Dec. 7, 1971 M. L. GREENE 3,625,066

WATER SAMPLING APPARATUS

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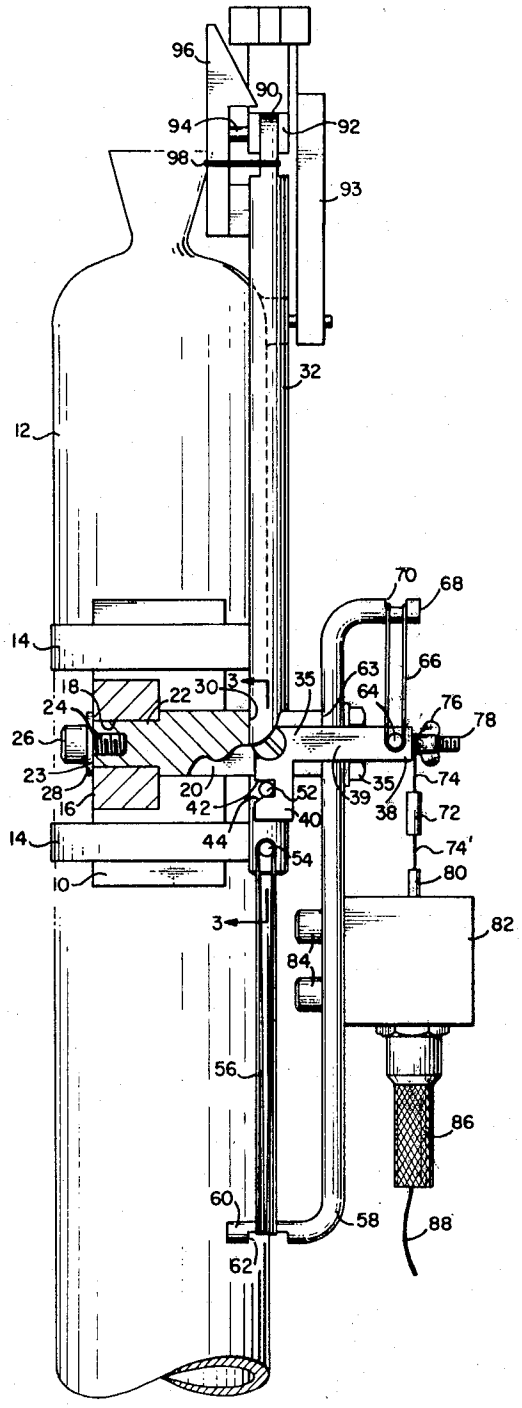
FIG. 1



