Nov. 3, 1970 R. L. STEWART ETAL 3,537,316

UNDERWAY WATER SAMPLER

Filed Jan. 25, 1968 2 Sheets-Sheet 1

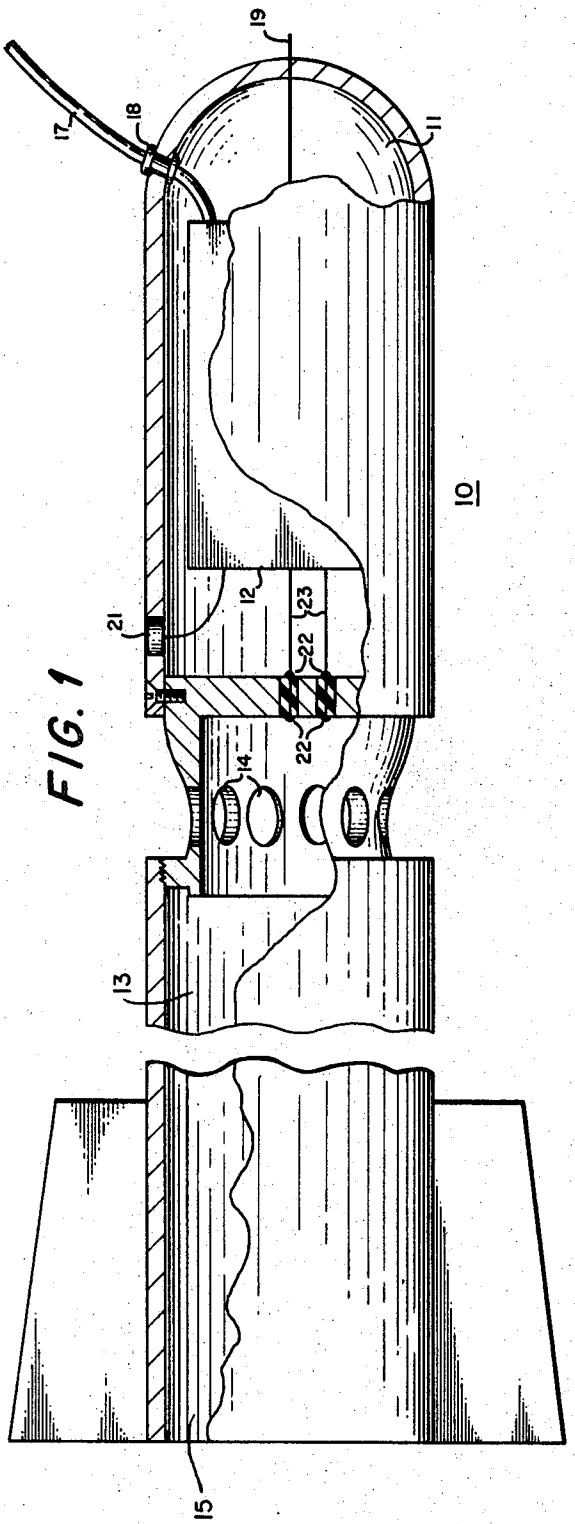

FIG. 1

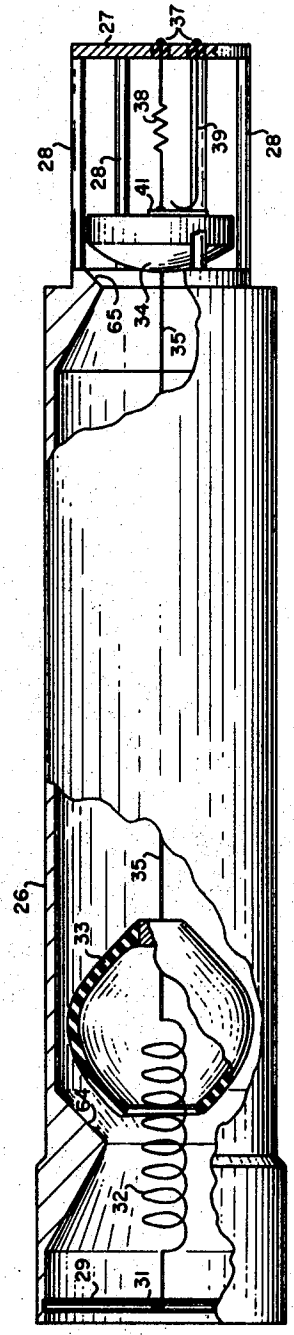

FIG. 2

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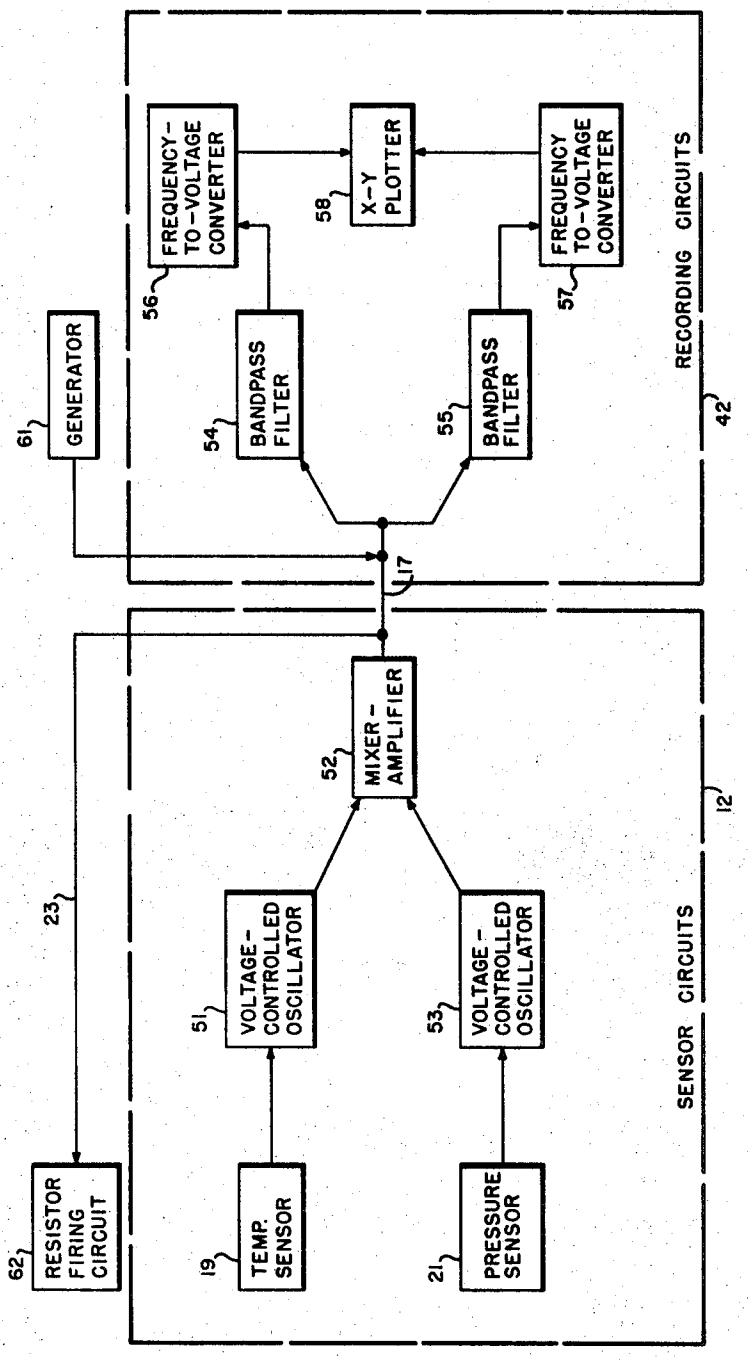
FIG. 3



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UNDERWAY WATER SAMPLER

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ABSTRACT OF THE DISCLOSURE

A liquid sampling apparatus having a chamber with a valve closure system which can be selectively triggered to capture a sample of liquid while the apparatus is being towed from a ship. Electronic pressure and temperature sensor systems are located within the submerged apparatus and supply information to an X–Y plot located above the surface aboard the towing ship so that a liquid sample can be collected based upon the information thus obtained.

