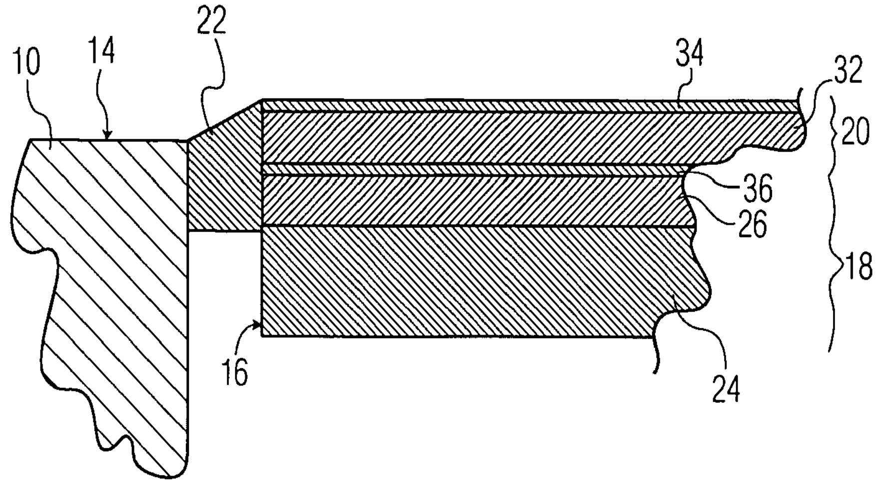


FIG. 6

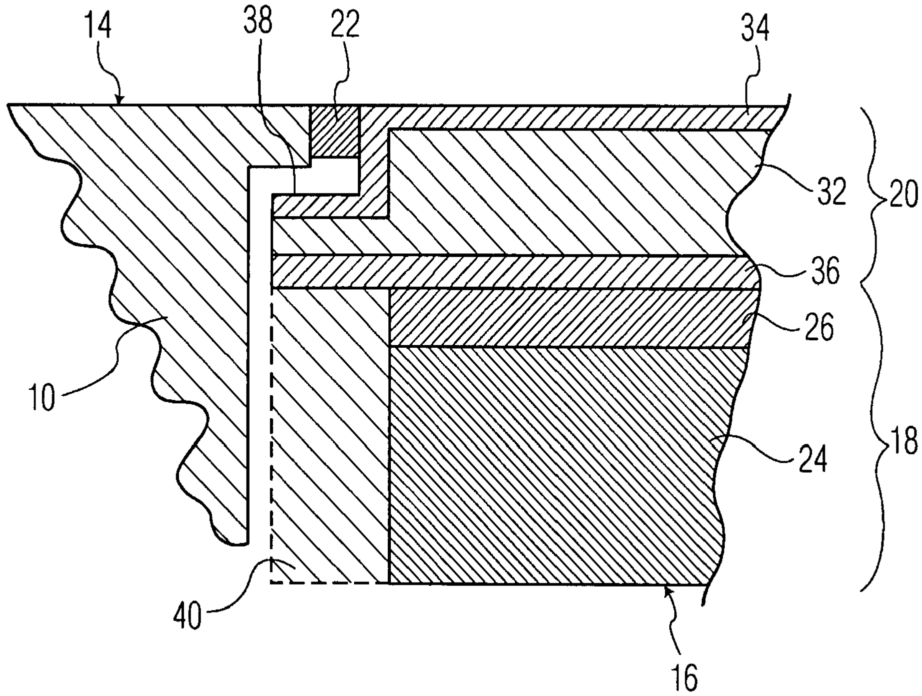


FIG. 7

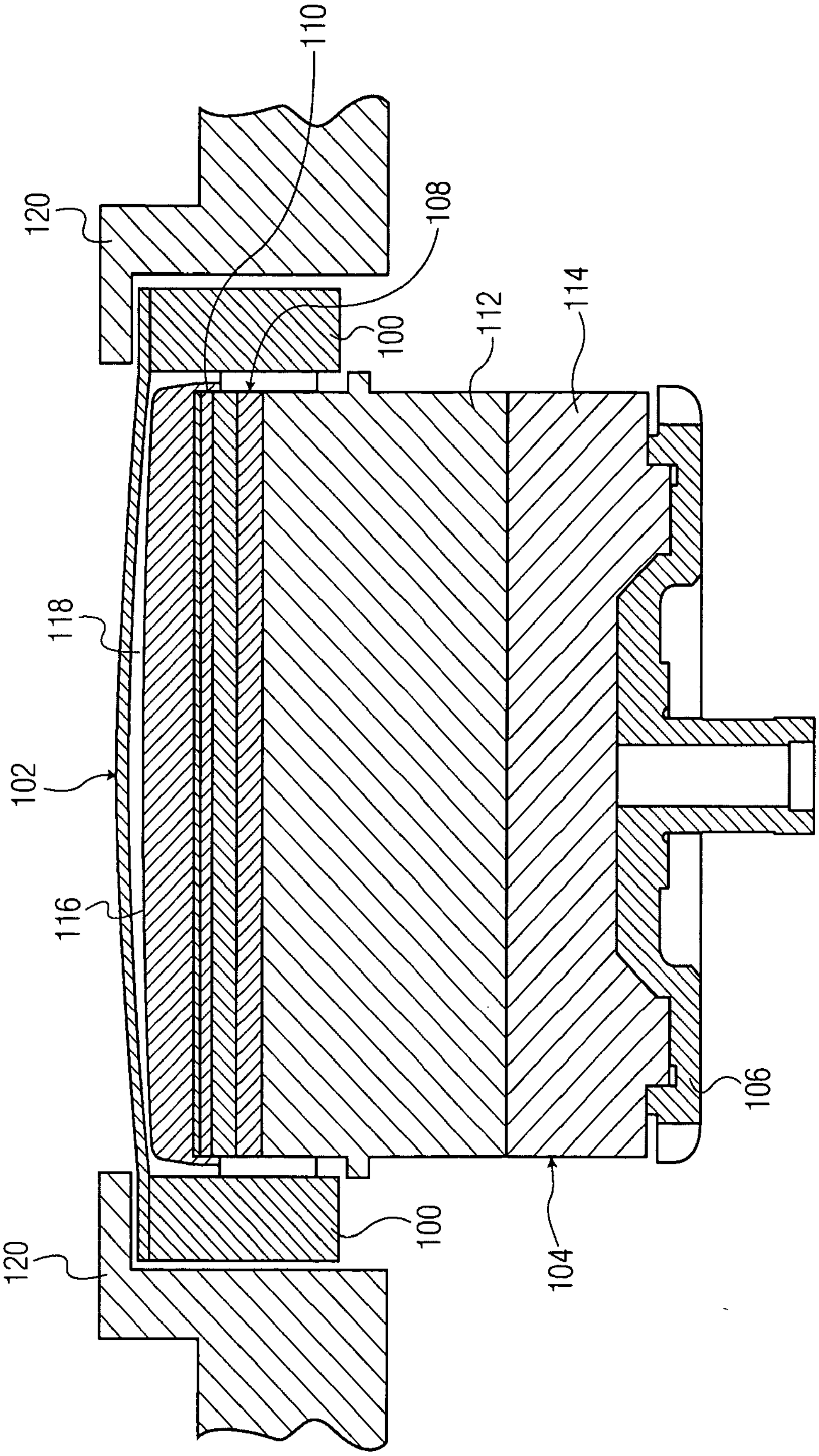


FIG. 8
PRIOR ART

TRANSDUCER ASSEMBLY FOR ULTRASOUND PROBES

CROSS REFERENCE TO RELATED CASES

[0001] Applicants claim the benefit of Provisional Application Ser. No. 60/539,300, filed 26 Jan. 2004.

FIELD OF THE INVENTION

[0002] The present invention relates generally to ultrasound probes and more particularly to a transducer assembly for ultrasound probes including an integral acoustic window.

