ACOUSTIC ABSORBING MATERIAL

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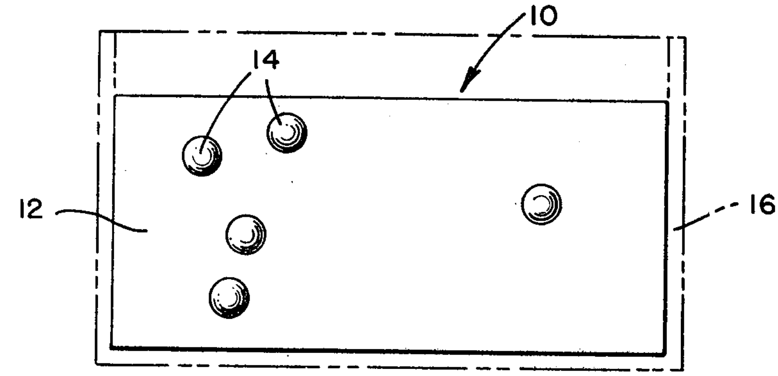

FIG. 1.

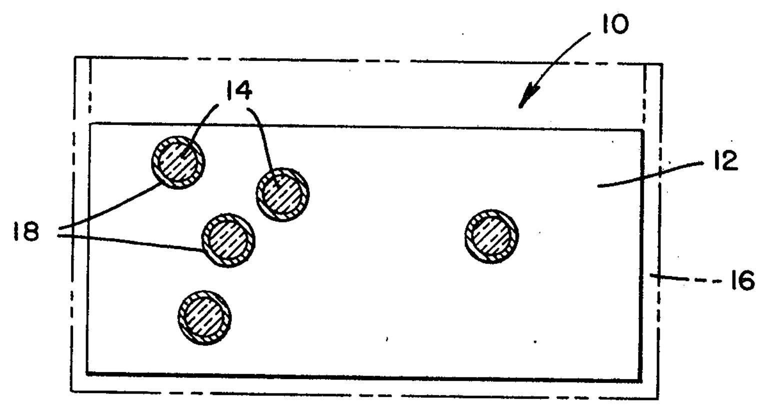

FIG. 2.

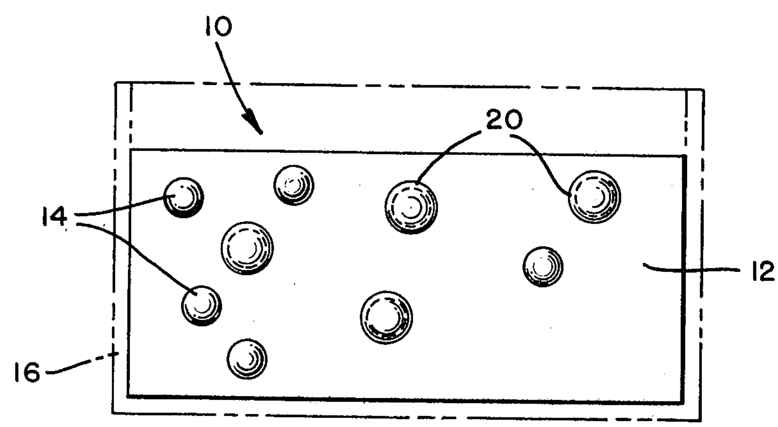

FIG. 3.

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ACOUSTIC ABSORBING MATERIAL

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ABSTRACT OF THE DISCLOSURE

This invention relates to an acoustic energy-absorbing material which will absorb sound energy under water, and which will retain its properties essentially independently of depth. Piezoelectric or ferroelectric material is either coated with an electrically-conductive material and distributed in a nonconductive base material or distributed uncoated in a conductive base material. The resultant matrix consists of a material having the density and sound propagation velocity of seawater. The material is able to convert incident soundwave energy into electrical energy through the agency of the piezoelectric or ferroelectric material, the electrical energy then being dissipated in the conductive coating.

The invention described herein may be manufactured and used by or for the government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

In the prior art, the only material commonly used as an acoustic energy-absorptive material was aluminum-filled butyl rubber. This material has the serious disadvantage that it loses its absorptive properties at depths over 50 feet.

This invention relates to an acoustic energy-absorptive material comprising distributed particles of an acoustically active material. The term "acoustically active" as used herein refers to a material which is either piezoelectric or ferroelectric. The particles are surrounded by electrically conductive material, either by mixing the pulverized particles with a conductive material, used as a base, such as an electrolyte or a conductive jelly, or by coating the particles with conductive material, for example, by electroless deposition. The coated particles are then inserted or mixed with a base or binder materail, the resultant acoustic energy-absorbing material having the density ρ and propagation velocity c of seawater.

It is desirable that the acoustic energy-absorbing material have the density and propagation velocity of seawater because only under these conditions will there be no reflection of acoustic energy and, therefore, more nearly complete absorption.

The theory of operation involves the conversion of incident soundwave energy into electrical energy through the agency of the piezoelectric or ferroelectric material, the electrical energy then being dissipated in the conductive coating, conductive solution or conductive matrix. The dissipated energy in the form of heat is passed to the surrounding environment, for example, seawater.

Accordingly, an object of the present invention is the provision of an energy-absorbing material which can be used for designing sonar transducers.

A further object of the invention is the provision of an acoustic energy-absorbing material which can be used with high pressure acoustic test tanks.

Still another object is to provide an acoustic energy-absorbing material which may be used in designing deep operating sonar systems.