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 a liquid sampling apparatus and more particularly to an underway water sampler which is designed to obtain seawater samples when being towed from a ship while the ship is underway.

In the past it has been the general practice to employ seawater sampling devices which could only be utilized if the ship from which the sampler was to be lowered was slowed or stopped dead in the water. In addition, these prior art sampling devices had to be preset so that the seawater sample obtained had to come from a depth which was determined prior to the lowering of the device into the water. Although such devices have served the purpose, they have not proved entirely satisfactory under all conditions of service. The limitation in the use of these prior art sampling devices which required the ship to stop prior to the lowering of the device into the water has been a very great restriction upon the utilization of these devices and has precluded their use aboard ships of opportunity (commercial vessels) since requiring these ships to stop interfers with their normal operations and schedules.

SUMMARY OF THE INVENTION

The general purpose of this invention is to provide a liquid sampling apparatus which embraces all the advantages of similarly employed devices and possesses none of the aforedescribed disadvantages. To obtain this the present invention contemplates a unique water sampler that is adapted to be towed behind a ship while the ship is underway. The invention also contemplates the use of a temperature and pressure sensor within the sampler, which are electronically associated with an X–Y plotter that is located aboard the towing ship so that when the desired conditions of temperature and pressure are sensed by the sampler a triggering system may be actuated from the towing ship so as to trap a water sample within the bottle portion of the sampler.

It is, therefore, an object of the present invention to provide a water sampler that can be operated while the ship from which it is being towed is underway and without requiring a reduction in speed of the towing ship.

Another object is to provide an underway water sampler wherein a sample can be collected from any desired depth based upon information obtained by observing an X–Y plot of temperature vs. depth.

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following description of the preferred embodiment of the invention as illustrated in the accompanying sheets of drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a sectional view, partly in block diagram form, of a preferred embodiment of the housing assembly of the invention;

FIG. 2 shows a sectional view of a preferred embodiment of the bottle portion of the invention; and

FIG. 3 shows, in block diagram form, the pressure and temperature sensing circuits and associated recording and firing circuits of the underway water sampler.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 the housing assembly of the underway water sampler. This assembly **10** includes a forward portion that encloses a cavity **11** within which are located sensor circuits **12** the details of which are illustrated in FIG. 3. The housing assembly **10** also includes a hollow after chamber **13**, a series of holes **14** and an open end **15** all of which are adapted to permit water to flow through the after chamber **13** when the housing assembly **10** is being towed through the water.

In addition, the underway water sampler of FIG. 1 includes a line **17** which is coupled to the housing assembly **10** at point **18**. This line **17** is used to tow the sampler in a submerged position behind a ship, and is also utilized to pass electrical signals from the towing ship to the circuits located within the housing assembly **10** as well as to pass electrical signals from the sensor circuits **12** to the recording circuits **42** aboard ship. A temperature sensor **19** extends through the housing **10** and is coupled to the sensor circuits **12**, as is shown in more detail in FIG. 3. Similarly, a pressure sensor **21** is exposed to the exterior of the housing **10** and is also coupled to sensor circuits **12**. Also included within the forward chamber **11** of the housing assembly **10** are electrical terminals **22** which are electrically coupled to the sensor circuits **12** and to the line **17**, again as is shown in more detail in FIG. 3.

