Oct. 11, 1966 R. H. BODMAN ETAL 3,277,723

FLUID SAMPLER

Filed May 8, 1964

3 Sheets-Sheet 1

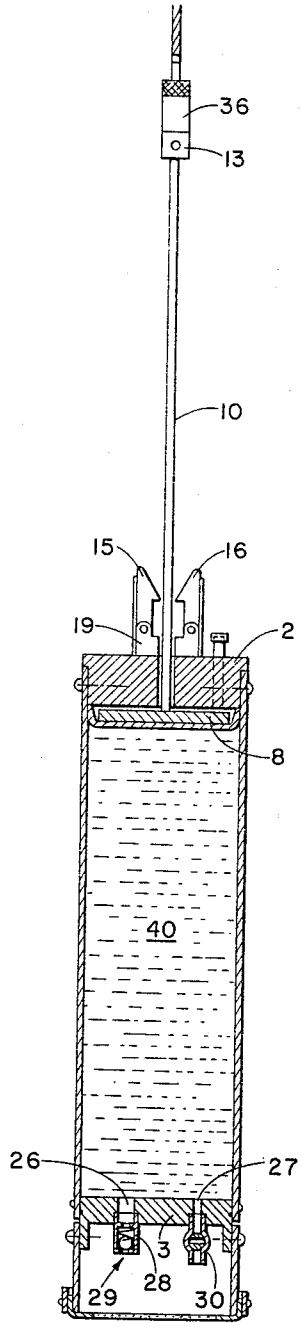


Fig. 2

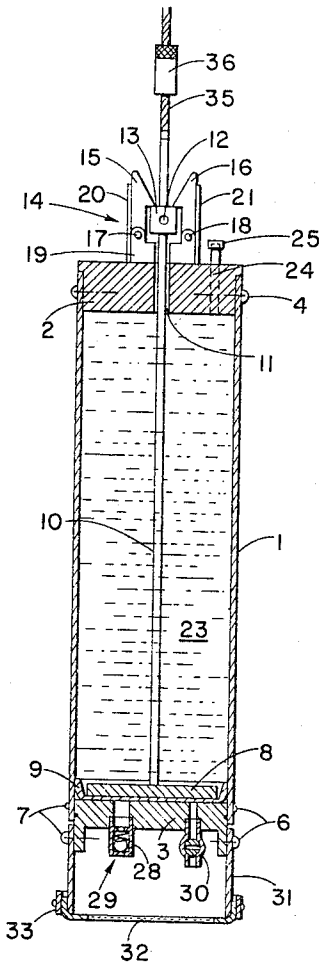


Fig. 1

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3 Sheets-Sheet 2

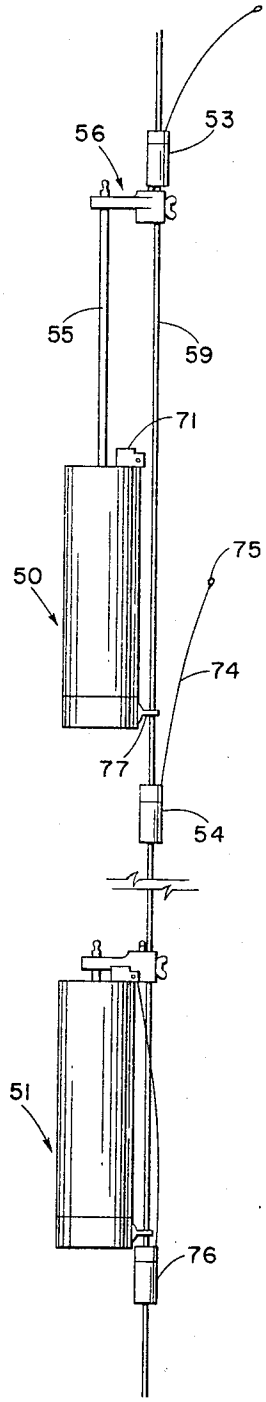


Fig. 4

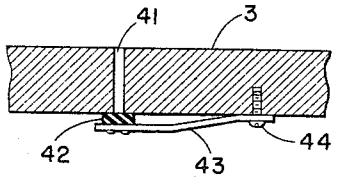


Fig. 3

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3 Sheets-Sheet 3

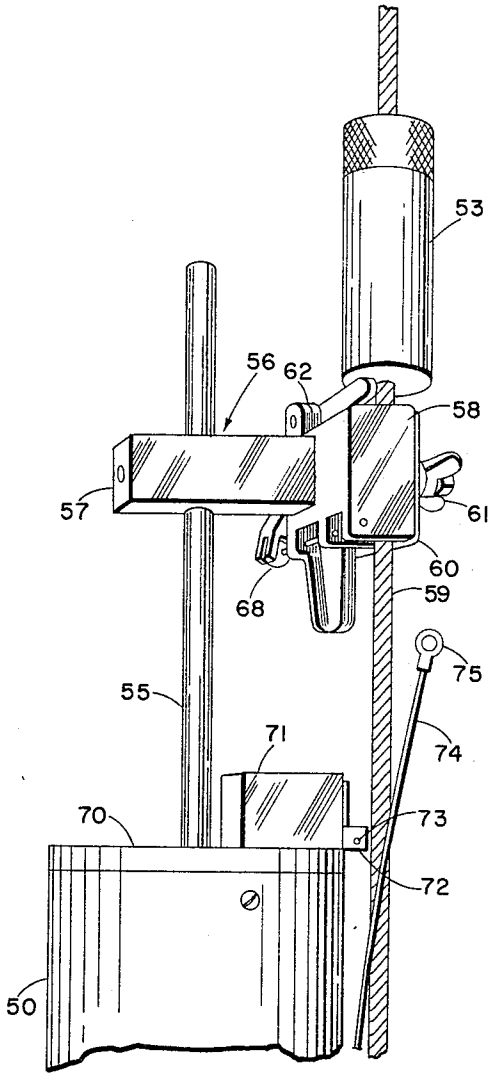


Fig. 5

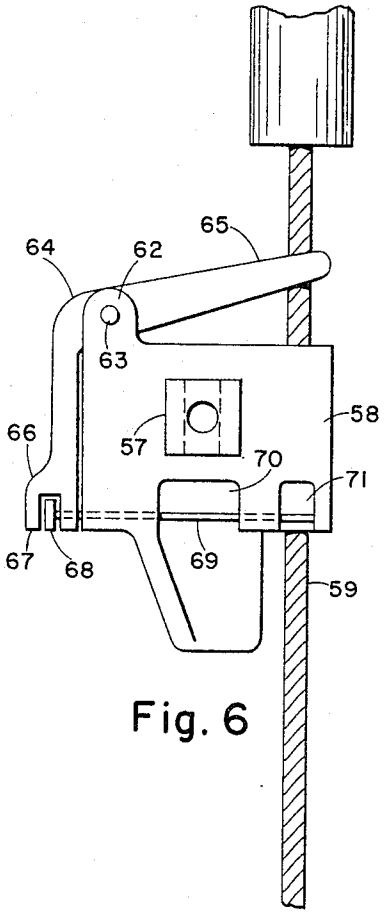


Fig. 6

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FLUID SAMPLER

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3 Claims. (Cl. 73—425.4)

The present invention relates generally to oceanographic apparatus and, more particularly, to a water sampler for obtaining uncontaminated samples of sea water at any desired depth.

It is common practice in oceanographic research to procure samples of sea water for analytical studies by lowering a device which is open at both ends to the desired depth and then releasing a weighted messenger down the supporting cable to close these ends and trap the water then present within the interior of the apparatus. Since this type of sampler is completely open to the sea water during its descent, there is no pressure problem and the apparatus can operate at any depth. However, one of the disadvantages of its open condition is that there is a continuous flow of sea water through its interior and if there is only partial flushing, the sample trapped within the apparatus may not be representative of the water and biological conditions at the closed depth. Also, in the case where the sampler is used to monitor the extent of radioactivity at different ocean levels, there is the additional possibility, because of its open condition, of prior contamination before it arrives at the depth under investigation.

It is accordingly a primary object of the present invention to provide a fluid sampler which produces an uncontaminated sample of the fluid for analytical studies.

Another object of the present invention is to provide a sea water sampler whose fluid storage area is not exposed to the surrounding sea during its descent.

A still further object of the present invention is to provide a water sampler which can work at any depth as a consequence of the filled condition of its fluid storage container.

A yet still further object of the present invention is to provide a fluid sampler which is filled with distilled water which can be discharged when the apparatus reaches a predetermined point to permit an equal amount of fluid from the surrounding medium to flow and then be stored therein.

A yet still further object of the present invention is to provide a fluid sampler of simple, reliable and rugged construction that can operate at any depth and, if desired, with companion samplers connected to the same lowering line.

