March 18, 1947. W. P. MASON 2,417,426

PIEZOELECTRIC CRYSTAL MOUNTING

Filed Oct. 6, 1943

FIG. 1.

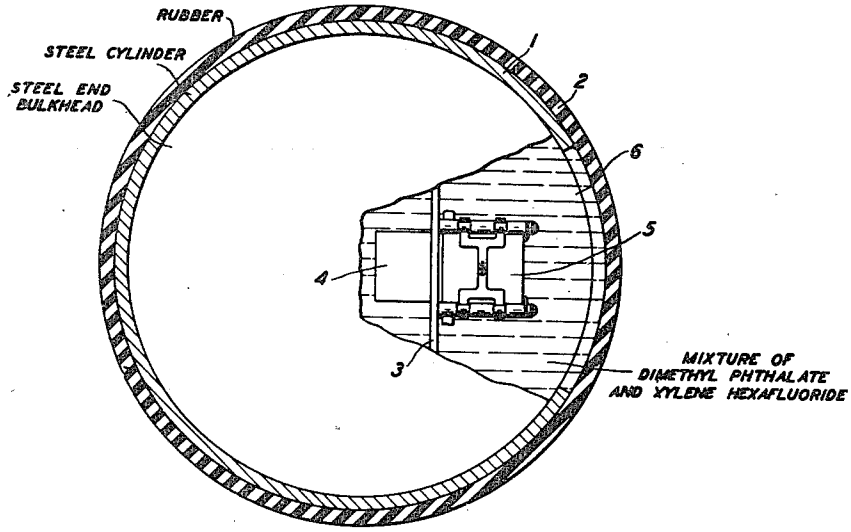


FIG. 2.

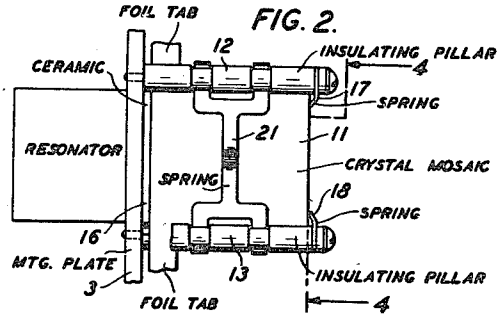


FIG. 3.

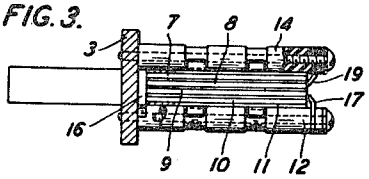
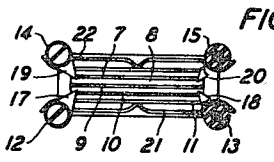


FIG. 4.



INVENTOR
W. P. MASON
BY
ATTORNEY

Patented Mar. 18, 1947

2,417,426

UNITED STATES PATENT OFFICE

2,417,426

PIEZOELECTRIC CRYSTAL MOUNTING

Warren P. Mason, West Orange, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 6, 1943, Serial No. 505,161

4 Claims. (Cl. 171—327)

1

This invention relates to the construction of electromechanical transducers of the type employing piezoelectric crystals, the object of the invention being to improve the work capabilities thereof.

As the power range of these devices has been increased changes in design and construction have been necessary. Thus it has been found that the phenomenon of cavitation has a limiting effect on the operation of an electromechanical transducer of the piezoelectric type. In order to increase the range of such a device a new liquid medium which would support the transmission of greater power before cavitation is established had to be found. The liquid dimethyl phthalate $C_6H_4(COOCH_3)_2$ has been found to fulfill substantially all requirements. It has a high cohesive force which renders it capable of transmitting great power in the form of compressional waves of ultrasonic frequency, and when mixed with xylene hexafluoride, $C_6H_4(CF_3)_2$ which has a high vapor pressure, will avoid the destructive effects of cavitation through the cushioning effect of vapor quickly placed in the voids thus formed. Dimethyl phthalate has a high electrical resistance and will maintain most of its properties unchanged through a wide range of temperatures. It has no corrosive effect on rubber which is used as a diaphragm about the transducer and from these standpoints appears to be the nearest to an ideal fluid yet found for these purposes. However, it has been found to attack the solution of cyclized rubber heretofore used as a cement for sealing the individual crystals and foils together and to secure such a mosaic to its ceramic wafer and thence to the mounting plate.