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WATER SAMPLING APPARATUS

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FIG. 2

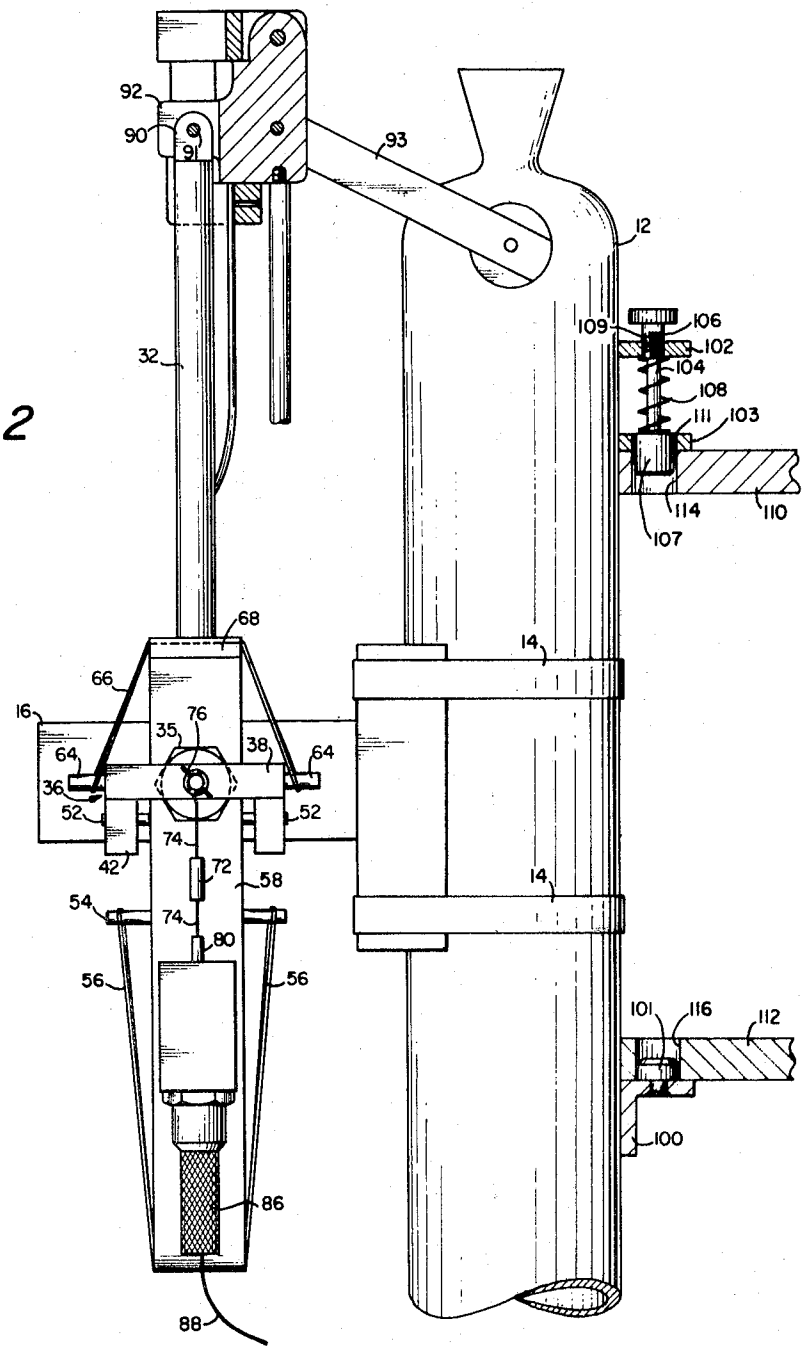

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FIG. 5

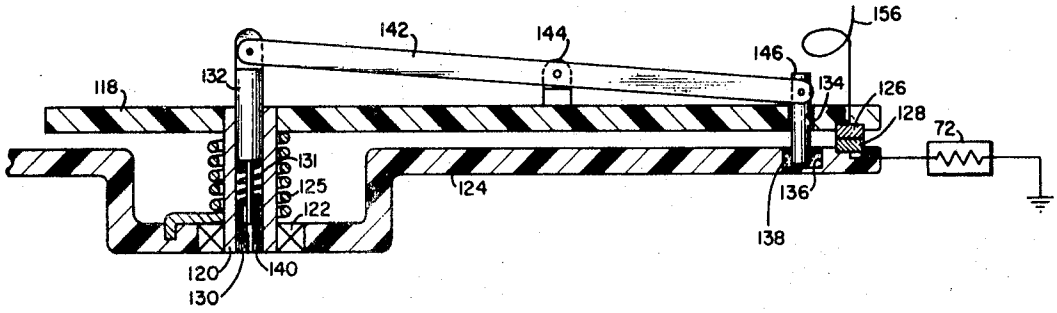
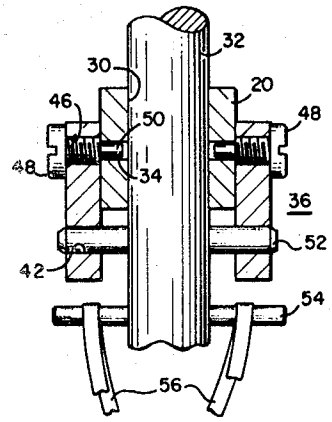


