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Igarashi et al.

[11] **3,774,718**

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[54] **IN-SITU ACOUSTIC SEDIMENT PROBE**

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[52] **U.S. Cl.**..... **181/.5 NP,** 181/.5 BE, 73/170 A, 73/152, 175/50, 175/67

[51] **Int. Cl.**..... **E21c 39/00**

[58] **Field of Search**..... 181/.5 BE, .5 NP, 181/.5 A; 340/7 R, 7 PC; 73/152, 170 R, 170 A, 421, 70; 175/67, 422, 50, 5

[56] **References Cited**

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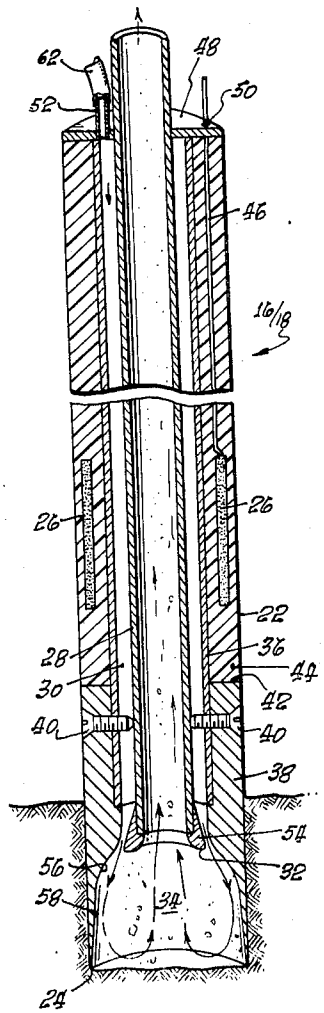
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Assistant Examiner—J. V. Doramus
Attorney—Richard S. Sciascia et al.

[57] **ABSTRACT**

An in-situ acoustic sediment probe which includes a barrel having a bottom cutting edge. An acoustic transducer is mounted on the barrel and means are mounted within the barrel for removing sediment adjacent to the cutting edge as the barrel penetrates the sediment. The sediment removing means may include an open-ended tube concentrically mounted within the barrel so as to provide an annular water passage between the barrel and the tube. The tube has a bottom end which is spaced above the bottom cutting edge of the barrel so that upon forcing water through the water passage the water will jet into the barrel space below the tube, remove sediment, and displace the sediment upwardly through the tube. In this manner, the sediment adjacent to the transducer will remain substantially undisturbed so that more accurate acoustic data can be obtained with the probe.

10 Claims, 3 Drawing Figures



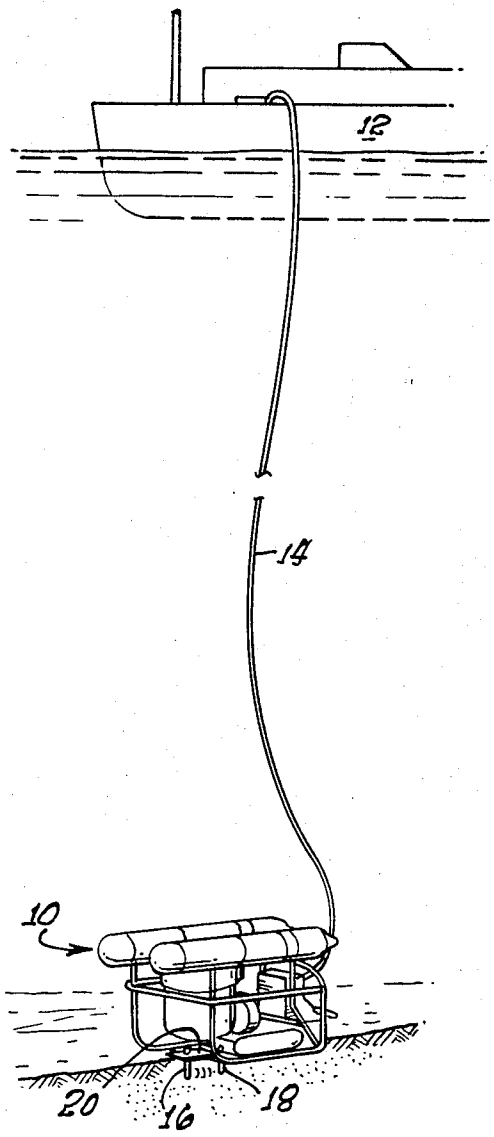

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FIG. 1.