In accordance with the present invention all the advantages heretofore realized through the use of dimethyl phthalate are retained by making use of the high cohesive force of this liquid to form a good bond between the crystal and its mounting plate in place of the cement heretofore used. By the use of springs to retain the crystal mosaic generally in place and by arranging the crystals and the ceramic wafer with reasonably flat surfaces so that good mechanical contact between them is made, the mosaic is held in position through the cohesive force of the liquid.

A feature of the invention is a crystal mosaic secured to a mounting plate by an arrangement of positioning springs and a liquid having a high cohesive force.

Another feature of the invention is the substitution as a bonding material of a liquid having a high cohesive force for an adhesive compound.

2

Another feature of the invention is the method of bonding a piezoelectric crystal to a mounting plate which consists of forming the surfaces of the crystal and the plate so that good mechanical contact is made therebetween, interposing a film of a liquid having a high cohesive force and pressing the crystal against the said plate.

Other features will appear hereinafter.

The drawings consist of a single sheet having four figures as follows:

Fig. 1 is a cross-sectional view showing the general disposition of a crystal mosaic in an electromechanical transducer;

Fig. 2 is a detail side view of the crystal mosaic showing the means for holding the crystal slabs generally in place;

Fig. 3 is a plan view; and

Fig. 4 is an end view of the same, partly in section, taken along the broken line 4—4 in Fig. 2.

One form of a device using a crystal mosaic is shown in Fig. 1. This consists of a tubular steel casing 1 covered on the outside with a layer of rubber 2 having the proper density and velocity for matching the characteristics of the sea water in which the device is immersed and the liquid medium with which the device is filled. A "window" is formed in front of the crystal array by removing part of the steel casing as shown. Within the casing and mounted in any appropriate manner is a mounting plate 3 to which the backing resonators such as 4 and the crystal mosaics here generally designated 5 are secured. The cavities within the casing are filled with a viscous liquid 6 such as dimethyl phthalate or a mixture of dimethyl phthalate and xylene hexafluoride which has been found to have excellent properties for this purpose.

As shown more in detail in Figs. 2, 3 and 4, the crystal mosaic consists of a plurality of piezoelectric crystal slabs 7, 8, 9 and 10 having electrodes such as metal foil interposed therebetween and on the outer faces thereof as the foil 11. This assembly is held generally in place by an arrangement of springs and dependence is placed on the cohesive force of the viscous liquid in which the assembly is immersed to hold them securely together and in place.

There are four posts 12, 13, 14 and 15 comprising insulating material secured to the mounting plate. A ceramic wafer 16 shaped to conform to the outline of the form posts is placed between the mounting plate 3 and the crystals. There are four leaf springs 17, 18, 19 and 20 se-

cured to the tops of the posts which exert a small pressure on the crystals toward the mounting plate. There are also two leaf springs 21 and 22 held between the said posts and the outer faces of the crystals to hold the assembly together.

With the ceramic wafer 16 formed substantially flat and the various abutting faces of the crystal cut substantially flat, the viscous liquid will form an excellent bond therebetween and will prevent dislodging of the crystals even when they are excited and caused to vibrate.

What is claimed is:

1. An electromechanical transducer comprising a cell filled with a liquid having a high cohesive force and immersed in said liquid a mounting plate, a thin flat surfaced ceramic wafer and a plurality of piezoelectric crystals, said mounting plate and said crystals having substantially flat surfaces whereby said crystals are bonded to said mounting plate through said wafer by the cohesive force of said liquid.

2. An electromechanical transducer comprising a cell filled with a liquid having a high cohesive force and immersed in said liquid a mounting plate, a thin flat surfaced ceramic wafer, a plurality of piezoelectric crystals and springs for holding said crystals in contact with said wafer and said wafer in control with said mounting

plate, the surfaces of said mounting plate and said crystals being substantially flat whereby a good bond therebetween is provided through the cohesive force of said liquid.

3. An electromechanical transducer comprising a cell filled with a liquid having a high cohesive force and immersed in said liquid a mounting plate, a thin flat surfaced ceramic wafer, a plurality of piezoelectric crystals, springs for pressing said crystals together and springs for pressing said crystals toward said plate, the abutting surfaces of said crystals being substantially flat whereby a good bond between said crystals and between said crystals, said wafer and said plate is provided through the cohesive force of said liquid.

4. An electromechanical transducer comprising a cell filled with a liquid having a high cohesive force and immersed in said liquid a mounting plate, a plurality of piezoelectric crystals, a ceramic wafer interposed between said crystals and said mounting plate, and springs for holding said mounting plate, said ceramic wafer and said crystals together, the abutting surfaces of said elements being substantially flat whereby a good bond therebetween is provided through the cohesive force of said liquid.

WARREN P. MASON.