Briefly and in general terms, the above objects of invention are realized in one preferred embodiment by utilizing as the fluid storage container a thin-walled, cylindrical casing, effectively closed off at both ends with a one-way check valve coupled to its lower end wall and a filling and discharge line passing through its upper end wall. Accommodated within this casing is a close-fitting piston whose piston rod passes through an aperture formed in its upper end wall. In one embodiment, the end of this rod is fixed to the end of the lowering cable. Prior to its descent and operation, the casing is latched to the piston rod in an upper position with the inner surface of its bottom end wall contacting or in close proximity to the lower face of the piston. In this standby condition, the complete interior of the casing, that is, the space above the piston, can be filled with distilled water through the above filling line. Because it is completely filled with distilled water during its descent, there is no possibility of the interior of the sampler being contaminated by the fluid in the surrounding sea. Neither, for the same reason, is there any pressure problem and the casing, therefore, may be of lightweight design.

After the apparatus is lowered to the desired depth, a weighted messenger is sent down the supporting cable to trip the latch mechanism. When so released, the unsupported casing, under its own weight, drops downwardly a distance corresponding to its over-all internal length, being stopped when the back face of the piston contacts the inner surface of the upper end wall of the casing. During its fall, the distilled water in the space above the piston discharges into the surrounding sea via the filling line, and an equal amount of sea water enters the lower part of the casing via the one-way check valve. There is, thus, a fluid interchange between the distilled water and the sea water; that is, as the distilled water is forced out of the sampler from the diminishing space above the piston, sea water flows into the expanding space below the piston. When the sampler is filled, the apparatus can be brought directly to the surface by reeling in the lowering cable. Since the back face of the piston is in contact with the upper end wall of the casing, the casing is supported in its lower position during its ascent. For draining the apparatus, a conventional petcock is included in the water inlet line leading to the interior of the casing.

In an alternative embodiment, a pair of these samplers are connected in tandem to the lowering cable and a second messenger is suspended from the latch mechanism of the upper sampler so that, when this sampler is operated in the manner described above simultaneously with its fall, this second messenger is sent further down the cable to operate the second sampler. As many samplers as desired can be coupled to the same line in order to procure water samples at a multiplicity of different depths from a single lowering operation.

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:

FIG. 1 illustrates a fluid sampler constructed in accordance with the present invention in its pre-descent or primed condition;

FIG. 2 illustrates a fluid sampler after it has been triggered by the messenger and filled with a fluid sample;

FIG. 3 illustrates a simplified pressure relief valve that may be built into the apparatus of FIG. 1;

FIG. 4 illustrates an arrangement wherein a pair of fluid samplers are connected in tandem to the same lowering line;

FIG. 5 illustrates the release mechanism utilized in the arrangement of FIG. 4; and

FIG. 6 illustrates additional details of the release mechanism.

Referring now to FIG. 1 of the drawings which depicts one embodiment of the invention in its pre-descent condition, it will be seen that the fluid sampler includes as its storage element a relatively thin-walled, cylindrical casing **1** which is closed off at each end so as to be fluidtight by end closure plates **2** and **3** secured thereto by suitable fastening means, such as bolts **4**, **5**, **6** and **7**. Accommodated within casing **1** is a piston **8** having a closely fitting Teflon sealing ring **9** affixed thereto and a piston rod **10** which passes through a bore **11** cut centrally through end plate **2**. Fastened to piston rod **10** at a point adjacent its end by a conventional locking device **12** is a circular collar **13** to which, as will be seen hereinafter, casing **1** is latched prior to and during the descent of the fluid sampler.

End closure plate **2** also serves as the support for the casing release mechanism **14**. This mechanism includes

a pair of latch members **15** and **16** which are hinged at **17** and **18** to a base member **19** affixed to the top of the end plate **2**. Each of the latch members **15** and **16** has a flat spring **20** and **21** attached to its rear surface, and these springs extend down behind an upright portion of base member **19**. It will be appreciated that springs **20** and **21** act to maintain latch members **15** and **16** in the vertical position shown, thereby locking these members to collar **13** and at the same time latching casing **1** at its upper position.

When casing **1** is in this upper position, as shown in FIG. 1, its complete interior, that is, the space above piston **8**, can be filled with distilled water **23** by means of a filling line **22** passing through end cover plate **2**. To keep this line unclogged, a suitable screen, not shown, and a retaining cap **25** may be fastened to the otherwise open end of this line.

End clossure plate **3**, the lower plate, has a pair of apertures **26** and **27** cut therethrough which provide access into the interior of casing **1**. Threaded into aperture **26** is a water inlet line **28** which has fastened to its lower end a conventional ball-type check valve **29**. This valve, which is spring biased to a closed condition, allows a one-way flow of fluid from the surrounding environment into the interior of casing **1** when the external pressure exceeds the interior pressure by a given amount. Since the fluid sampler is sent down into a completely filled condition, valve **29** remains closed during the descent of the apparatus, opening only, if at all, to introduce into the sampler sufficient water to equalize the pressure within the casing and the environmental pressure.