Other objects and many of the attendant advantages of this invention will be readily appreciated as it becomes better understood by reference to the description and accompanying drawings which follow.

FIG. 1 is a diagrammatic view of one embodiment of the material of the invention.

FIG. 2 is a diagrammatic view of another embodiment of the material.

FIG. 3 is a diagrammatic view of still another embodiment of the material.

Referring now to the drawings, wherein like reference numerals designate like or corresponding parts throughout the several views, there is shown in FIG. 1, which illustrates a preferred embodiment of the acoustic energy absorbing material **10**, a base material **12**, within which are embedded or homogenously dispersed particles **14** of an acoustically active material, for example, particles of tourmaline. In this FIG. 1, the base material **12** is a conductive binder, such as conductive epoxy which is allowed to solidify by the action of a catalyst. Typical conductive epoxies are those manufactured by Emerson & Cuming, Inc., of Canton, Mass., such as the one-component Eccobond Solder 58C, which requires heat for curing, and the two-component Eccobond Solder 70C, which can be cured at room temperature. A typical non-epoxy type conductive binder is the Eccobond Solder 56C by the same manufacturer. If in a non-solid form, the acoustic energy-absorbing material **10** would be immersed in a container **16**.

In another embodiment of the acoustic energy-absorbing material **10**, shown in FIG. 2, the particles of the acoustically active material **14** are coated with an electrically conductive material **18**, for example, by electroless deposition, the coated particles then being immersed in a base material or binder **12**, which in this case need not be conductive.

It should be pointed out that, by adding suitable portions of other materials, such as glass microballoons, which consist of small glass balls enclosing a gas at low pressure, the propagation velocity c or density ρ may be independently controlled. A given proportion of microballoons will increase the propagation velocity, at the same time reducing the density to perhaps a lower value than desired. Some other inert material with suitable acoustic properties may then be added which will increase the density. Inasmuch as polyurethane is manufactured with a wide range of physical properties, it also may be used to control the propagation velocity or the density of the final form of the acoustic energy-absorbing material. Some silicone rubbers may also be used.

FIG. 3 shows an embodiment of the acoustic energy-absorbing material **10** in which the acoustically active particles **14** of FIG. 1 are dispersed in the binder **12** as are micro-balloons **20**.

Although a container **16** is shown in phantom view in all figures, inasmuch as a liquid or viscous binder **12** may be used, if the binder be of the type which can solidify, the container would then, of course, no longer be required. Alternatively, the particles of acoustically active material **14** may be mixed with a solid conductive binder in powdered form, and then pressed in a die to form a free-standing mass of acoustic energy-absorbing material **10**.

Not all piezoelectric or ferroelectric materials may be used for the purposes of this invention. The following piezoelectric materials have been found useful: tourmaline, lithium sulfate monohydrate and tartaric acid, although care must be exercised when using the last two named materials, since the first of the two is deliquescent while tartaric acid is hygroscopic.

The following ferroelectric materials have been empirically determined to be useful for the purposes of this invention: lead metaniobate, barium titanate, and other ceramic transducer materials.

The particles of acoustically active material may be coated by electroless deposition, by spraying of the liquid metal on the pulverized particles or by vacuum deposition. If the conductive coating be graphite it may be deposited in the form of the product known under the tradename of "Aquadag."

The particle size of the acoustically active material must be smaller then the wavelength of the highest frequency to be absorbed.

While the size of the conductive particles is not critical, they must be small enough so that the pressure, caused by the incident acoustic wave, on all sides of a particle must be substantially the same, that is, there should be no significant pressure differential between any two portions of the particle. Under these conditions, the particles are said to be "hydrostatically sensitive."

The operational principles are not affected by hydrostatic pressure, so that depth limitation is not involved.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An acoustic energy-absorbing material comprising:
a base material;
particles of an acoustically active material;
an electrically conductive material surrounding said particles;
the particles with their electrically conductive material being distributed homogenously within the base material;
the resultant energy-absorbing material having a predetermined density and a predetermined velocity of propagation.

2. An acoustic energy-absorbing material as recited in claim **1**, wherein;
the resultant energy-absorbing material has a density and velocity of propagation equal to that of sea water.

3. An acoustic energy-absorbing material as recited in claim **2**, wherein:
said base material and said electrically conductive material together comprise a conductive epoxy.

4. An acoustic energy-absorbing material as recited in claim **2**, wherein:
the acoustically active material is a piezoelectric material.

5. An acoustic energy-absorbing material as recited in claim **4**, wherein:
the piezoelectric material is tourmaline.

6. An acoustic energy-absorbing material as recited in claim **2**, wherein:
the acoustically active material is a ferroelectric material.

7. An acoustic energy-absorbing material as recited in claim **6**, wherein:
the ferroelectric material is lead metaniobate.

8. An acoustic energy-absorbing material as recited in claim **2**, wherein:
the electrically conductive material is the base material.

9. An acoustic energy-absorbing material as recited in claim **2**, wherein:
the electrically conductive material surrounding said particles is a conductive coating upon said particles.

10. An acoustic energy-absorbing material as recited in claim **9**, wherein:
the coating is an electroless deposition.

11. An acoustic energy-absorbing material as recited in claim **9**, wherein:
the coating is a layer of carbon.

12. An acoustic energy-absorbing material as recited in claim **1** wherein:
the particles are smaller than the wavelength of the highest frequency to be absorbed.

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