

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
10 June 2004 (10.06.2004)

PCT

(10) International Publication Number
WO 2004/048932 A2

(51) International Patent Classification⁷: **G01N**

(21) International Application Number:
PCT/US2003/037480

(22) International Filing Date:
25 November 2003 (25.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/303,522 25 November 2002 (25.11.2002) US
10/319,683 13 December 2002 (13.12.2002) US

(71) Applicant (for all designated States except US): **UNIVERSITY OF SOUTH FLORIDA** [US/US]; 4202 East Fowler Avenue, FAO 126, Tampa, FL 33620-7900 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **FRIES, David, P.** [US/US]; 755 19th Avenue North, St. Petersburg, FL 33704 (US). **JANOWIAK, Michelle, L.** [US/US];

1316 Chesterfield Drive, Clearwater, FL 33756 (US). **STEIMLE, George** [US/US]; 1040 17th Avenue North, St. Petersburg, FL 33704 (US). **BROADBENT, Heather, A.** [US/US]; 750 19th Avenue North, St. Petersburg, FL 33704 (US).

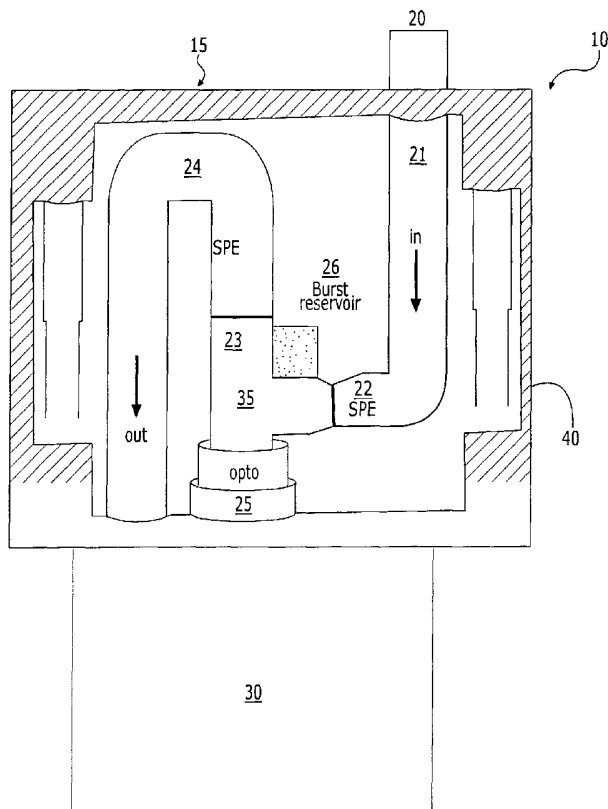
(74) Agent: **WARREN, William, L.**; Sutherland Asbill & Brennan LLP, 999 Peachtree Street, N.E., Atlanta, GA 30309-3996 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: SELF-PROPELLED SENSOR APPARATUS FOR IN SITU ANALYSIS OF ENVIRONMENTAL PARAMETERS



(57) Abstract: An analytical system is provided which uses the kinetic energy of motion of the entire system to drive a fluid under analysis through the system. This is preferably accomplished by use of a propulsion system that is attached to the analytical portion of the system. Various sensors may be used to analyze the sample collected within the confines of an analysis chamber contained within the system. Trace quantities of suspect materials may be detected or monitored by use of the instant system. The invention further provides for methods of using the analytical apparatus.



European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

- *without international search report and to be republished upon receipt of that report*

**SELF-PROPELLED SENSOR APPARATUS FOR IN SITU ANALYSIS OF
ENVIRONMENTAL PARAMETERS**

STATEMENT OF GOVERNMENT INTEREST

[001] The work that led to this invention has been supported in part by a grant from the Department of the Navy, Grant Number ONR –N0014-98-1-0848. Thus, the United States Government may have certain rights to this invention.