FIG. 3



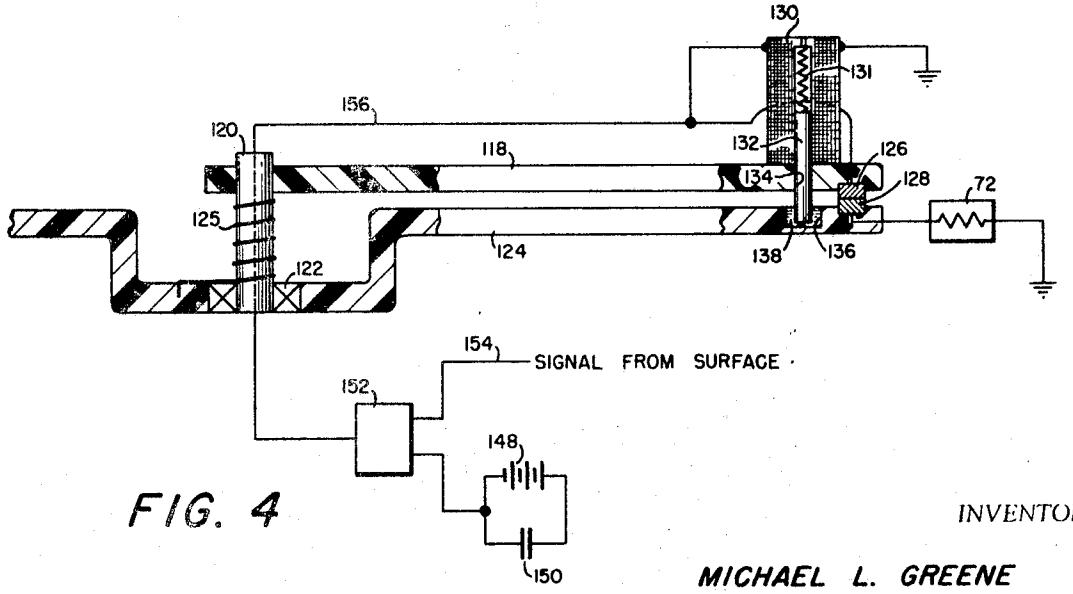


FIG. 4

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3,625,066

WATER SAMPLING APPARATUS

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Int. Cl. G01n 1/10
U.S. Cl. 73—425.4 R 5 Claims

ABSTRACT OF THE DISCLOSURE

Water sampling apparatus includes a standard Nansen bottle to which is clamped a mounting block which swivelingly supports a support bar, transversely bored to guide a slide rod. A slide rod, slidably disposed in the bore of the support bar, is attached to the upper valve lever of the Nansen bottle. A connecting rod conventionally connects the upper and lower valve levers so that the valves close together. The slide rod is urged downward by several elastic bands, but is prevented from downward movement by a pivoted latch which engages a pin projecting from the slide rod. The latch is, in turn, urged to unlatching position by its own elastic bands, but is restrained in latching position by a low wattage resistor. When the apparatus has been lowered to the proper depth in the sea, a high voltage can be delivered to the resistor through appropriate circuitry to break the resistor and permit the latch to move under the influence of its elastic bands out of latching position and release the slide rod to move downward under the influence of its elastic bands. Downward movement of the slide rod closes both top and bottom valves of the Nansen bottle, and the water sample is trapped.

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

This invention relates to devices for trapping and recovering samples of liquid from various depths in a body of the liquid, and more particularly, to improved apparatus for modifying existing equipment to greatly speed, simplify and improve the task of recovering samples of sea water from a series of depths from the ocean.

The practice of the science of oceanography often requires the collection of samples of sea water from various depths of the ocean. These samples are then returned to the surface and analyzed for the various substances that they contain such as minerals, microscopic animal and plant life, gaseous content, and so forth.