BACKGROUND OF THE INVENTION

[0003] Ultrasound probes are commonly used for imaging internal body parts. One type of ultrasound probe includes a transducer array mounted in a body and having an active surface oriented toward an acoustic window connected to the body and which is separate from the transducer array. The body is usually made of hard plastic and is referred to as a housing for transesophageal echocardiographic or TEE probes and as a nose for transthoracic or intracavity probes. Thus, while the term housing will be used hereinafter in connection with the description of the invention below, it should be understood that when applied to ultrasound probes other than TEE probes, it denotes the nose or equivalent body thereof.

[0004] TEE probes are used for viewing planar ultrasound images of a patient's heart from inside of the patient's esophagus. The tip of a typical prior art TEE probe houses a rotatable transducer array. Rotation of the transducer array causes a corresponding rotation of the image plane about an image axis. Once the TEE probe is inserted in the esophagus, rotation of the transducer array is controlled at a remote distance from a tip of the probe.

[0005] A drawback of such prior art TEE probes is that it is necessary to rotate the transducer array to obtain multi-planar images of the object being examined in the patient's body. Accordingly, the probe must include associated structure to provide for rotation of the transducer array during an examination. This associated structure imposes size and space constraints on the probe.

[0006] A portion of a prior art TEE probe is shown in **FIG. 8** and includes a support **100**, an acoustic window **102** fixed to the support **100** and a transducer array **104** rotatable on a gear **106** relative to the support **100** and the acoustic window **102**. Transducer array **104** is sometimes referred to in the art as an acoustic stack assembly. The transducer array **104** includes a layer of piezoelectric material **108**, one or more acoustic matching layers **110** adjacent the active surface of the piezoelectric material **108** and a backing layer **112** on the reverse side of the piezoelectric material **108**. A heatsink **114** supports the backing layer **112** on the gear **106**. A lens **116** is formed over the acoustic matching layer(s) **110**. Between an inner surface of the acoustic window **102** and an outer surface of the lens **116**, an oil/lubrication layer **118** is provided. The acoustic window **102** is exposed to the environment through an opening formed in the housing **120** of the probe.

[0007] During use of a TEE probe, an outer surface of the acoustic window **102** is exposed to the surrounding environment and thus the acoustic window **102** serves as the interface between the transducer array **104** and the surrounding environment. Ultrasonic waves generated by the transducer array **104** pass through the acoustic window **102** in their path toward and from the body parts being imaged. The acoustic window **102** also contacts the patient to ensure optimal acoustic conditions.

[0008] Various factors are considered when selecting materials from which to construct the acoustic window. It is desired that the acoustic window is formed from a material that has an acoustic impedance which matches, or at least closely approximates, that of the human body part being imaged, such as tissue of the human body. Acoustic impedance is based on the elasticity, mass density and speed of sound of the material. Additional characteristics of the material include acceptable mechanical and electrical performance, biocompatibility, chemical resistance, low attenuation and stability to ultraviolet rays.

OBJECTS AND SUMMARY OF THE INVENTION

[0009] It is an object of the present invention to provide a new and improved transducer assembly including an integral acoustic window and an ultrasound probe including the same.

[0010] It is another object of the present invention to provide a new and improved ultrasound probe including a transducer assembly which does not have to rotate to obtain multi-planar, volumetric three-dimensional images.

[0011] In order to achieve these objects and others, a transducer assembly for an ultrasound probe in accordance with the invention includes a transducer array comprising a plurality of transducer elements and an acoustic window attached directly to the transducer array such that the transducer array and the acoustic window form an integral unit. The transducer elements may be electronically controlled to provide the multi-planar, volumetric three-dimensional images.

[0012] The transducer array may include a layer of piezoelectric material having an active surface and defining the transducer elements, an acoustic matching section having a lower surface adjacent the active surface of the piezoelectric material and an opposed upper surface and a backing layer arranged on an opposite side of the piezoelectric material from the acoustic matching section. The acoustic window would then be attached to the upper surface of the acoustic matching section.