FIELD OF THE INVENTION

[002] The instant invention is directed to a fluid analysis method and apparatus, and particularly to such a method and apparatus for use in analysis of biological or chemical, particle or physical species contained in fluid milieus that include trace amounts of the species. More specifically, the instant invention is concerned with an analytical apparatus that additionally contains a propulsion unit to convey the analytical unit through the fluid medium to collect and/or detect desired materials.

BACKGROUND OF THE INVENTION

[003] In recent years the presence of contaminants in bodies of water both fresh and salt varieties has become an issue of both public and governmental interest. In addition, air quality with respect to pollution from industrial or bellicose activities deeply affects the daily lives of most of the world's population. With the changing political situation in the world as well as concern over contamination from industrial and agricultural activity, a new intense interest has developed in monitoring water and air sources for pollutants and trace quantities of materials. As technology progresses, it has become increasingly important to know

immediately the content of a body of water or air, thus necessitating the development of new analytical systems to give precise information on the presence and/or quantities of microbial and chemical contaminants.

[004] To date, the prior art method and devices have been concerned with “capturing” a sample for transportation to a laboratory for analysis and, in the case of trace quantities, concentration of the suspect species for that analysis. In addition, many of the prior art devices include sophisticated sensors and pumping apparatus that make the devices cumbersome as well as expensive to assemble and to maintain. Even though towed or tethered samplers have been known the art previously, their uses have been limited to physical characteristics and not monitoring of chemical or biological species.

[005] U.S. Pat No. 3,537,316 to Stewart et al. shows a towed underwater sampler having an internal cavity that houses sensor circuits. In this device, water is permitted to flow through the analysis chamber so that temperature and pressure may be evaluated. However, the sensors here are measuring physical parameters and not the chemical or biological content of the water passing through the sensor cavity. In fact, there is no actual sample reading made by the instrument since only the desired parameters of temperature and pressure are immediately evaluated, and the actual sample is captured in a bottle for later analysis. Another towed sensor system is disclosed in U. S. Pat. No. 4,713,967 to Overs et al. Again the sensors only are concerned with physical properties, these being temperature and water speed. In this patent, the speed and temperature are then equated to the presence of fish bait but no information is obtained about any compositional make-up of the environment or the nature of the fish bait itself.

[006] Inner chambers in contaminant sensing devices for water analysis are described in the prior art as well. One example is U. S. Pat. No. 6,272,938 to Baghel et al. which describes an inner chamber formed by a semi-permeable membrane in communication with an inner chamber containing a sensor to monitor contaminants in a tethered style apparatus. The water in this case diffuses through the membrane until a threshold is reached and then the diffusion is stopped. In this system, the quantity of contaminant is a function of diffusion time and thus is controlled by an unpredictable parameter.

[007] U. S. Pat. No. 6,306,350 to Mereish et al. describes a portable water sampling device that captures the sample in a chamber that is then removed and sent to a lab for analysis. The concentration of the component using this device is a function of time since a

timer is used to determine the sample collection period; in this patent a pump is also used to force the water being tested into the system and past the extraction membrane.

[008] Similar devices that incorporate sampling chambers are described in U. S. Patents 5,844,147 to Fiedler et al. and 5,167,802 to Sandstrom et al. Again, the samples are collected and sent to a remote lab for analysis.

[009] In addition to water environments, similar devices have been used in the atmosphere. Examples of these are U. S. Patent No. 6,321,609 to Mengel et al. and U. S. Patent No. 6,354,135 to McGee et al. Again, these systems include suction devices or pumps to facilitate the flow of effluent through the monitoring apparatus.

[010] It is readily apparent that a system for immediate analysis of contaminants in situ is needed to overcome the disadvantages of the prior art systems. It is also apparent that there is a need for a system that incorporates reliability and sensitivity in performing the necessary analyses that is low-cost and easy to maintain. It is, therefore, to the provision of such an instrument that the instant invention is directed.

