

[54] SONAR TRANSDUCER HOUSING

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[22] Filed: Nov. 16, 1970

[21] Appl. No.: 89,735

[30] Foreign Application Priority Data

Nov. 25, 1969 France 6940589

[52] U.S. Cl. 181/5 A, 340/8 MN

[51] Int. Cl. H04b 13/00, H04r 1/28

[58] Field of Search 181/5 A; 340/8 R, 340/8 MN

[56] References Cited

UNITED STATES PATENTS

3,051,927	8/1962	Mazzagatti.....	340/8 MM
2,527,217	10/1950	Hayes	340/8 MM
3,136,380	6/1964	McCoy et al.	181/5 A
3,123,176	3/1964	Greenberg	181/5 A

OTHER PUBLICATIONS

W. P. Mason, Electrochemical Transducers and Wave Filters, 1942, pgs. 245-247.

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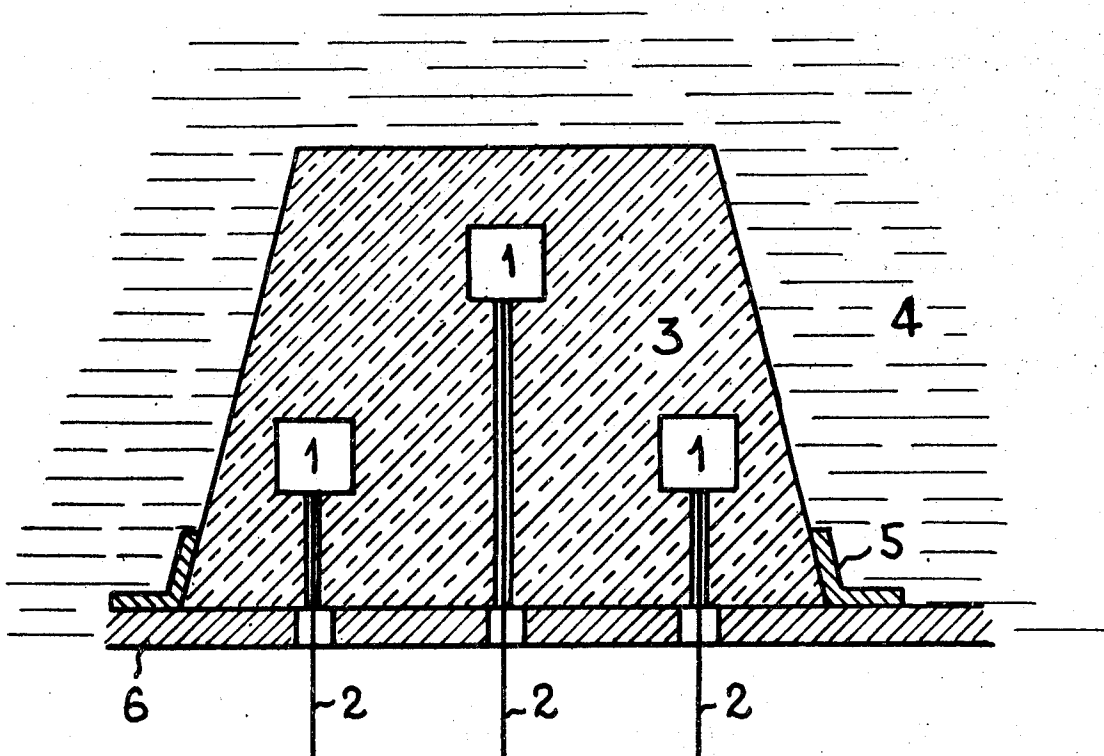
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[57] ABSTRACT