Also fastened to lower end plate **3** by conventional means and coupled to aperture **27** is a conventional drain valve **30**. This valve, it will be appreciated, is normally closed and can be manually opened after the sampling operation has been completed to drain the device. In order to protect valve **29** from fouling, contamination or accidental damage and at the same time provide the sampler with a conventional rest stand, a protective sleeve **31** is detachably fastened to end plate **3**. The lower end of this sleeve is covered by a suitable screen **32** held in place by a clamping band **33**.

To prepare the sampler of the present invention for operation, piston **8** is depressed to the position shown in FIG. 1, casing **1** is latched to collar **13** and the interior of the apparatus is filled with distilled water via filling line **24**. To expedite this last operation, cap **25** and the screen associated therewith may be temporarily removed from the apparatus. Next, the apparatus is connected to the end of the lowering cable **35** and dropped to the desired depth. Once this depth has been reached, the operator need only send a weighted messenger, such as **36**, down the lowering cable to procure the water sample. When this messenger strikes release mechanism **14**, it, of course, forces latches **15** and **16** out of locking engagement with collar **13**, overcoming the opposing effect of springs **20** and **21**, and casing **1**, now unsupported, falls free under its own weight, dropping a distance approximately equal to its internal length and being stopped when the back face of piston **8** contacts the innerwall surface of top closure plate **2**. As casing **1** falls free, the distilled water **23** in its interior is forced out through filling line **24** into the surrounding sea. As this discharge takes place, the pressure in the interior of the casing the piston drops below the outside pressure and valve **29** opens to admit sea water into this area. Thus, as casing **1** continues to drop, distilled water flows out of the top of the sampler and sea water flows into the bottom of the sampler. When casing **1** reaches its final position, as shown in FIG. 2, its complete interior is thus filled with sea water **40** taken in at the desired depth. Since the back surface of piston **8** now contacts the inner surface of top cover plate **2**, casing **1** is supported in its lower position and the apparatus can be reeled in without disturbing the fluid sample stored therein.

When the fluid sampler of the present invention is filled at an extreme depth, the water stored therein is at a correspondingly high pressure. If such a pressure were not relieved, the water, during the draining operation, would spurt from the drain valve at a high velocity. To avoid this and insure a more controllable fluid flow, the apparatus of FIG. 1 can include as an optional feature a simple pressure relief valve of the type schematically shown in FIG. 3 Here, lower end plate **3** is provided with an additional aperture **41** which is adapted to be sealed shut by a suitable closure element **42** affixed to the free end of a bent spring member **43** whose other end is secured at **44** to the outer surface of this end plate. If spring **43** has the proper stiffness, aperture **41** will be periodically opened whenever the pressure within the casing exceeds the external pressure by a given amount. This simple arrangement, therefore, permits an intermittent flow of fluid out of the apparatus as it is raised so that when the sampler reaches the surface the fluid stored therein is at a nominal pressure.

FIG. 4 illustrates an arrangement which permits a pair or several fluid samplers, such as **50** and **51**, to be connected in series to a single lowering cable **52** for procuring water samples at different depths at a particular location. This figure shows the condition of the apparatus after an upper sampler **50** has been operated by messenger **53** and before its messenger **54** has triggered a lower sampler **51**.

For multiple sampling, as perhaps best seen in FIGS. 5 and 6, each piston rod **55** has attached thereto a casing release mechanism **56** of a modified design which includes a post **57** having a crossarm piece **58** depending therefrom. This crossarm is connected to the lowering cable **59** by means of a clamping plate **60** and a lock nut arrangement **61**. Formed in an upper portion of crossarm **58** are a pair of spaced ears **62** which are journalled to accept a stub shaft **63** which pivotally supports a release lever **64**. This release lever is normally maintained in the position shown in FIG. 6 by a coil spring, not shown, positioned about shaft **63**. One arm **65** of lever **64** extends to a position immediately adjacent cable **59** while another arm **66** is bifurcated at **67** to coact with the head **68** of a pull rod **69**. This pull rod passes through openings **70** and **71** formed in a lower portion of crossarm **58**.

