United States Patent [19]

Butter

[11] **3,872,332**

[45] **Mar. 18, 1975**

[54] **COMPOSITE BOND FOR ACOUSTIC TRANSDUCERS**

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[22] Filed: **Apr. 19, 1971**

[21] Appl. No.: **135,287**

[52] **U.S. Cl.** ..... **310/9.7,** 310/8.2, 340/8 MM, 333/30 R

[51] **Int. Cl.** **H01v 7/00**

[58] **Field of Search** ..... 310/8.2, 8.3, 9.6, 9.7, 310/8; 340/8 MM; 333/30 R

[56] **References Cited**

UNITED STATES PATENTS

2,106,143	1/1938	Williams	310/9.7
2,260,842	10/1941	Schwarzhaupt	310/9.7 X
2,384,465	9/1945	Harrison	340/8 MM
2,416,314	2/1947	Harrison	340/8 MM
2,430,013	11/1947	Hansell	340/8 MM
2,830,201	4/1958	Wilson	310/8.3
3,051,927	8/1962	Mazzagatti	340/8 MM
3,564,303	2/1971	Geil	310/8.3 X

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[57] **ABSTRACT**

A piezoelectric transducer is bonded to an acoustic medium by a composite bond formed by a polymerizable plastic material and a sheet-like grid. Proper selection of the material and percentage of open space of the grid allows the acoustic impedance of the composite bond to be adjusted to a desired value.

2 Claims, 2 Drawing Figures

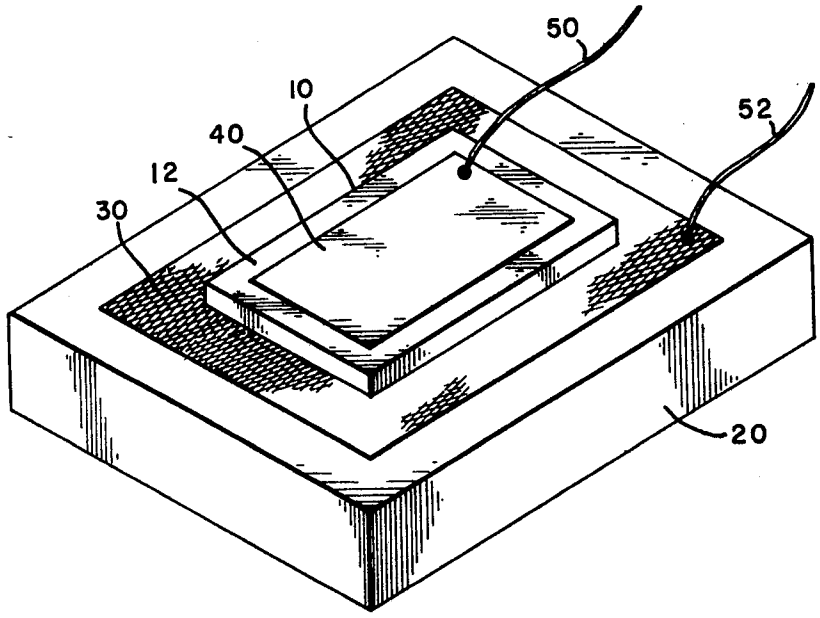


FIG. 1

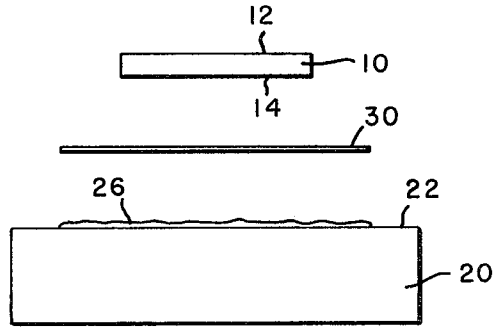
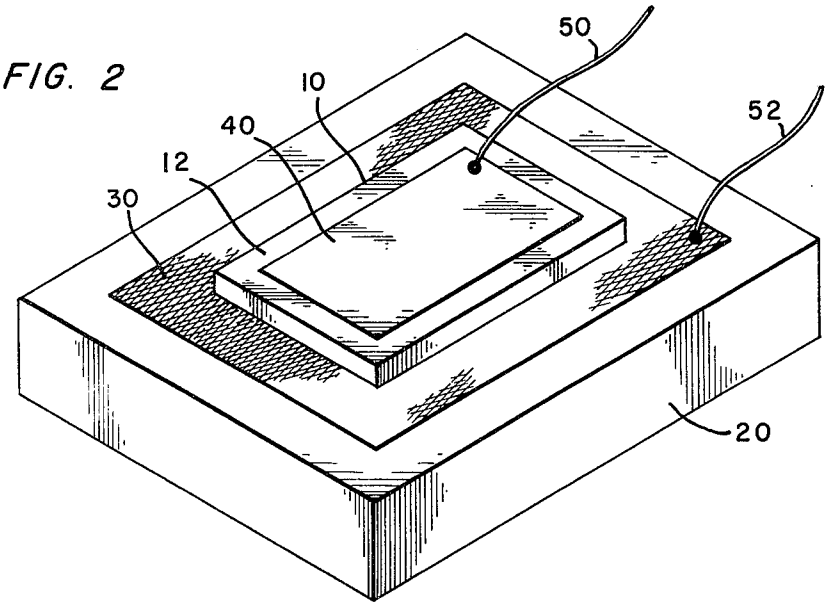


FIG. 2



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COMPOSITE BOND FOR ACOUSTIC TRANSDUCERS

BACKGROUND OF THE INVENTION

This invention relates to an acoustic device having an improved bond between a piezoelectric transducer and an acoustic medium.