Since 1611 when the first sea water sampling bottle was first invented by Hooke, various water sampling bottles have been invented and tested by oceanographic workers in the field. The water sampling bottle most widely used at this time is a modification of one developed in the latter part of the 19th century by the Norwegian Arctic explorer and oceanographer Fridtjof Nansen, and now known as the Nansen bottle. Because of its sturdy construction and many years of reliable performance the Nansen bottle has won wide acceptance with, and is very extensively used by oceanographic workers in the field. Consequently, there is an immense inventory of Nansen bottles in existence, and the directors of the various institutions are very reluctant to discard a tool of proven value, forfeit the considerable

capital investment represented thereby, and bear the considerable cost required to replace the Nansen bottles with improved models. As a result, despite various improvements in the art, the Nansen bottle continues to be widely used in the field, and the apparent advantages offered by these more recent developments have not inured to the benefit of the art.

While the Nansen bottle has proven itself a rugged and reliable tool, its use is not entirely free of disadvantages. For example, a Nansen cast is a long and tedious process. The bottle must be fastened to the cable at intervals and lowered slowly into the ocean. When all the bottles have been attached to the cable and the cable lowered to the proper depth, a brass messenger is released to slide down the wire. When it strikes the first Nansen bottle it causes the valves to close and releases a second messenger which is releasably suspended from the first bottle. The second messenger slides down the wire until it strikes the second bottle, causing its valves to close and releasing a third messenger to repeat the process until the valves on all the bottles have been closed. Depending on the depth to which the cable is lowered this process may take several hours. Moreover, if the cable is not lowered properly, one of the messengers may be prematurely released which will trip all the lower bottles. Then if the cable is lowered further, the great pressure of the ocean depths may crush the bottles.

If concurrent data as to salinity, temperature, and depth is desired while the samples are being collected it is necessary to lower a sensor package known as an STD fish alongside the Nansen bottle cable. The STD fish, also a common item of inventory among oceanographic institutions, is a group of sensors and related telemetering apparatus held in a metal pipe cage of approximately 3 feet in diameter by approximately 6 feet in height. The top of the cage is connected to a cable by means of which the data is continuously telemetered back to the surface ship. The STD fish cable must remain separated from the Nansen bottle cable to avoid fouling the two cables.

It has for some time been the wish of oceanographic institutions to improve the somewhat awkward existing procedures for collecting water samples and take advantage of the improvements offered by recent developments in the art without the necessity for discarding the considerable inventory existing today and thereby avoid the capital loss which would be incurred thereby.

SUMMARY OF THE INVENTION

Accordingly it is an object of this invention to provide an apparatus for collecting samples of sea water from various depths of the ocean in which the sample may be trapped upon a signal from a surface vessel.

It is another object of the present invention to provide a water sample collecting apparatus in which the ambient environment at various depths of the ocean is continuously monitored and in which samples may be trapped from any depth as desired.

It is still another object of this invention to provide an improved water sample collection apparatus which employs equipment in the existing inventories of oceanographic institutions, which continuously monitors and relays to the surface various parameters of the deep sea environment and which permits the trapping of a water sample from various depths on command from an operator on the surface.

Briefly in accordance with one embodiment of this invention these and other objects are attained by providing special racks for the STD fish to which the Nansen bottles are fastened using a set of existing brackets attached to the bottles. A slide rod is connected to the top valve lever of the Nansen bottle and is biased downward by strong

elastic bands, but is restrained in its uppermost position by a latch. The latch is biased to open by its own elastic bands but is restrained in latching position by a low wattage resistor. Through appropriate leads, a high voltage pulse may be delivered to the resistor to break it thus release the latch to be opened by its elastic bands. The slide rod is thus released to move under the influence of its elastic bands to close the bottle valves.

DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and its many attendant advantages will develop as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a front elevation of the invention shown clamped to a Nansen bottle;

FIG. 2 shows a side elevation of the invention attached to a Nansen bottle which in turn is attached to the STD fish mounting brackets;

FIG. 3 is a sectional view along lines 3—3 in FIG. 1;

FIG. 4 is an elevation, partly in section, of a voltage pulse delivery mechanism; and

FIG. 5 is an elevation, partly in section, of another embodiment of a voltage pulse delivery mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views and more particularly to FIGS. 1 and 2, one embodiment of a water sampling apparatus according to the present invention is shown. The invention employes a conventional Nansen bottle **12**, which is a cylindrical metal container with a 1.25 liter capacity. It is fitted with a tapered plug valve at either end, both of which are open to provide that the bottle flushes itself as it is lowered into the ocean. In the use for which it was originally designed, both valves were connected to levers, the lower of which was attached to a cable connecting bracket securely clamped to the cable. The top lever was connected to the cable but could be disconnected therefrom by a messenger which was slid down the cable. When disconnected at the top, the bottle swung out away from the cable in approximately a 180° C. arc about the lower connector to the cable. The lower lever swung with the bottle through 90° but was then stopped by a dog on the lower connecting bracket and the continued swing of the bottle through the remaining 80°–90° was effective to rotate the lower level 80°–90° with respect to the bottle, which rotated the valve 80°–90° in its valve seat. By means of a rod connecting the upper and lower valve levers, the top valve was rotated when the bottom valve rotated. The valves were thus closed and the bottle was sealed.

As used in this invention, the Nansen bottle has secured thereto, by means of a pair of hose clamps **14**, a mounting block **10** having an arcuate inner face which abutts against the outer cylindrical surface of the Nansen bottle **12**. A projecting stud **16** is integrally formed on mounting block **10** and projects outwardly therefrom. A transverse hole **18** is formed through projected stud **16** and swivelingly holds a support bar **20** having a square cross-section for all but a short portion **22** adjacent the inner end **23** thereof. Portion **22** is formed with a circular cross-section which fits with a close clearance within hole **18**. A machine screw **26** is screwed into a threaded bore **24** formed axially in end **23** of bar **20** and holds a washer **28**, having a diameter somewhat larger than the diameter of hole **18**, to end **23** of bar **20** to prevent axial movement thereof out of hole **18**. This arrangement provides cantilever support for bar **20** while permitting free swiveling thereof about its axis in hole **18** for a purpose to be explained later.

As best seen in FIGS. 1 and 3, a vertical bore **30** is formed through support bar **20** and slideably receives a slide rod **32**. A pair of holes **34** are formed in the side of support bar **20** perpendicular to and intersecting bore **30** to provide bearing surfaces for pivot pegs about which a latch **36** swivels. Latch **36**, best seen in FIG. 1, is formed of a pair of parallel L-shaped members **35**, each having a base **40** and a leg **39**. L-shaped members **35** are connected at the top of leg **39** by a connecting cross member **38**. Each base **40** has formed therein a notch **42** beveled on the lower outer corner at **44**. At the bend of each L-shaped member **35** a threaded hole **46** is formed, best seen in FIG. 3, which threadedly receives a screw **48** having a small peg **50** formed on the inner end thereof. When screw **48** is fully threaded into hole **46**, peg **50** projects beyond the inner surface of L-shaped member **35** and extends into hole **34** of support bar **20** and forms a pivot about which latch **36** swivels. The notch **42** of latch **36**, illustrated in FIG. 1, in its latching position encloses a pin **52** rigidly secured by a force fit in a hole through slide rod **32** and prevents downward movement thereof. When latch **36** swivels counter-clockwise as viewed in FIG. 1, pin **52** is free of notch **42** and slide rod **32** is free to slide downwardly. A second pin **54**, also rigidly secured to slide rod **32** just below pin **52**, has looped therearound the ends of a stretched elastic band **56**. The middle of elastic band **56** is stretched around and held in a notch **62** formed on the lower inwardly bent end **60** of an S-shaped purchase bar **58** which is secured to the outer end **63** of support bar **20**. Stretched elastic band **56** provides the energy to move slide rod **32** downwardly when latch **36** swivels counter-clockwise to free pin **52** from notch **42**.