SUMMARY OF THE INVENTION

[011] The present invention provides an analytical apparatus for analysis of a component contained in a fluid medium. Preferably, the apparatus comprises (a) a fluid inlet; (b) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (c) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end; (d) a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway; (e) a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway; (f) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (g) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

[012] In alternative embodiments, the apparatus comprises: (a) a fluid inlet; (b) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (c) an analysis chamber, wherein said analysis chamber is located

intermediate to said fluid inlet and said fluid outlet in said fluid pathway, and wherein the analysis chamber has a proximal and a distal end; (d) a reagent system capable of isolating the component of interest, wherein said reagent system is located within the analysis chamber; (e) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (f) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

[013] The present invention also encompasses methods of using the claimed apparatus for analyzing a component of interest in a fluid medium. One method comprises:

(a) providing an analytical apparatus comprising: (i) a fluid inlet; (ii) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (iii) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end; (iv) a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway; (v) a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway; (vi) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (vii) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium and propel the fluid through the fluid conduit by movement of the analytical system; and (b) introducing the apparatus into the fluid medium to permit the flow of the fluid medium through said apparatus to thereby analyze a component of interest in said fluid medium. A second method comprises: (a) providing an analytical apparatus comprising: (i) a fluid inlet; (ii) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (iii) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway, and wherein the analysis chamber has a proximal and a distal end; (iv) a reagent system capable of isolating the component of interest, wherein said reagent system is located within the analysis chamber; (v) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (vi) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium a

fluid inlet; and (b) introducing the apparatus into the fluid medium to permit the flow of the fluid medium through said apparatus to thereby analyze a component of interest in said fluid medium.

[014] In one embodiment of the above inventions the conveyance system is attached to the remainder of the apparatus by a tether. In a further embodiment, the tether transmits data from the apparatus. Preferably the data is transmitted to a remote location. As used herein, the term "remote" means that the data is transmitted to an apparatus not in immediate contact with the analytical apparatus. In still a further embodiment, the tether provides a power source for the apparatus.

[015] In a preferred embodiment of the apparatus, the conveyance system comprises a propulsion system connected to said analytical apparatus. Optionally, the propulsion system comprises a power source for said analytical apparatus and comprises a power source for secondary communication equipment. In certain embodiments, the propulsion system is renewable. In other embodiments, the propulsion system is detachable from the remainder of the apparatus.

[016] In other embodiments of the present invention, the apparatus comprises a second power source. It is also contemplated that the apparatus may further comprise a means for transferring data.

[017] The sensor system of the present invention may determine a threshold concentration of a component of interest of the fluid system. Alternatively, the sensor system may quantify the concentration of a component of interest of the fluid system. In certain embodiments, the sensor system is selected from the group consisting of an optical system, an electrochemical system, and electrical system, a gravimetric system, a mass loading system, an ion trap system, a molecular trap system, and a particle trap system. Preferably, the sensor system is an optical system.

[018] In other embodiments of the present invention, the apparatus further comprises a burst reservoir containing one or more means for enhancement of the detection of the component of interest. The means for enhancement are preferably chemical compounds that aid in the detection and/or the quantification of the component of interest.

[019] In other embodiments of the present invention, the apparatus further comprises a pre-extractor positioned upstream of the fluid intake.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the complete analytical apparatus of the invention.

FIG. 2 is a representation of one sampling chamber of the instant analytical system.

FIG. 3 represents another configuration of an optical sensor based analysis chamber

5 usable in the instant invention.

FIG. 4 is a further structure of an optical sensor type of detection system.

FIG. 5 is another embodiment showing a further geometry for the analysis chamber
of the instant invention.

FIG. 6 shows an overall schematic of the instant device including the propellant

10 portion attached to the analytical portion.