[0013] One particular form of an acoustic window includes a layer of elastomer having opposed surfaces, a first layer of an impervious polymer arranged on one surface of the elastomer layer and a second layer of an impervious polymer arranged on the other surface of the elastomer layer. As such, the elastomer layer is sandwiched between the first and second impervious polymer layers. With this construction, a lower surface of one polymer layer is attached to the upper surface of the transducer array and an upper surface of the other polymer layer defines an exposed surface of the transducer assembly.

[0014] The elastomer may be PEBAX™ while the polymer layers may be thin polymer films made from a material having a negligible acoustic impact such as polyethylene, Mylar™ and Kapton™. A different polymer can be used for each impervious polymer layer or the same polymer can be used for both layers.

[0015] An alternative construction of the acoustic window includes a layer of elastomer having opposed surfaces and only a layer of an impervious polymer arranged on an upper surface of the elastomer layer which is designed to be exposed to the ambient atmosphere, i.e., come into contact with the patient. In this case, the elastomer layer is attached directly to the upper surface of the transducer array, possibly by heat, pressure and optionally primers and/or adhesives. Also, the polymer layer would preferably be sealed with an impervious seal to the housing of the probe into which the transducer assembly is installed in order to prevent ingress of solvent into the probe.

[0016] Another alternative construction of the acoustic window is to provide only a polymer the layer between the elastomer layer and the transducer array in which case the upper surface of the elastomer layer is exposed. In yet another alternative construction, the acoustic window consists of only the elastomer layer, without any covering polymer layers.

[0017] An ultrasound probe in accordance with the invention includes a housing defining a cavity extending inward from an opening in a peripheral surface, a transducer array as described above arranged in the cavity of the housing to produce ultrasound beams and an acoustic window attached directly to the transducer array such that the transducer array and the acoustic window form an integral unit. The housing may be in any form of a medical imaging device including in the form of a housing of a transesophageal echocardiographic ultrasound probe or transnasal probe, or a nose for a transthoracic, intracavity or intraoperative probe. The combination of the housing and the cushion of the integral window further serve to protect the array from impact (biting by the patient in particular).

[0018] A flexible seal is interposed between the acoustic window and the housing to seal the cavity and prevent the entry of fluids into the cavity. The flexibility of the seal also enables it to absorb impacts into the acoustic window without breaking.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings wherein like reference numerals identify like elements.

[0020] **FIG. 1** is a cross-sectional view of a portion of a first embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0021] **FIG. 2** is an enlarged view of the section designated A in **FIG. 1**.

[0022] **FIG. 3** is a cross-sectional view of a portion of a second embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0023] **FIG. 4** is a cross-sectional view of a portion of a third embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0024] **FIG. 5** is a cross-sectional view of a portion of a fourth embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0025] **FIG. 6** is a cross-sectional view of a portion of a fifth embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0026] **FIG. 7** is a cross-sectional view of a portion of a sixth embodiment of a generic ultrasound probe in accordance with the invention taken through the transducer assembly.

[0027] **FIG. 8** is a cross-sectional view of a portion of a prior art ultrasound probe taken through the transducer assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Referring to the accompanying drawings wherein like reference numerals refer to the same or similar elements, an ultrasound probe in accordance with the invention includes a housing **10** defining a cavity **12** extending inward from an opening in a peripheral surface **14** and a transducer assembly **16** arranged in the cavity **12**. Housing **10** can be shaped in the form of any type of TEE, transthoracic, intracavity or transnasal probe. Housing **10** and the transducer assembly **16** in accordance with the invention can also be used in any imaging device in the medical field.

[0029] Transducer assembly **16** includes a transducer array **18** and an acoustic window **20** attached or bonded directly to the transducer array **18**. The direct attachment or bonding of the acoustic window **20** to the transducer array **18** may be accomplished through the use of an adhesive or other suitable means known in the art. By attaching the acoustic window **20** directly to the transducer array **18**, a transducer assembly with an integral acoustic window is formed and an acoustic window separate from the transducer array is not required, as in the prior art. Accordingly, it becomes possible to construct an ultrasound probe by providing a housing with an opening leading into a cavity in the housing, placing the entire transducer assembly **16** into the cavity and then sealing the transducer assembly **16** to the housing. The acoustic window is thus fixed to the transducer assembly and not to the housing.