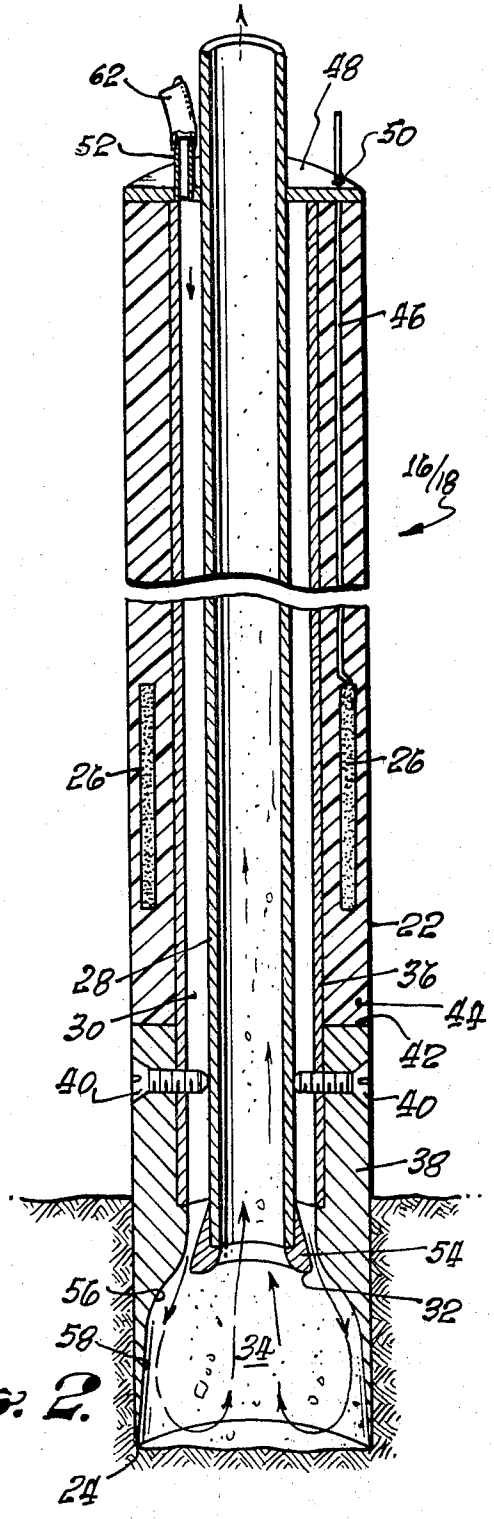
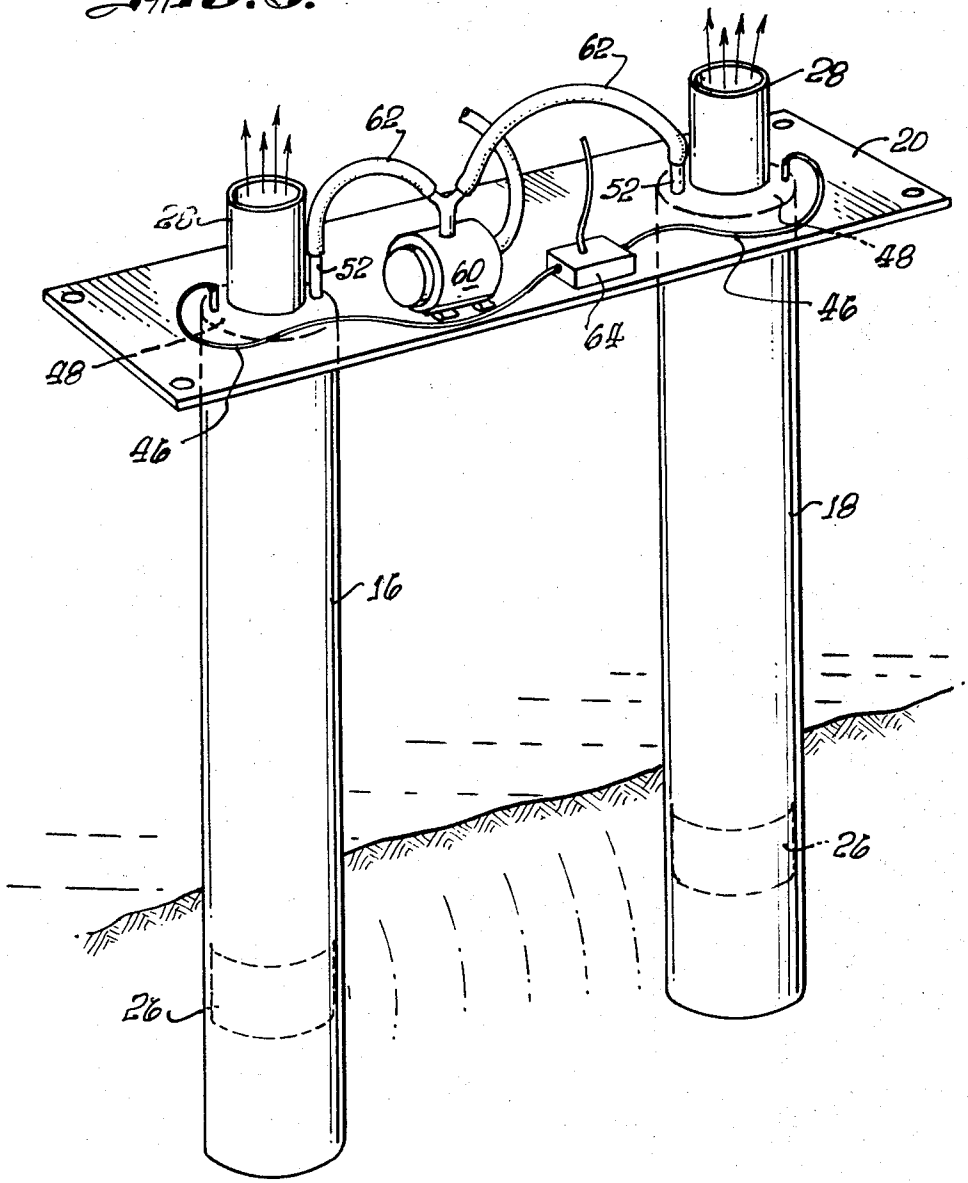