Referring now to FIG. 2 there is shown the removable bottle portion of the underway sampler which includes an exterior housing **26** that is connected to a frontal plate **27** by means of a plurality of struts **28** that are circularly spaced apart from one another. A supporting rod **29** is connected to the housing **26** at the after end of the housing and includes an anchoring point **31** to which a spring **32** is connected. This spring **32** is connected to a valve closure **33**, which in turn, is connected to valve closure **34** by rod **35**. A pair of electrical terminals **37** are located on the exterior side of the frontal plate **27** and are electrically coupled to triggering resistor **38** and to return lead **39**. The resistor and return lead are also electically connected by means of a metallic plate **41** located on the forward side of valve closure **34**.

In the operation of the underway water sampler the bottle portion of the sampler, as shown in FIG. 2, is first inserted into the after cavity **13** of the housing assembly of FIG. 1. This bottle portion is locked in place within the cavity **13** by means of a locking mechanism

(not shown) which causes the electrical terminals **37** to contact the terminals **22**. The sampler is then lowered into the water from the towing ship by means of the line **17** according to conventional or loop-drop launching techniques. The sampler is then towed behind the towing ship and during this time water continually passes through holes **14** and between supporting struts **28** into the interior of the bottle which is secured within the cavity **13**. The water then flows through the interior of the bottle and around the valve closure **33** out the after end of the bottle and of the housing assembly at **15**. Thus, a continuous valume of sea water passes through the bottle and out its after end as the sampler is being towed.

Referring now to FIG. 3, there is shown, in block diagram form, the sensor circuits **12** which are located within the forward cavity **11** of the underway water sampler, and the recording circuits **42** which are located aboard the towing ship. The temperature sensor **19**, in response to the water temperature, determines the feaquency output of a voltage-controlled oscillator **51**, which in turn, is coupled to a mixer amplifier **52**. Similarly, the pressure sensor **21** continuously senses the pressure of the water, which is directly related to depth, and determines the frequency output of a voltage-controlled oscillator **53** that is coupled to the same mixer amplifier **52**. The resulting signal at the output of mixer amplifier **52** is transmitted via line **17** up to the towing ship and to the recording circuits **42** located thereon. Upon reaching the recording circuits **42**, the output signal from mixer amplifier **52** is divided and introduced to the inputs of filters **54** and **55**. Because the frequency range for each of the voltage-controlled oscillators **51** and **53** is known, and because these ranges are different, filter **54** is set so as to pass the frequencies generated by voltage-controlled oscillator **51** while filter **55** is set so as to pass the frequencies of voltage-controlled oscillator **53**. In this way the temperature information is separated from the pressure information.

The signals, after having passed through filters **54** and **55**, are fed into respective frequency-to-voltage converters **56** and **57**, which convert the frequencies originally generated by oscillators **51** and **53** to voltages that are proportional to the temperature sensed by the temperature sensor **19** and to the pressure sensed by sensor **21**, respectively. The outputs of these frequency-to-voltage converters, in turn, are then fed into X–Y plotter **58**.

Thus, as the underway water sampler is towed through the water by the ship, a continuous X–Y plot of temperture vs. pressure is obtained on the plotter **58**. By observing this X–Y plot an accurate determination of the temperature of the water and of the depth of the sampler can be maintained until the desired conditions are present to capture a sample of water. When the desired conditions occur a signal generator **61**, also located aboard the towing ship, is activated so as to transmit a triggering signal down through line **17** and through lines **23** into resistor firing circuit **62**. This firing circuit could be of many configurations, but for the purpose of illustration it is herein described as including a firing resistor **38** which normally holds the valve closures **33** and **34** in an open condition. When the generator **61** is activated, the resistor firing circuit **62** is energized and an extremely large voltage is impressed across the firing resistor **38** so that it is completely burned up, thus allowing the spring **32** to contract and to pull the valve closures **33** and **34** so as to close on their respective valve seats, **64** and **65**. This closing of the valve closures **33** and **34** traps the desired water sample within the bottle and retains it. In order to remove the water sample from the bottle the sampler must first be taken aboard the towing ship and the bottle removed from the cavity **13** of the housing assembly. At this point, a petcock (not shown) located on the bottle allows the water sample to be drained off in desired amounts for test purposes.