[0030] By bonding the acoustic window **20** directly or intimately to the transducer array **18**, the presence of a layer of lubricant between the transducer array and the acoustic window is avoided (see lubricant layer **118** in the prior art construction shown in **FIG. 8**). The absence of an interposition between the transducer array **18** and the acoustic window **20** improves acoustic performance. It also eliminates significant operational problems that may arise with the prior art ultrasound probe as a result of leakage of the lubricant caused by deficient construction and maintenance of the lubricant layer.

[0031] Another advantage is that the shape of the housing **10** of the probe and specifically the shape of a tip of the housing **10** in which the transducer assembly **16** is situated can be better designed for tip contact and patient intubation, without the size and space constraints necessitated for example by the presence of a rotating gear as in the prior art (see **FIG. 8**). Moreover, prior art acoustic windows fixed to the housing require mounting accommodations on the housing around the transducer array, e.g., a surrounding ledge to which the acoustic window is fixed. By attaching the acoustic window to the transducer array as in the invention, the space required for the mounting accommodations can be reduced.

[**0032**] To prevent fluids which come into contact with the acoustic window **20** from entering into the interior of the housing **10** during use of the ultrasound probe, a seal **22** is arranged between the housing **10** and the acoustic window **20**. The seal **22** is made of a flexible material and should be sufficiently impermeable to fluids and materials impervious to fluids such as those used during an ultrasound examination are known to those skilled in the art.

[**0033**] The flexible seal **22** may be matched with the durometer of the acoustic window **20** and will thus conform to the shape of the acoustic window **20** if the acoustic window **20** is impacted. By contrast, the interface or seal between acoustic windows and housings of ultrasound probes in the prior art is stiff so that the seal will often break when the window is impacted resulting in a potential electrical safety risk.

[**0034**] Transducer array **18** includes a layer of piezoelectric material **24**, an acoustic matching section **26** adjacent the active surface of the piezoelectric layer **24** and a backing layer **28** on the opposite side of the piezoelectric layer **24** from the acoustic matching section **26**. A heatsink **30** may be arranged under or within the backing layer **28**. The acoustic matching section **26** may contain one or more acoustic matching layers. The acoustic window **20** is attached to the upper surface of the acoustic matching section **26**.

[**0035**] The transducer array **18** is preferably constructed as a matrix array for which it is not necessary to provide lateral focus through the use of a lens or structure to cause rotation thereof in order to obtain multi-planar and volumetric, three-dimensional views of the body parts being imaged. Thus, the transducer array **18** is fixed and non-rotatable relative to the housing **10** of the ultrasound probe. However, the same effect of rotation of the array element in the prior art (see **FIG. 8** and the discussion above) is obtained electronically via control of the transducer elements of the transducer array **18**.

[**0036**] To this end, transducer elements in the piezoelectric layer **24** are independently addressable and are connected to an integrated circuit which is connected in turn to a circuit board. The transducer elements may be segmented into (or designated as) transmit sub-arrays and receive sub-arrays. Each transmit sub-array may be connected to a respective intra-group transmit pre-processor which is connected to a respective transmit beamformer channel. Each receive sub-array may be connected to a respective intra-group receive pre-processor which is connected to a respective receive beamformer channel. Control of the sub-arrays is obtained by a control processor in a manner known in the art, for example, as disclosed in U.S. Pat. No. 6,572,547, the entire contents of which are incorporated by reference herein.

[**0037**] A matrix array will therefore be considered as a type of transducer array which is capable of generating multi-planar images on an object by appropriate electronic control of transducer elements of the transducer array.

[**0038**] Alternatively, a conventional two-dimensional array in which the transducer elements themselves are curved to provide the focus could be used in combination with the acoustic window **20**. Furthermore, in another alternative use, the acoustic window **20** could be bonded on top of a conventional lens material to form a window or standoff.