The upper closure plate **70** of each casing in this design has mounted thereon a block member **71** which has a lower projecting portion **72** extending therefrom which contains an aperture **73** formed therethrough. When the casing of fluid sampler **50** is elevated to its upper or standby condition, block **71**, it will be appreciated, intimately fits into the L-shaped space formed by post **57** and crossarm **58**, and projecting portion **72** occupies space **71**. In this position, push rod **69** passes through aperture **73**, locking block **71** in place and preventing sampler **50** from dropping to its lower position. When sampler **50** is latched to its upper position, its messenger **54** is also suspended from push rod **69** by means of wire **74** having a loop connector **75** fastened thereto. Messenger **54**, of course, is also positioned on the lowering cable as shown in the lower portion of FIG. 4.

The operation of the apparatus of FIGS. 4 and 5 is as follows: When the first messenger **53** is dropped down the lowering cable and reaches casing release mechanism **56**, it strikes arm **65** of lever **64**, causing this lever to pivot in a clockwise direction as seen in FIG. 6. Push rod **69** is displaced to the left as seen in this figure and withdrawn from the aperture **73** formed in projection **72**, permitting sampler **50** and messenger **54** to drop down the cable. As sampler **50** falls, its interior is emptied of the distilled water stored therein, and sea water from the surrounding environment flows therein in the manner previously described. While sampler **50** is being filled, messenger **54** proceeds further down the cable to trigger lower sampler **51** and release its messenger **76** for activat-

ing a third fluid sampler, not shown. This action can be repeated for any number of fluid sampling units.

In order to insure that each of the samplers drops properly, the lower portion of the casing, as seen in FIG. 4, can be equipped with a suitable guide latch **77** that hooks around the lowering cable. These guide latches also prevent the sampler from swinging away from the lowering cable when the wire angle is excessive, a condition which would result in excessive strain being placed on the clamping release mechanism.

In the modification of FIG. 1, the open condition of the filling line allows some mixing to occur between the distilled water and the surrounding sea. However, the relatively small size of this line prevents this intermixing from reaching a significant level. Of course, a simple check valve can be affixed to the end of the filling line after the sampler has been filled to eliminate any intermixing. This valve, of course, should be mounted to permit only a one-way flow of fluid out of the sampler.

It will also be recognized that the fluid sampler can be filled with ordinary water or any other fluid of known composition and that the distilled water mentioned above need only be used where the most precise studies are 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. Apparatus for procuring an uncontaminated sample of fluid at a given depth within a fluid medium comprising, in combination,

a cylindrical casing closed off at opposite ends with upper and lower closure plates;

a central bore cut through said upper closure plate;

a piston accommodated within said casing and having a diameter approximately equal to the interior diameter of said casing;

a piston rod connected at one end to said piston and adapted to have its other end connected to a lowering cable,

said piston rod having a length such that when said piston is in contact with the lower end closure plate the other end of said rod projects through said central bore;

means for latching said casing to said piston rod such that said piston is retained against said lower closure plate, said last-named means including

a collar secured to said piston rod at a point adjacent said other end thereof,

a pair of pawls pivotally secured to the upper closure plate on opposite sides of said central bore and being spring biased to a vertical position,

each of said pawls having a tooth portion which is in locking engagement with a rim portion of said collar when said pawls are in said vertical position,

and an adjacent slanted surface which, when struck by a downward force, causes said pawl to rotate backwardly to disengage said tooth portion from locking engagement with said rim portion of said collar;

a filling aperture cut through said upper end closure plate;

a fluid of known composition filling the interior space of said casing which is above said piston when said casing is latched to said piston rod;

a water inlet aperture formed in the lower end closure plate;

a check valve connected to said water inlet aperture for permitting a flow of fluid into the interior of said casing whenever the pressure within said casing is a predetermined amount below the outside pressure;

means for unlatching said casing from said piston rod when said casing is supported at a given depth within a fluid medium by a lowering cable attached to said other end of said piston rod whereby said casing drops downwardly under its own weight until said piston contacts said upper end plate, the relative movement between said piston and said casing occurring when said casing is so unlatched causing the fluid stored above said piston to be discharged through said filling aperture into the surrounding fluid medium and also causing an equal amount of fluid from said surrounding fluid medium to flow through said check valve and water inlet aperture into the interior of said casing;

and means for draining said casing of the fluid stored therein.

2. In an arrangement as defined in claim **1** wherein said means for unlatching said casing from said piston rod comprises

a messenger dropped down said lowering cable which strikes said slanted surfaces of said pawls and causes said tooth portions to be removed from locking engagement with the rim portion of said collar.

3. In an arrangement as defined in claim **1**,

a pressure release valve mounted in the lower end wall portion of said cylindrical casing for permitting an intermittent flow of fluid out of the interior of said casing when the pressure within said casing exceeds the outside pressure by a predetermined amount.

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