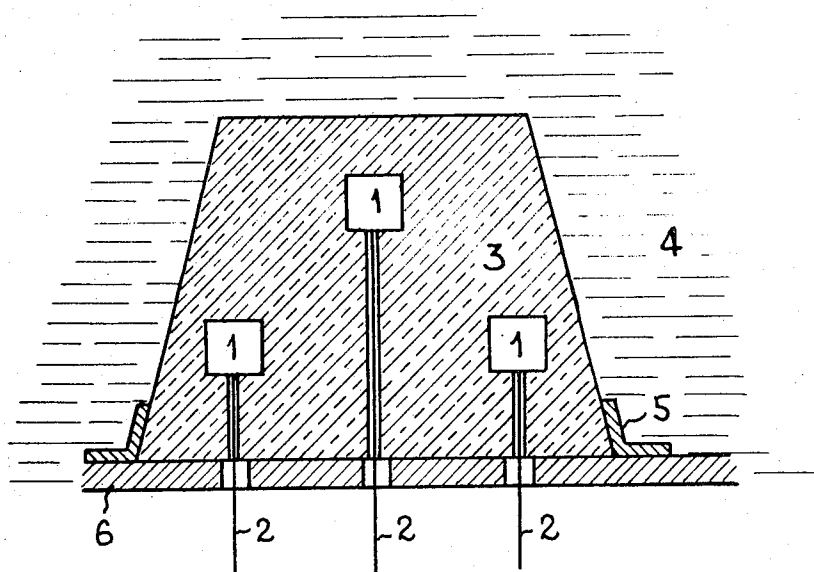
A solid block of material has an outer surface shaped to be streamlined, or otherwise present little flow resistance within a liquid medium; the block has a base, and an inner surface which surrounds the outer surface of transducer elements, the entire volume of the solid block and the material between the outer surface thereof and the inner surface of the transducer elements being homogeneous throughout and of a material which is permeable to sound waves created by the transducer element, the material having a specific gravity similar to that of the liquid medium and propagating sound waves therethrough at a velocity substantially similar to the velocity of propagation of sound waves through the liquid, the transducer being located within the block at a distance which is large with respect to the wave lengths of the waves propagated by the transducer through the block of material. To make this transducer, a mold is provided having a desired exterior outline and then the transducer, or a mold form is inserted therein and elastic material is poured into the mold and permitted to harden to form the housing.

4 Claims, 1 Drawing Figure



PATENTED SEP 11 1973

3,757,888



SONAR TRANSDUCER HOUSING

The present invention relates to sonar transducer housings, and to methods of their manufacture, and more particularly to sonar domes made of plastics materials housing sonar transducer elements and used for under-water sound propagation capable of being used at great depths.

The acoustic transducer elements in sonar systems require mechanical protection and separation from sea water. It has previously been proposed to insert such transducer elements into underwater domes which have such an outside shape that noises due to water flow thereover are eliminated, or at least greatly reduced. This can be obtained by providing streamlined outlines, fairings, or fish-shaped covers. The materials for these sonar transducer domes must, therefore, be capable of being readily shaped to desired profiles and further must have sufficient acoustical transparency so that the performance of the sonar system is not essentially modified or impaired. Due to the speed, and the depth at which they may be used, it is important, additionally, that the sonar domes are of great mechanical strength.

Various types of sonar domes are being used; most have as a common characteristic that they are hollow and have a fairly thin shell. This introduces problems with respect to mechanical rigidity. The thickness of the wall is usually in the order of only a few wavelengths of the signal which is propagated by the transducer. Mostly, the materials of the walls are plastics. These materials, at the present time, are practically the only ones which have a sufficient acoustic transparency so that the performance of the sonar system is not substantially affected. The mechanical strength of these domes is increased if metallic reinforcements are introduced into the plastics material, or if different materials are layered or laminated together. This introduces additional difficulties, however, particularly in the operation of the system, since distortions and reflections, as well as refractions of parasitic nature may give rise to standing waves inside the sonar domes. Additionally, and particularly in sonar domes formed of laminated plastic materials, problems of uniformity of the domes arise, since air bubbles must be absolutely excluded.

Hollow domes are usually filled with a liquid medium, such as, for example, sea water, or appropriate oil, which, additionally, causes the possibility of introducing air or gas bubbles and thus, in the interior of sonar dome; the captive air or gas may locally assemble to form undesirable cavities when large temperature changes take place.