[**0039**] Referring now to **FIG. 2**, in accordance with the invention, the acoustic window **20** includes an elastomer layer **32** sandwiched between upper and lower polymer layers **34, 36**, respectively, with the upper polymer layer **34** defining an outer, exposed surface of the transducer assembly **16**. The lower polymer layer **36** is attached directly to the upper surface of the acoustic matching section **26** of the transducer array **18**. As noted above, the absence of a gap between the transducer array **18** and the acoustic window **20**, specifically between the lower polymer layer **36** and the acoustic matching section **26**, avoids the need to provide an oil/lubrication layer as in the prior art embodiment shown in **FIG. 8**.

[**0040**] The elastomer layer **32** is sandwiched between the two polymer layers **34,36**, e.g., thin films of polymer, and the polymer layers **34, 36** and the elastomer layer **32** are bonded to one another. The polymer layers **34,36** will therefore not separate from the elastomer layer **32** during mechanical stress or environmental cycling. The elastomer layer may be made of PEBAX™, SBS (styrene-butadiene-styrene) or SEBS (styrene-ethylene-butylene-styrene) or other suitable materials known to those in the art.

[**0041**] Bonding of the polymer layers **34,36** to the elastomer layer **32** can be accomplished in several ways. For example, the elastomer layer **32** can be primed and/or heated, such that it acts as an adhesive to cause the polymer layers **34,36** to be bonded thereto. In addition to or instead of priming the elastomer layer **32**, it is possible to provide adhesive between each polymer layer **34,36** and the elastomer layer **32**.

[**0042**] Bonding of materials directly to an elastomer is often problematic. Thus, in the invention, by providing the lower polymer layer **36**, the transducer array **18** can be bonded more easily to the lower polymer layer **36** than to the elastomer layer **32**. On the other hand, providing the upper polymer layer **34** protects the elastomer layer **32** from scratches and other types of mechanical damage and also creates a barrier that eliminates chemical susceptibility.

[**0043**] Although the embodiment of the acoustic window **20** shown in **FIG. 2** includes both an upper polymer layer **34** and a lower polymer layer **36**, it is possible to construct an acoustic window without the lower polymer layer **36**. In this embodiment, shown in **FIG. 3**, the elastomer layer **32** is bonded directly to or formed directly on the upper surface of the transducer array **18**, i.e., the upper surface of the acoustic matching section **26** of the transducer array **18**.

[**0044**] The elastomer is a moldable material and therefore lends itself nicely to the production of acoustic windows having various shapes and sizes. Elastomers such as PEBAX™ can also be blended with polyethylene or other materials to tailor its properties. It is available in a range of durometers, several of which are appropriate for use in an acoustic window.

[**0045**] The polymer layers **34, 36** may each be made from any type of impervious polymer which preferably has a negligible acoustic impact including, but not limited to, polyethylene, Mylar™ and Kapton™. A different polymer can be used for each polymer layer **34, 36** if desired or the same polymer can be used for both polymer layers **34,36**.

[**0046**] The acoustic window **20** may have a larger cross-sectional area than the acoustic matching section **26** so that a portion of the acoustic window **20** is situated alongside the acoustic matching **26**. The lower polymer layer **36** is therefore bonded to the lateral edge of the acoustic matching section **26** (see **FIG. 2**) or may have a cross-sectional area which is substantially the same as the acoustic matching section **26** (see **FIGS. 5 and 6**). The acoustic window **20** has an extended section **38** alongside an upper portion of the transducer array **18** which serves to create a convoluted path (in combination with the peripheral surface of the cavity of the housing **10** into which the transducer assembly **16** is placed) to prevent fluids from entering into interior of the housing **10**. This improves the electrical safety of the probe. Further, the presence of the upper polymer layer **34** provides an easy bonding of the acoustic window **20** to the seal **22**.

[**0047**] By covering at least the portion of the elastomer layer **32** which would otherwise be exposed to the surrounding environment with the upper polymer layer **34**, the outer, exposed surface of the acoustic window **20** is defined by the upper polymer layer **34** and therefore disinfectants such as isopropyl alcohol come into contact with the upper polymer layer **34** and do not come into contact with the elastomer layer **32**. This avoids the problems which arise when the elastomer layer **32** comes into contact with such disinfectants.