S-shaped purchase bar **58** has formed on the upper end thereof an outwardly bent portion **68**, having formed on the top surface thereof a notch **70**. Aligned immediately below notch **70**, a pin **64** is secured to the connecting cross-member **38** and has looped therearound the ends of an elastic band **66**, the middle of which is stretched over and lies in notch **70**. As best seen in FIG. 1, latch **36** is urged by elastic band **66** to rotate counterclockwise about pegs **50**, but is restrained from so rotating by a low wattage electrical resistor **72**, one lead **74** of which is connected to latch **36** by means of a wing nut **76** threaded to a machine screw **78** secured to cross-member **38**, and the other lead **74'** of which is connected to a terminal post **80** which extends out of a terminal block **82** secured to purchase bar **58** by machine screws **84**. A high voltage line **88** is connected to terminal block **82** and thence to terminal post **80** by means of an electrical connector **86**.

In partial explanation of the operation of the device as disclosed thus far, when resistor **72** is broken by a high power electrical impulse delivered through cable **88**, elastic bands **66** are effective to rotate latch **36** counterclockwise and thus free the pins **52** from notches **42**, thereby allowing slide rod **32** to slide downwardly under the influence of stretched elastic bands **56**.

The upper end of slide rod **32**, best seen in FIGS. 1 and 2, is formed into a flat bar **90**, and a hole **91** is formed laterally therethrough. Flat bar portion **90** is bracketed by the two arms of a clevis **92** which is conventionally attached to a valve lever **93** of the Nansen bottle. A pin **94** extends through a pair of holes in the clevis arms and through hole **91** in flat bar **90** to hold slide rod **32** securely to the Nansen bottle valve actuated mechanism. A cam **96** which forms part of the conventional wire release mechanism, for the bottle as heretofore used and to which the pin **94** is attached, is wired to slide rod **32** by means of a safety wire **98** to prevent the undesired pivoting of wire release cam member **96** from withdrawing pin **94** from clevis **92** and releasing slide rod **32**.

Looking at FIG. 2, the reason for the swivel connection of support bar **20** in hole **18** of stud **16** now becomes apparent. As slide rod **32** moves downwardly it rotates valve lever **93** down around the top valve, thus causing the top **90** of slide rod **32** to describe an arc as it moves downwardly. Since the radial distance of bore **30** from the bottle remains fixed, the angle that rod **32** makes with

the bottle changes as the rod descends. This cant of rod **32** would cause it to bind in bore **30** were it not for the swiveling support of bar **20**. Since bar **20** can swivel freely about its axis, the axis of bore **30** can follow and remain coincident with the axis of rod **32** as it cants with respect to the bottle. The free movement of rod **32** through bore **30** is thus assured.

The free sliding of rod **32** in bore **30** is further insured by the mounting of purchase bar **58** on the end **63** of support bar **20**. As rod **32** cants with respect to the bottle, bar **20** swivels with it and purchase bar **58** thereby necessarily remains parallel to rod **32**, thus assuring that the force exerted by elastic band **56** will remain exactly axial to rod **32**. There can, therefore, be no tendency whatever for rod **32** to skew or bind in bore **30**.