DETAILED DESCRIPTION OF THE INVENTION

[020] The present invention provides an analytical apparatus for analysis of a component contained in a fluid medium. Preferably, the apparatus comprises (a) a fluid inlet; (b) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (c) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end; (d) a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway; (e) a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway; (f) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (g) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

25 [021] In alternative embodiments, the apparatus comprises: (a) a fluid inlet; (b) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (c) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway, and wherein the

analysis chamber has a proximal and a distal end; (d) a reagent system capable of isolating the component of interest, wherein said reagent system is located within the analysis chamber; (e) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (f) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

[022] The present invention also encompasses methods of using the claimed apparatus for analyzing a component of interest in a fluid medium. One method comprises:

(a) providing an analytical apparatus comprising: (i) a fluid inlet; (ii) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (iii) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end; (iv) a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway; (v) a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway; (vi) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (vii) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium and propel the fluid through the fluid conduit by movement of the analytical system; and (b) introducing the apparatus into the fluid medium to permit the flow of the fluid medium through said apparatus to thereby analyze a component of interest in said fluid medium. A second method comprises: (a) providing an analytical apparatus comprising: (i) a fluid inlet; (ii) a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway; (iii) an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway, and wherein the analysis chamber has a proximal and a distal end; (iv) a reagent system capable of isolating the component of interest, wherein said reagent system is located within the analysis chamber; (v) a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and (vi) a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium a fluid inlet; and (b) introducing the apparatus into the fluid medium to permit the flow of the

fluid medium through said apparatus to thereby analyze a component of interest in said fluid medium.

[023] It is to be understood that as used in the specification and in the claims, "a" or "an" can mean one or more, depending upon the context in which it is used. Thus, for example, reference to "an analysis chamber" can mean that at least one analysis chamber can be utilized, and reference to "a component" can mean that at least one component can be analyzed.

[024] In one embodiment of the above inventions the conveyance system is attached to the remainder of the apparatus by a tether. In a further embodiment, the tether transmits data from the apparatus. Preferably the data is transmitted to a remote location. As used herein, the term "remote" means that the data is transmitted to an apparatus not in immediate contact with the analytical apparatus. In still a further embodiment, the tether provides a power source for the apparatus.

[025] In a preferred embodiment of the apparatus, the conveyance system comprises a propulsion system connected to said analytical apparatus. Optionally, the propulsion system comprises a power source for said analytical apparatus and comprises a power source for secondary communication equipment. In certain embodiments, the propulsion system is renewable. In other embodiments, the propulsion system is detachable from the remainder of the apparatus.

[026] In other embodiments of the present invention, the apparatus comprises a second power source. It is also contemplated that the apparatus may further comprise a means for transferring data.

[027] The sensor system of the present invention may determine a threshold concentration of a component of interest of the fluid system. Alternatively, the sensor system may quantify the concentration of a component of interest of the fluid system. In certain embodiments, the sensor system is selected from the group consisting of an optical system, an electrochemical system, and electrical system, a gravimetric system, a mass loading system, an ion trap system, a molecular trap system, and a particle trap system. Preferably, the sensor system is an optical system.

[028] In other embodiments of the present invention, the apparatus further comprises a burst reservoir containing one or more means for enhancement of the detection

of the component of interest. The means for enhancement are preferably chemical compounds that aid in the detection and/or the quantification of the component of interest.

[029] In other embodiments of the present invention, the apparatus further comprises a pre-extractor positioned upstream of the fluid intake.

5 [030] Referring to **FIG. 1**, the analytical apparatus **10** of the invention comprises a detection portion **15** connected to a support system **30**. In the preferred embodiment, the two sections are encased in a housing (not shown) that may be any suitable housing as known to those of ordinary skill in the art for the environment of use. The two sections **15** and **30** may be detachably connected, a single unit, or arranged so that reuse of desired components may
10 be performed. Any desired geometry for the overall system may be chosen by one of ordinary skill in the art, **FIG. 1** represents only one preferred embodiment.

[031] The detection portion **15** comprises a fluid intake **21** for ingress of the fluid to be examined. This intake **21** may be co-extensive with the housing, protrude therefrom or be recessed within the interior confines of the housing. A pre-extractor **20** may be also present
15 at the proximal end of the fluid intake **21** if desired to separate deleterious material from entering the detection portion **15**. The fluid intake **21** as well as the fluid outflow **24** may be formed of any suitable material as known to those of ordinary skill in the art. In the preferred embodiment, a preferred material is any suitable plastic material that is non-porous and inert to the environment.