[**0048**] The acoustic window **20** described above can be used in various types of ultrasound probes having transducer arrays which do not require focussing. For example, the acoustic window can be formed in a transesophageal echocardiographic (TEE) ultrasound probe, transnasal ultrasound probe, transnasal echocardiograph ultrasound probe, an intraoperative ultrasound probe or an intracavity ultrasound probe.

[**0049**] It is also envisioned that the acoustic window **20** is formed without the upper polymer layer **34**, i.e., with only a single lower polymer layer **36** between the transducer array **18** and the acoustic window **20** (as shown in **FIG. 4**), or without both the upper and lower polymer layers **34,36** (as shown in **FIG. 5** with the elastomer layer **32** being formed directly on the transducer array **18** as discussed above). In this case, since the elastomer layer **32** is exposed to the surrounding environment, the use of disinfectants which are not compatible with the elastomer would be prohibited. These designs could also be used for single-use devices.

[**0050**] **FIG. 6** shows an embodiment wherein the acoustic window **20** includes the elastomer layer **32** and the upper and lower polymer layers **34,36**. In this embodiment, as well as in the embodiment shown in **FIG. 5**, the acoustic window **20** does not extend beyond the lateral edges of the transducer array **18**. Thus, the length and width of the transducer array **18** and the acoustic window **20** are substantially the same, i.e., they have the same cross-sectional area. The seal **22** thus engages the acoustic window **20** and a part of the transducer array **18**.

[**0051**] **FIG. 7** shows another embodiment wherein the acoustic window **20** includes the elastomer layer **32** and the upper and lower polymer layers **34,36**. In this embodiment, the acoustic window **20** does not have an extended portion **38** alongside the transducer array **18** and thus is entirely above the transducer array **18**. That is, as shown in **FIGS. 2-4**, a portion of the acoustic window **20** is alongside the acoustic matching section **26** of the transducer array **18**. By appropriate construction of the housing **10**, it is possible to create a convoluted path between the housing **10** and the acoustic window **20** to prevent fluids from entering into interior of the housing. To support the portion of the acoustic window **20** extending laterally beyond the transducer array **18**, an optional support **40** (shown in dotted lines) may be provided.

[**0052**] Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to these precise embodiments, and that various other changes and modifications may be effected therein by one of ordinary skill in the art without departing from the scope or spirit of the invention.

1. A transducer assembly for an ultrasound probe, comprising:

a transducer array comprising a plurality of transducer elements; and

an acoustic window attached directly to said transducer array such that said transducer array and said acoustic window form an integral unit.

2. The transducer assembly of claim 1, wherein said transducer array comprises a layer of piezoelectric material having an active surface and defining said transducer elements, an acoustic matching section having a lower surface adjacent the active surface of said piezoelectric material and an opposed upper surface and a backing layer arranged on an opposite side of said piezoelectric material from said acoustic matching section.

3. The transducer assembly of claim 2, wherein said acoustic window is attached to said upper surface of said acoustic matching section.

4. The transducer assembly of claim 1, wherein said acoustic window comprises an elastomer layer having first and second opposed surfaces, a first layer of an impervious polymer arranged on said first surface of said elastomer layer and a second layer of an impervious polymer arranged on said second surface of said elastomer layer such that said elastomer layer is sandwiched between said first and second polymer layers.

5. The transducer assembly of claim 4, wherein a lower surface of said first polymer layer is attached to said transducer array and an upper surface of said second polymer layer defines an exposed surface of the transducer assembly.

6. The transducer assembly of claim 4, wherein said elastomer layer includes an elastomer selected from a group consisting of PEBAX™, SBS and SEBS.

7. The transducer assembly of claim 4, wherein said first and second polymer layers are thin polymer films having negligible acoustic impact.

8. The transducer assembly of claim 1, wherein said acoustic window comprises a layer of elastomer having a lower surface attached directly to said transducer array and an upper surface, and a layer of an impervious polymer arranged on said upper surface of said elastomer layer, said upper surface of said polymer layer defining an exposed surface of the transducer assembly.