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FIG. 2.

Fig. 3.



IN-SITU ACOUSTIC SEDIMENT PROBE

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

The present invention relates to an in-situ acoustic sediment probe which can be driven into sediment with substantially no disturbance of the sediment adjacent to its exterior wall.

Ocean-bottom sediment can be classified according to its acoustic properties by inserting a pair of spaced probes within the sediment. One probe transmits an acoustic signal and the other probe receives the signal. These signals are then compared to determine the speed and attenuation of sound within the particular sediment in question.

A prior method of obtaining acoustic data of ocean sediment consisting of driving solid cylinder acoustic probes with conical points into the sediment. This type of configuration disturbed the sediment surrounding the probe since the conical point deflected the sediment laterally upon penetration. This disturbance resulted in erroneous data. Further, in marine sediments with a high sand content, measurements at desired depths were often impossible because of the resistance to penetration of a solid probe.

SUMMARY OF THE INVENTION

The present invention provides an acoustic sediment probe which can be easily inserted into marine sediment with substantially no disturbance of the sediment adjacent to the exterior wall of the probe. This has been accomplished by providing a barrel which has a bottom cutting edge, a transducer mounted on the barrel, and means mounted within the barrel for removing sediment adjacent to the inside cutting edge as the barrel penetrates the sediment. The sediment-removing means may include an open ended tube concentrically mounted within the barrel so as to provide an annular passage between the barrel and the tube. The tube has a bottom end which is spaced above the bottom cutting edge of the barrel so that upon forcing water through the water passage the water will get into the barrel space below the tube, remove sediment therefrom, and displace the sediment upwardly through the tube. In this manner, a sediment core with substantially the same diameter as the barrel is removed as the barrel penetrates the ocean bottom. Sediment adjacent to the barrel is left substantially undisturbed so that sediment sound speed and attenuation can be measured under true in-situ conditions.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an in-situ acoustic sediment probe which can be inserted into soil or sediment with substantially no disturbance thereof.

Another object is to provide an in-situ sediment probe which can be easily inserted into sandy sediment and enable collection of accurate acoustic data.