20 [032] Located at the distal end of the fluid intake **21** is a first separator **22** that serves to block unwanted material from entering the analysis chamber **35**. This separator may comprise any suitable separator such as a filter, screening material, or in a preferred embodiment, a semi-permeable membrane. This first separator **22** is chosen for the milieu of use and for optimizing the effectiveness of performing a concentrating and screening
25 function, these systems being well-known to those of ordinary skill in the art.

[033] A second separator **23** is located in fluid communication with the first separator **22** with the intermediate portion of the fluid pathway defining an analysis chamber **35**. The second separator **23** is chosen to prevent the component of interest from exiting the analysis chamber **35** and is chosen of a material again suited for this purpose. In addition,
30 both the first and second separator may have coatings applied to them to assist in the detection of the component, such as, but not limited to, reflectance coatings applied to

enhance optical characteristics of the system. The fluid of interest exits the analytical system **10** via fluid outlet **24**.

[034] The analysis chamber **35** by virtue of the separators **23** also functions as a means for concentrating the component for interest. Thus the component of interest is substantially trapped within the confines of the analysis chamber **35** so that the sensor **25** is able to respond to its presence. The sensor **25** may be designed to respond to a threshold value of the component or may be chosen to actually quantify the concentration of the component contained in the analysis chamber **35**. In addition, the sensor **25** may be constructed to react to a plurality of components of interest, thus being a multi-sensor type of device.

[035] In addition, an optional burst reservoir **26** may be included in the structure of the detection portion **15**, so that a means for chemical enhancement may be introduced into the analysis chamber **35** to aid the sensor **25** in performance of its task. Again, if a plurality of analyses are performed, this burst reservoir **26** may actually be compartmentalized and serve to introduce a plurality of enhancement means.

[036] The support system **30** comprises the electronic components necessary to support the function of the sensor **25**. This may include power supplies, either battery or cable supplied as well as the support electronics necessary to run the sensors. In addition, any other necessary or desired support equipment may also be contained within this structure, these including, but not limited to, telemetry devices, GPS units, and data storage units. Optionally, the power source is contained within the conveyance system.

[037] Preferably the analytical system **10** is removably connected to a conveyance system (not shown) by line **40**. This may be a tethering line only or may also include a means for communication and a power source to the analysis system **10** and means for feedback for the retrieval of data or other information from the analysis system **10**. Preferably, if the conveyance system is a tether, it is connected to a second conveyance. Any suitable means known to those of ordinary skill in the art may be used for any of the desired embodiments as described above. The conveyance system may be a watercraft or aircraft of any description, either manned or remote controlled, suitable as a means for transporting the analytical system **10** through the fluid to be analyzed.

[038] In one preferred embodiment of the present invention, the conveyance system is a propulsion system. In one embodiment, the analytical system **10** is connected to a

propulsion system **80** as shown in **FIG. 5**. This may be any either an integral system to the overall device or a detachable propulsion system that may even be replaceable if the overall system is intended to be reusable. Examples of propulsion system include, but are not limited to: bullets, artillery shells, torpedos, drop projectiles, fired projectiles, missiles, and other munition systems. In addition, telemetry systems may be included for relaying the desired data back to a monitoring station.

[039] The propulsion system of the instant invention serves to not only transmit the analytical device to the location of interest, but also to provide the fluid flow within the system to effect the analytical functions. The sampling function may occur while the propulsion system is actively powering the device, or after the propulsion system is spent in a free-drift type of mode. Additional power sources may also be present for telemetry, GPS, electronic controls and other communication purposes. Further instrumentation may also include receivers, steering devices and other ground or ship communication devices, so that adjustments may be made to the flight path of the instrument after it is deployed. In addition, a second propulsion system may be incorporated into the device so that it may be transmitted after a period of time to a further location, such as a pick-up location. One embodiment incorporating a second propulsion system is an aerial type of device for overland applications or a flotation device for aqueous applications.