Referring now to FIG. 2, the Nansen bottle conventionally includes a top bracket **102**, a middle bracket **103**, and a lower bracket **100**. The top and middle brackets **102** and **103** have formed respectively therethrough a threaded aperture **109** and a smooth walled aperture **111**. A pin **104**, biased downwardly by a spring **108** and having a threaded upper end **106** and an enlarged diameter lower portion **107** extends through and is held in apertures **109** and **111**. A pair of hemispherical knobs **101**, only one of which appears in FIG. 2 since they are aligned in this view are formed on the top surface of lower bracket **100**. The original purpose of brackets **100**, **102** and **103** and pin **104** was to hold a deep sea reversing thermometer. However, this structure in the present invention is used to hold the Nansen bottle to the STD fish. This is accomplished by clamping pair of racks **110** and **112** to the STD fish by screws or other convenient means. The top rack **110** has formed therethrough a bore **114** of a diameter slightly larger than enlarged diameter portion **107** of pin **104**, and the bottom rack **112** has a pair of bores **116** formed therethrough of a diameter slightly larger than the diameter of hemispherical knobs **101**.

To secure the Nansen bottle to the rack, the bottle is placed with the top surface of lower bracket **100** abutting against the under surface of bottom rack **112** and with hemispherical knobs **101** extending into apertures **116**. Pin **104** is then lifted against the action of spring **108** and the large diameter portion **107** is aligned with and fitted into aperture **114** of rack **110**. The threaded portion **106** of pin **104** is then threadedly connected with the threaded aperture **109** of top bracket **102**. The Nansen bottle is now securely fastened to racks **110** and **112** of the STD fish. In the embodiment tested, a group of twelve bottles were fitted to the hexagonal STD fish, two to a side.

Looking now at FIG. 4, a device is shown which delivers the necessary high power electrical pulse to resistor **72** on command from the surface. A rotor **118** is rigidly mounted on a hollow shaft **120** which in turn is journaled in bearings **122** fixed in a base **124** attached to the STD fish. A torsion spring **125** coiled coaxially around hollow shaft **120** urges the shaft **120** and rotor **118** in clockwise rotation as seen from the top. An electrical contact button **126** is fixed to the outer underside of rotor **118** and a series of contact buttons **128** are angularly spaced around a circular arc on base **124** centered at shaft **120** and of a radius equal to the radial distance of button **126** from shaft **120**. As rotor **118** rotates, button **126** thus sequentially makes contact with buttons **128**. The number of buttons **128** may be as many as there are Nansen bottles and in the embodiment tested there were **12** buttons. Radially aligned with button **126**, a small solenoid **130** is mounted rigidly on the top of rotor **118** directly over an aperture **134** formed therethrough. A series of apertures **136**, one for each contact button **128**, having beveled surfaces **138** on the clockwise upstream side, are formed in base **124** around an arc over which aperture **134** passes as rotor **118** rotates. A plunger **132** mounted coaxially within solenoid **130** and biased downwardly by a spring **131**, is slideably received in aperture **134** and normally extends therethrough and into an aperture **136**. When plunger **132** is thus disposed, rotation of rotor **118** is prevented. When a current pulse is delivered to solenoid **130** sufficient to lift plunger **132** out of aperture **136**, spring **125** will act to rotate rotor **118** clockwise. When the current in solenoid **130** decreases, as it does very quickly, the plunger is released to be returned downwardly by spring **131** and travels around the surface of base **124** until it drops into the next aperture **136** that is encountered. The rotor is there stopped, and the next contact button **128** is in contact with button **126**.

The current pulse is delivered by a battery **148** connected in parallel with a large value capacitor **150**, both of which are connected in series with an electronic AND gate **152** which could also be a simple relay. An electrical conductor **154** extends down from the ship on the surface and is connected to AND gate **152**. An electrical conductor **156** is connected to AND gate **152**, passes up through the hollow bore of shaft **120**, and is connected in parallel to solenoid **130** and button **126**.