It is an object of the present invention to provide a sonar transducer housing, or, as also referred to, a sonar dome, and a method of its manufacture, which is effective in use, easy to make and presents little attenuation to sonar waves from the transducer.

SUBJECT MATTER OF THE PRESENT INVENTION

Briefly, a solid block of material is used which has an outer surface, preferably streamlined, to be in contact with the liquid medium. The sonar transducer is inserted into the solid block; the material between the surface of the transducer and the outer surface of the block is homogeneous throughout, permeable to sound waves created by the transducer, and has a specific gravity similar to that of the liquid medium (typically

sea water) in which it is to be immersed, and further has a velocity of sound propagation which is likewise similar to that of sound propagation in the liquid medium and a shear modulus of substantially zero. The transducer element is located in the block at a distance which is large with respect to the wavelength of the waves being propagated by the transducer element. To make such an element, in accordance with the present invention, a mold is prepared having the exterior outline of the housing, into which is then introduced, for example by gravity flow, the material of the block and the transducers, or mold forms therefor; the cast material is then permitted to harden to form the housing.

The invention will be described by way of example with reference to the accompanying drawings, wherein :

the single FIGURE is a transverse schematic cross-sectional view through a sonar dome in accordance with the present invention.

Three acoustical elements 1 of a sonar system are inserted in a block 3. Block 3 is a solid dome of streamlined shape. The transducer elements 1 are acoustically insulated from a support base 6 carrying the sonar dome. The acoustic isolation of the transducers from the support base 6, carrying the solid dome 3, permits avoidance of noise and other disturbances from being transmitted from support 6 through the housing attachment elements 5, for example attaching angle pieces. The electrical connections 2 are likewise carried through the support base 6 in such a manner that acoustic vibration is isolated.

The massive dome block provides a transmission system medium which has a thickness substantially larger than the wavelength of the transmitted acoustical vibrations. Such massive, solid blocks require a special material which must satisfy different conditions.

The necessary requirements to obtain a sound transmitting block, without reflections, and without change of direction of the acoustic energy with respect to two homogenous media, requires that the media have approximately the same acoustical impedance and that the velocity of sound between the two shall be substantially identical. If one of the materials is water, typically sea water, the other material must have a density close to unit, and a velocity of sound C which should be in the neighborhood of 1,500 m/sec. Additionally, the material must not be susceptible of transmission of shear waves which reach the dome surface at an oblique angle of incidence. The material must, additionally, be homogenous capable of being easily shaped into a streamlined form, preferably by permitting it to be cast without excessive heating. An additional requirement for casting is that high temperatures and casting pressures must be avoided since both heat and pressure may damage the transducer elements 1 in the sonar dome.

It can be shown theoretically, and actual operating experience confirms, that a satisfactory material which simultaneously essentially meets all the above requirements must have a density between about 1 and 1.1; that the velocity of sound therein shall be approximately 1,500 m/sec. and that it shall have a modulus, in shear, which is practically zero. The hardness thereof is chosen additionally not to exceed 60A on the shore scleroscope. The time during which the material, after the components thereof have been mixed, reaches a viscosity which no longer permits effectively degassing

of the material shall, additionally, be sufficiently long to permit molding of large masses or blocks which are uniformly polymerized. None of the materials which are usually utilized to make the thin, hollow sonar domes simultaneously have all the necessary characteristics. Thus, materials ordinarily used for massive, solid sonar transmission blocks, in accordance with the present invention, are different. Known materials which have been used are polyvinyl chloride, polyesters, methyl polymethacrylate and ethyl cellulose plastics. These latter have a density in excess of 1.1, and molding can be carried out only under pressure and at temperatures in excess of 100° C. Known rubbers, and particularly the P-C rubbers have certain characteristics which are close to those of water, particularly the natural latex rubbers; yet, they cannot be utilized to make a massive solid sonar dome block since they cannot be cast and molded to large domes at a sufficiently low temperature and pressure to prevent any damage to the transducer elements.