A further object is to provide a method of enabling a more accurate determination of the acoustic properties of a material.

Other objects, advantages, and novel features of the invention will become apparent from the following detailed description of the invention, when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical ocean view of the sediment probes mounted on a work vehicle which is tethered to a surface ship.

FIG. 2 is a longitudinal vertical cross-section view of the sediment probe.

FIG. 3 is an isometric view of a pair of laterally spaced probes mounted on a horizontal member which is removed from the work vehicle to illustrate various details.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings there is shown in FIG. 1 a submerged work vehicle **10** which is tethered to a surface ship **12** by a cable **14** for desired movements and work functions within the water. A pair of the present acoustic probes **16** and **18** may be mounted in a laterally spaced relationship on the work vehicle **10** by a horizontal member **20.** The probe **16** may be adapted for transmitting acoustic signals and the probe **18** may be adapted for receiving these signals. When the work vehicle is lowered so that the probes **16** and **18** are allowed to penetrate the ocean bottom this acoustic transmission will enable a determination of sound velocity and attenuation characteristics of the sediment. The work vehicle **10** is merely a typical platform for the probes **16** and **18,** and it should be understood that other platforms, such as independently operating submarine vehicles, or even divers, could place the probes into position.

In FIG. 2 there is shown an illustrative embodiment of the present acoustic sediment probe **16** or **18.** This probe includes a barrel assembly **22** which has a bottom cutting edge **24.** A transducer **26,** for either transmitting or receiving acoustic signals, is mounted on the barrel assembly **22.** It is important that when the probe penetrates the ocean bottom that the sediment surrounding the transducer **26** be substantially undisturbed. In this manner, the acoustic data obtained will more nearly indicate the true characteristics of the sediment in question. This has been accomplished by providing the probe with means in the barrel assembly **22** for removing sediment adjacent the inside of the cutting edge **24** as the barrel penetrates the ocean bottom.

The sediment removing means may include an open ended sediment discharge tube **28** which is concentrically mounted within the barrel assembly **22** so as to provide an annular water passage **30** between the barrel **22** and the tube **28.** The tube **28** has a bottom end **32** which is spaced above the bottom cutting edge **24** so as to provide a sediment removing chamber **34** therebetween.

The barrel **22** may include a tube **36** and a cutting head **38** which is mounted to the tube **36** by any simple means such as bolts **40.** These bolts **40** may extend inwardly beyond the tube **36** so as to concentrically position the bottom end of the sediment discharge tube **28** within the barrel assembly **22.** The cutting head **38** may have a top end **42** which radially extends from the barrel tube **36.** An elastomeric jacket **44,** such as polyethylene, may be mounted about the barrel tube **36** above

and substantially coextensive with the exterior surface of the cutting head **38.** In this manner the probe **22** has a smooth exterior surface along its entire length. The transducer **26** may be embedded in the elastomeric jacket **44** along with its connecting wire **46.**

As illustrated in FIG. **2** the top end of the barrel assembly **22** may be closed by a plate **48.** The tube **28** may extend through this plate **48** and be open at its top for the discharge of sediment as will be described in more detail hereinbelow. The plate **48** also serves as a means for positioning the top end of the sediment discharge tube **28** within the barrel assembly **22.** The wire **46** may exit the plate **48** through a plug **50** and the plate **48** may be provided with a fitting **52** for introducing water under pressure into the annular water passage **30.**

It is desirable that water exiting the bottom of the water passage **30** and entering the sediment removing chamber **34** efficiently remove the sediment therefrom so that there is a minimum of disturbance to the sediment surrounding the exterior of the probe. This function can be enhanced by providing the bottom of the tube **28** with a flare **54** so that the water will jet outwardly in the sediment removing chamber **34.** This jetting action can be optimized by providing the inside surface of the barrel cutting head **38** with a first rapidly diverging portion **56** and then a more gradual diverging portion **58** in the sediment removing chamber **34.** This uniquely configured cutting head causes inward deflection of the sediment and almost no outward deflection so as to produce minimum disturbance to the sediment adjacent to the exterior of the barrel assembly **22.** The annular jet of water from the water passage **30** cuts out the sediment along the thin cross section of the cutting head **38** and circulates the mixture of water and sediment upwardly into the tube **28.**