One type of acoustic device in which the present invention can be used to a particular advantage is an acousto-optic light beam deflector. In this device light waves are diffracted by acoustic waves, resulting in the deflection of the light waves to a particular angle or angles depending upon the frequency of the acoustic waves.

In the prior art, problems have arisen in bonding a piezoelectric transducer to an acoustic medium since typically the acoustic impedances of the piezolectric transducer and the acoustic medium are different. Therefore, the ideal acoustic impedance of the bonding material is equal to the square root of the product of the impedances of the acoustic medium and the piezoelectric transducer, so that impedance matching is achieved. However, it has been very difficult to select a bonding material which has this ideal acoustic impedance.

SUMMARY OF THE INVENTION

The present invention provides an improved bond for which the proper acoustic impedance can be achieved by a simplified procedure, thereby reducing the cost of fabrication.

A sheet-like grid is positioned between a surface of the piezoelectric transducer and a surface of the acoustic medium desired to be bonded. The sheet-like grid has a plurality of openings therein. A polymerizable plastic material fills the openings of the sheet-like grid and adheres to the surfaces of the transducer and the acoustic medium. The sheet-like grid and the polymerizable plastic material thereby form a composite bond.

The acoustic impedance of the composite bond is adjusted to a desired value by proper selection of the material forming the grid and the percentage of open space in the grid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a piezoelectric transducer and an acoustic medium prior to formation of the improved bond of the present invention.

FIG. **2** shows an acoustic device having a piezoelectric transducer bonded to an acoustic medium by the improved bond of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1,** an acoustic device is shown prior to formation of the improved bond of the present invention. Piezoelectric transducer **10** having a first surface **12** and a second surface **14** is positioned opposite acoustic medium **20.** Located on a third surface **22** of acoustic medium **20** is a polymerizable plastic material **26.** Positioned between second surface **14** and third surface **22** is a sheet-like grid **30.** Extending through the sheet-like grid are a plurality of openings.

Upon bonding, polymerizable plastic material **26** fills the interstices or openings of sheet-like grid **30** and adheres to second surface **14** and third surface **22.** In this manner, the sheet-like grid **30** and polymerizable plastic material **26** form a composite bond.

The acoustic impedance of polymerizable plastic material **26** differs from that of sheet-like grid **30** and therefore by selecting the appropriate percentage of open space of sheet-like grid **30** it is possible to achieve a composite bond having a desired acoustic impedance. Since sheet-like grid **30** ordinarily has the larger acoustic impedance, a reduction in the percentage of open space increases the acoustic impedance of the composite bond. Further adjustment of the acoustic impedance of the composite bond is achieved by utilizing different material for the sheet-like grid.

FIG. **2** shows a completed acoustic device having a composite bond. In this embodiment sheet-like grid **30** comprises a metal mesh. A first electrode **40** is attached to first surface **12** of piezoelectric transducer **10.** The metal mesh comprising sheet-like grid **30** forms a second electrode adjacent second surface **14.** Electrical leads **50** and **52** are attached to first electrode **40** and sheet-like grid **30,** respectively, so that an electrical signal can be applied to piezoelectric transducer **10.**

In one successful embodiment of the present invention a 35° Y-cut Lithium Niobate crystal having an acoustic impedance of approximately 34.8×10^6 Kg/m^2 sec is used as the piezoelectric transducer. The crystal is approximately 10 millimeters long, 1.5 millimeters wide and 80 microns thick. The acoustic medium is a body of fused quartz having an acoustic impedance of 13.1×10^6 Kg/m^2 sec. A 0.3 mil thick copper mesh having 750 lines per inch and 55% open area is positioned on one surface of the acoustic medium. An epoxy material, Epon 815 manufactured by Shell Chemical Company, is placed on top of the copper mesh so that the interstices or open spaces in the mesh are filled with the epoxy. The transducer is then placed on top of the metal mesh and epoxy so that it becomes fixed to the fused quartz acoustic medium. The composite bond thus formed has an acoustic impedance of approximately 21.3×10^6 Kg/m^2 sec, which is very close to the ideal value for acoustic impedance matching.

In operation the bonded transducer is utilized in an acousto-optic light beam deflector. The fused quartz acoustic medium is placed in a housing so as to contact water. The acoustic signal produced by the piezoelectric transducer is directed through the fused quartz and into the water. A light beam directed through the water is deflected by an angle dependent upon the frequency of the acoustic signal.

While this invention has been disclosed with particular reference to the preferred embodiments, it will be understood by those skilled in the art that changes in form and details may be made without departing from the spirit and the scope of the invention. For example, the sheet-like grid need not be electrically conductive. In that case, an evaporated conducting film on the transducer forms the second electrode.

The embodiments of the invention in which an exclusive property or right is claimed are defined as follows:

1. An acoustic device comprising:

a piezoelectric transducer having a first and a second surface and a first acoustic impedance,

an acoustic medium having a third surface and a second acoustic impedance different from the first acoustic impedance,

first electrode means attached to the first surface, a sheet-like electrically conductive metal mesh posi-

tioned between the second and third surfaces and forming a second electrode means, the electrically conductive metal mesh having a plurality of openings therein, and,

a polymerizable plastic material filling the openings of the electrically conductive metal mesh and adhering to the second and third surfaces, the electrically conductive metal mesh and the polymerizable plastic material forming a composite bond having a third acoustic impedance essentially equal to the square root of the first and second acoustic impedances, the third acoustic impedance being determined by the impedance of the electrically conductive metal mesh, the impedance of the polymerizable plastic material, and the percentage of open space in the electrically conductive metal mesh.

2. The invention that is described in claim **1** wherein the polymerizable plastic material is epoxy.

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