In operation, the battery **148** of the current pulse delivery mechanism fully charges capacitor **150**. A signal from the ship on the surface down conductor **154** effects the discharge of capacitor **150** through the AND gate **152** along conductor **156** to solenoid **130** and button **126**. The current pulse is delivered through button **126** and button **128** which is in contact therewith to resistor **72** which blows the resistor to cause one of the Nansen bottles to drop a water sample as previously described. At the same time, solenoid **130** is energized to lift solenoid plunger **132** out of aperture **136** which frees rotor **118** to move clockwise under the influence of torsion spring **125**. The short current pulse is effective to lift plunger **132** for just a moment, and it immediately thereafter moves downwardly again under the influence of spring **131** and drops into the next aperture **136** encountered around base **124**. Contact button **126** is at that point in contact with the next contact button **128** to which is connected the next resistor **72** of the next Nansen bottle. In this way, a relatively small electrical signal from the surface is effective to release a high energy current pulse which assures the breakage of resistor **72** and the closing of the valves of the Nansen bottle.

Another embodiment of this device as shown in FIG. 5 which shows the solenoid **130** mounted within the bore **140** of hollow shaft **120**. The solenoid plunger **132** is connected to one end of a lever **142**, the other end of which is connected to a pin **146** which fulfills the same function as the solenoid plunger in the embodiment of FIG. 4. When a current pulse is delivered to solenoid **130**, plunger **132** is pulled downwardly which causes lever **142** to pivot about a fulcrum post **144** and lift pin **146** to permit spring **125** to rotate rotor **118**. Spring **131** then lifts plunger **132** and pin **146** drops into the next aperture **136** encountered.

Obviously many modifications and variations of the present invention are possible in 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 and desired to be secured by Letters Patent of the United States is:

1. Water sampling apparatus comprising:

a conventional Nansen bottle having a pair of opposed ports formed therein and valves associated therewith for ingress and egress of water into and out of said bottle;

shiftable actuating means connected to said valves for changing the position thereof;

motive means connected to said actuating means for exerting a force thereon to shift said actuating means and thereby close said valves;

shiftable latch means for releasably holding said actuating means against the urging of said motive means;

means for biasing said latch means to release said actuating means;

electrical release means for releasing said latch in response to an electrical signal to permit said latch biasing means to shift said latch and release said actuating means for movement under the influence of said motive means to close said valves;

all said means being located outside said bottle.

2. The water sampling apparatus defined in claim 1, wherein said actuating means comprises:

a mount attached to said bottle;

a rod support means swivelingly connected to said mount and having a bore formed therethrough; and

a rod slidably held coaxially in said bore and connected at the upper end thereof to one of said valves;

whereby binding of said rod in said bore is precluded by the ability of said rod support means to swivel and allow the axis of said bore to remain coincident with the axis of said rod.

3. The water sampling apparatus defined in claim 2, wherein said motive means comprises:

a purchase bar mounted on said rod support means; and

an elastic band connected to and stretched between said purchase bar and the lower end of said rod;

whereby said purchase bar can swivel with said rod support means to provide that the force exerted by said elastic band will remain axial with respect to said rod.

4. The water sampling apparatus defined in claim 1, wherein:

said actuating means comprises a rod attached at one end thereof to one of said valves, and having a pin fixed to the other end thereof;

said motive means comprises a purchase bar attached

to said bottle, and an elastic band connected to and stretched between said other end of said rod and said purchase bar; and

said latch means comprises a latch swivelingly mounted on said bottle and having a notch formed thereon to engage and hold said pin and thereby to hold said rod from movement under the influence of said elastic band.

5. The water sampling apparatus defined in claim 4, wherein:

said latch biasing means comprises a pin connected to and projecting from said latch, and an elastic band connected to and stretched between said latch pin and another portion of said purchase bar; and

said electrical release means comprises a low wattage electrical resistor, one lead of which is connected to said latch and the other lead of which is connected to said purchase bar,

whereby the delivery of a high current pulse to said resistor will break said resistor and allow said latch biasing elastic band to swivel said latch and disengage said notch from said rod pin to free said rod for movement under the influence of said rod elastic band.

References Cited

UNITED STATES PATENTS

3,489,012	1/1970	Niskin	73—425.4 R
3,537,316	11/1970	Stewart	73—425.4 R X
3,339,417	9/1967	Richard	73—425.4 R

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