In FIG. **3** the work vehicle, the member **20** has been shown removed so that various details can be described more fully. The top plates **48** of the probes **16** and **18** may be mounted to the bottom side of the member **20** with the sediment discharge tubes **28** and the water fittings **52** extending therethrough. A pump **60** may be mounted on the top of the member **20** and the water fittings **52** may be joined thereto by water hoses **62.** In this manner the pump **60** will be capable of pumping water through the hoses **62** into the annular water passages **30** (see FIG. **2**) of the probes **16** and **18.** A pressure-limiting device (not shown) may be included either internal to or external to the pump. Also there may be mounted on the member **20** an electronics relay box **64** for relaying the transmitted and received acoustic signals from and to the surface ship. The wires **46** from the transducers **26** of the probes **16** and **18** extend through the member **20** and are connected to this relay box **64.** Accordingly, the transmitted acoustic signals of **16** are received by the probe **18** and these received signals provide the data which enables classifying the sediment of the ocean bottom.

OPERATION OF THE INVENTION

In the operation of the invention the surface ship **12** may control the work vehicle **10** so that it is lowered until the probes **16** and **18** engage the ocean bottom. The pump **60** is on so that further lowering of the work vehicle **10** causes the probes **16** and **18** to easily penetrate the ocean bottom. During penetration water is pumped through the water passages **30** into the sediment removing chambers **34.** This action loosens the sediment and forms a water sediment mixture which is forced upwardly within the sediment discharge tubes **28** and finally discharged through the tops thereof. After the probes **16** and **18** have been penetrated within the ocean bottom to a desired depth acoustic signals are transmitted from the probe **16** and received by the probe **18.** It can readily be understood that the sediment between the probes has been substantially undisturbed since all sediment represented by the penetrated volumes of the probes **16** has been removed.

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.

We claim:

1. An in-situ acoustic sediment probe comprising:
a barrel assembly having a bottom cutting edge;
a transducer mounted on the barrel assembly outside the inner surface thereof;
means mounted within the barrel assembly for removing sediment adjacent the inside cutting edge and discharging the sediment through the barrel assembly as the barrel penetrates the sediment,
whereby sediment adjacent the exterior of the barrel assembly is substantially undisturbed for acoustic transmission.

2. A probe as claimed in claim **1** wherein the sediment removing means includes:
an open ended tube concentrically mounted within the barrel assembly so as to provide an annular water passage between the barrel assembly and the tube; and
said tube having a bottom end which is spaced above the bottom cutting edge of the barrel assembly
whereby upon forcing water through the water passage the water will jet into the barrel space below the tube, remove sediment, and displace the sediment upwardly through said tube.

3. A probe as claimed in claim **2** including:
the bottom end of the tube being flared so that water leaving the water passage will jet outwardly in the barrel space below the tube.

4. A probe as claimed in claim **3** including:
the inside surface of the barrel assembly below the tube first rapidly diverging and then gradually diverging to the bottom cutting edge of the barrel assembly.

5. A probe as claimed in claim **2** including:
said barrel assembly comprising:
a tube;
a cutting head concentrically mounted to the barrel tube and having a top end which radially extends from the barrel tube;
an elastomeric jacket mounted about the barrel tube and substantially coextensive with the exterior surface of the cutting head; and
said transducer being imbedded in the elastomeric jacket.

6. A probe as claimed in claim **2** including:
means closing the top end of the barrel assembly; and
the closing means having a water inlet which opens into the water passage between the barrel assembly and the tube.

7. A probe as claimed in claim **6** including:

said tube extending through the top closed end of the barrel assembly.

8. A probe as claimed in claim **7** including:

the bottom end of the tube being flared so that water leaving the water passage will jet outwardly in the barrel space below the tube.

9. A probe as claimed in claim **8** including:

the inside surface of the barrel assembly below the tube first rapidly diverging and then gradually diverging to the bottom cutting edge of the barrel assembly.

10. A probe as claimed in claim **9** wherein:

said barrel assembly comprises:

a tube;

a cutting head concentrically mounted to the barrel tube and having a top end which radially extends from the tube;

an elastomeric jacket mounted about the barrel tube and substantially coextensive with the interior surface of the cutting head; and

said transducer being imbedded in the elastomeric jacket.

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