9. The transducer assembly of claim 1, wherein said acoustic window comprises a layer of elastomer having an exposed upper surface defining an exposed surface of said transducer assembly and a lower surface, and a layer of an impervious polymer arranged on said lower surface of said elastomer layer and attached to said transducer array such that said polymer layer is interposed between said transducer array and said elastomer layer.

10. The transducer assembly of claim 1, wherein said acoustic window comprises a layer of elastomer having a lower surface attached directly to said transducer array and an exposed upper surface defining an exposed surface of said transducer.

11. The transducer assembly of claim 1, wherein said transducer elements are independently-addressable or curved.

12. An ultrasound probe, comprising:

a housing defining a cavity extending inward from an opening in a peripheral surface;

a transducer array arranged in said cavity of said housing to produce ultrasound beams, said transducer array comprising a plurality of transducer elements which generate ultrasound beams in various planes and volumes; and

an acoustic window attached directly to said transducer array such that said transducer array and said acoustic window form an integral unit.

13. The ultrasound probe of claim 12, wherein said housing is in the form of a housing of a transesophageal echocardiographic probe, a housing of a transnasal probe, a nose of a transthoracic probe, a nose of an intracavity probe or a nose of an intraoperative probe.

14. The ultrasound probe of claim 12, further comprising a flexible seal interposed between said acoustic window and said housing to seal said cavity.

15. The ultrasound probe of claim 12, wherein said transducer array comprises a layer of piezoelectric material having an active surface and defining said transducer elements, an acoustic matching section having a lower surface adjacent the active surface of said piezoelectric material and an opposed upper surface and a backing layer arranged on an opposite side of said piezoelectric material from said acoustic matching section, said acoustic window being attached to said upper surface of said acoustic matching section.

16. The ultrasound probe of claim 12, wherein said acoustic window comprises an elastomer layer having first and second opposed surfaces, a first layer of an impervious polymer arranged on said first surface of said elastomer layer and a second layer of an impervious polymer arranged on said second surface of said elastomer layer such that said elastomer layer is sandwiched between said first and second polymer layers.

17. The ultrasound probe of claim 16, wherein a lower surface of said first polymer layer is attached to said transducer array and an upper surface of said second polymer layer defines an exposed surface of the transducer assembly.

18. The ultrasound probe of claim 16, wherein said elastomer layer includes an elastomer selected from a group consisting of PEBAX™, SBS and SEBS.

19. The ultrasound probe of claim 12, wherein said acoustic window comprises a layer of elastomer having a lower surface attached directly to said transducer array and an exposed upper surface, and a layer of an impervious polymer arranged on said upper surface of said elastomer layer.

20. The ultrasound probe of claim 12, wherein said acoustic window comprises a layer of elastomer having an exposed upper surface and a lower surface, and a layer of an impervious polymer arranged on said lower surface of said elastomer layer and attached to said transducer array such that said polymer layer is interposed between said transducer array and said elastomer layer.

21. The ultrasound probe of claim 12, wherein said acoustic window comprises a layer of elastomer having a lower surface attached directly to said transducer array and an exposed upper surface.

22. The ultrasound probe of claim 12, wherein said transducer elements are independently-addressable or curved.

* * * * *

专利名称(译)	用于超声探头的换能器组件		
公开(公告)号	US20050165313A1	公开(公告)日	2005-07-28
申请号	US11/040057	申请日	2005-01-21
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CPC分类号	G10K11/02		
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外部链接	Espacenet USPTO		

摘要(译)

用于超声探头的换能器组件包括具有换能器元件的换能器阵列和直接连接到换能器阵列的声窗，使得换能器阵列和声窗形成整体单元。声窗包括一层弹性体，其任选地由不透水的聚合物层覆盖在上表面和下表面上。还公开了超声探头，例如经食管超声心动图探针，经鼻探针，经胸探针，腔内探针和术中探针，包括壳体或鼻腔中的换能器组件。

FIG. 2