Preferably the material for the solid sonar dome is made from polyisocyanates crosslinked with polyols. The degree of crosslinking of these mixture is selected to obtain a shear modulus of the material which is practically zero.

Polyols, as well as the polyisocyanates are selected to be free from water; the polyisocyanates are, advantageously, prepolymerized.

Example 1 : A polyether polyisocyanate is crosslinked with a mixture of diols and triols, to produce a composition having these characteristics

Density : 1.06

Velocity of sound transmission : close to 1,500 m/sec.

Shear modulus : practically zero

Hardness : 60 A shores.

The transducer elements block dome is made as follows: said polyether is first heated until its viscosity is very low; thereafter, said polyether is degassed in accordance with known technology. The crosslinking system, upon mixing with the diols and the triols, previously prepared, is then added to said polyether. If desired, accelerators, plasticizers, or stabilizers may be additionally added. The various components of the mixture are preferably mixed together at an elevated temperature, of approximately 100° C, or close to it, and under vacuum, while controlling their uniformity. The sonar dome is then cast by gravity, preferably under vacuum in a preheated mold, the temperature of which may be less than 100° C. Degassing is carried out until the viscosity of the mixture has reached a point at which degassing is no longer effective. It has been found that the time during which effective degassing can be carried out is more than one hour; thus, large blocks can be cast and molded. The entire block is then polymerized by heating to a temperature which can be somewhat less than 100° C, for a period of time until the hardness reaches a stable value. After removal of the mold, a massive block, or dome is obtained, with the profile of the mold which can be streamlined and hydrodynamic; the dome volume is generally large of substantial circumference, and totally encloses the acoustic transducer elements. The acoustic transducer elements themselves will remain sensitive to exterior sound, and will be retained enclosed in the dome with-

out having suffered any damage by heating or pressure during the molding being generally made of piezoelectric ceramics.

In certain applications the acoustic transducer elements need not be introduced into the mold before casting, but rather similar mold elements can be introduced therein to provide space for subsequent introduction of the acoustic elements into the transducer housing or dome.

Domes in accordance with the present invention, and made in accordance with the method have the additional advantage that the respective wave phase characteristic of enclosed different acoustic elements is unchanged, which is particularly important for hydrographic goniometry.

What is claimed is :

1. Sonar transducer housing, usable at great depths in a liquid medium and embodying a streamlined dome for mechanical protection and separation from said medium of associated electroacoustical transducer elements (1) when the housing is immersed, said housing comprising

a large mass dome block (3) of a polymer material of poly isocyanate crosslinked with polyols having an outer surface coming in contact with said liquid medium (4), and inner surfaces provided for closely surrounding the outer surfaces of at least one said transducer element (1) and the corresponding electrical connections (2) therefor, said block (3) being mounted on an acoustically insulated support base (6), the entire internal volume of said dome, defined by the said block outer and inner surfaces, being solid and homogeneous throughout;

said material being transparent to elastic longitudinal waves propagated therethrough and having the combination of features

- a shear modulus of substantially zero,
- a specific gravity substantially identical to that of the liquid medium, and
- the velocity of elastic wave propagation therethrough being substantially the same velocity as the velocity of propagation in said liquid medium;

the space within said dome provided for the transducer operating on a given wave-band being such that the designed distance separating any of its surfaces from any said outer dome surfaces is substantially larger than the wave length of the propagated waves.

2. Sonar housing according to claim 1, wherein the poly-isocyanate comprises a polyether poly-isocyanate crosslinked by mixture with at least one of diols or triols.

3. Sonar housing according to claim 1, wherein the specific gravity of the dome block is approximately equal to that of sea water and the hardness of the polymer is in the range of 60A shores.

4. Sonar housing according to claim 1, wherein the outer surface of said block of material is streamlined into hydrodynamic form to reduce liquid flow noises upon relative movement of said block and said fluid medium.

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