This invention provides for a water sampler that can be utilized in conjunction with a ship that is underway and does not require that the ship reduce its speed or stop in order for the water sampler to be operative. Thus, this device can be used aboard commercial vessels without interfering with their normal operations or schedules, and as a result, will greatly expand the number of ships that can aid in the taking of ocean samples all over the world. This underway water sampler also is provided with sensing circuits which accurately determine the temperature and depth at which the sampler is located so that the desired conditions are present when the sample is taken.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A water sampler adapted to be towed behind a ship underway, comprising:

a housing assembly having first and second axially aligned cavities formed therein and having opening formed in said housing adjacent both ends of said first cavity;

a bottle having exterior dimensions substantially the same as the interior dimensions of said first cavity and removably fittable within said first cavity and having openings at both ends;

means within said second cavity for sensing predetermined characteristics of water adjacent to the sampler as the sampler is being towed through the water;

means mounted upon said ship and operatively associated with said sensing means for recording said predetermined characteristics; and

means associated with said bottle for selectively closing the openings therein by remote control from said ship so as to trap a sample of water therein from any depth of the water while the ship is underway.

2. The water sampler of claim **1** wherein said sensing means includes:

at least one temperature sensor extending through said housing assembly;

at least one pressure sensor integral with said housing assembly;

at least two voltage-controlled oscillators, one each associated with a respective one of said temperature and pressure sensors; and

a mixer-amplifier associated with each of said voltage-controlled oscillators.

3. A water sampler adapted to be towed behind a ship underway, comprising:

a housing assembly having a forward cavity, and an after cavity, with at least one opening in said housing adjacent to the forward end of said after cavity and at least one opening in said housing adjacent to the after end of said after cavity to enable water to flow therethrough when the sampler is being towed;

a collecting bottle having an exterior shape generally similar to the inside dimensions of said after cavity so as to be insertable therein and having openings at opposite ends;

means within said forward cavity for sensing predetermined characteristics of water adjacent to the sampler; and means operatively associated with said bottle for selectively closing the openings of said bottle by remote control from said ship so as to trap water therein when desired water characteristics are sensed by said sensing means.

4. The sampler of claim **3** further including:

means mounted upon said ship and operatively associated with said sensing means for recording said predetermined characteristics.

5. The sampler of claim 4 wherein said closing means includes:

a generator;

a firing circuit within said bottle and in circuit relationship with said generator;

a first valve closure normally fixedly attached to said firing circuit and oriented so as to close a first one of said bottle openings only upon the activation of said firing circuit;

a second valve closure mechanically coupled to said first valve closure and oriented so as to close the second one of said openings in said bottle only upon the activation of said firing circuit; and

resilient means fixed between an end of said bottle and said second valve closure for forcing said valve closures to close said bottle openings upon the activation of said firing circuit.

6. A water sampler adapted to be towed behind a ship underway, comprising:

a housing assembly having at least one cavity therein with openings in said housing adjacent both ends of said cavity;

a bottle fittable within said one cavity and having openings at either end;

means associated with said bottle for selectively closing the openings therein by remote control from said ship so as to trap a sample of water therein from any depth of the water while said ship is underway;

said means including a generator mounted upon said ship; and

a firing circuit within said bottle and in electrical circuit relationship with said generator;

a first valve closure normally fixably attached to said firing circuit and oriented so as to close a first one of said openings in said bottle only upon the activation of said firing circuit;

a second valve closure mechanically coupled to said first valve closure and oriented so as to close the second one of said openings in said bottle only upon the activation of said firing circuit; and

resilient means fixed between an end of said bottle and said second valve closure for forcing said valve closures to close said bottle openings upon the activation of said firing circuit.

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