[040] In a further embodiment, the conveyance system may be detachable so that the analytical system **10** may be released and gravity acts to propel it through the fluid medium. In this embodiment, telemetry may also be used to transmit the data or other results back to a monitoring station or the instrument may be retrieved. Also contemplated is the use of balloons, or kites with sampling taking place during ascent and travel, and if detachable cords are used, sampling may also occur during gravitational descent.

[041] Because gravity or the motion of the conveyance system are used to impel the flow of fluid in the instant system, the need for the auxiliary pumps of the prior art is obviated. This enables the instant device to be reduced in size and simplifies the power requirements of the system. In addition, the analysis chamber **35** may be a micro-sized portion of the overall system, so that minute or trace amounts of a component of interest may be captured and detected.

[042] The analysis chamber **35** may be constructed in any geometry necessary to enhance the performance of the chosen sensor, component of interest, and fluid medium.

Three possible geometries for an optical sensor type detection system are shown in **FIGs. 2-5**. In each of these systems a source **60** sends out a light beam through the analysis chamber **35** to detector **61**. Other geometries are also available and are considered as design variations to one of ordinary skill in the art, including a linear arrangement as shown in **FIG. 5**.

5 **[043]** In addition to a single detection system, it is contemplated that a flow splitting arrangement may also be incorporated so that multiple discreet detections of the same or different component may be made simultaneously. In addition, either one or both of the separators **22** and **23** may be omitted depending on the sensor system used. Reagent systems that trap the component of interest or assist in the detection of the component may also be
10 used. This type of format is shown in **FIG. 5** in conjunction with a linear, non-membrane detection system. Here, a reagent trap **50** is used for isolation of the desired component.

[044] In addition to optical sensors, various other type of sensors may be employed; these including, but not limited to, electrical, electrochemical, gravimetric, mass loading and ion or molecular and particle traps. Various configurations of the analysis chamber **35** to
15 accommodate these types are systems are considered within the scope of knowledge to one of ordinary skill in the art. In addition, a threshold type of sensor may also be incorporated into the analytical system, with comparison to a pre-determined level being the output of choice.

[045] Modification and variation can be made to the disclosed embodiment of the instant invention without departing from the scope of the invention as described. Those
20 skilled in the art will appreciate that the applications of the present invention herein are varied, and that the invention is described in one preferred embodiment. Accordingly, additions and modifications can be made without departing from the principles of the invention. Particularly with respect to the claims it should be understood that changes may be made without departing from the essence of this invention. In this regard it is intended
25 that such changes would still fall within the scope of the present invention. Therefore, this invention is not limited to the particular embodiments disclosed, but is intended to cover modifications within the spirit and scope of the present invention as defined in the appended claims.

CLAIMS

We Claim:

1. An analytical apparatus for analysis of a component contained in a fluid medium
5 comprising:

- a. a fluid inlet;
- b. a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway;
- c. an analysis chamber, wherein said analysis chamber is located intermediate to
10 said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end;
- d. a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway;
- 15 e. a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway;
- f. a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and
- 20 g. a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

2. The analytical apparatus of Claim 1, wherein the conveyance system is attached to the remainder of the apparatus by a tether.

25 3. The analytical apparatus of Claim 2, wherein the tether transmits data from the apparatus.

4. The analytical apparatus of Claim 2, wherein the tether provides a power source for the apparatus.

30 5. The analytical apparatus of Claim 1, wherein the conveyance system comprises a propulsion system connected to said analytical apparatus.

6. The analytical apparatus of Claim 5, wherein the propulsion system comprises a power source for said analytical apparatus and comprises a power source for secondary communication equipment.

5

7. The analytical apparatus of Claim 5, wherein the propulsion system is renewable.

8. The analytical apparatus of Claim 5, wherein the propulsion system is detachable.

10

9. The analytical apparatus of Claim 4 or Claim 6, wherein the apparatus further comprises a second power source.

10. The analytical apparatus of Claim 1, wherein the apparatus further comprises a means for transferring data.

15

11. The analytical apparatus of Claim 1, wherein the sensor system determines a threshold concentration of a component of the fluid system.

12. The analytical apparatus of Claim 1, wherein the sensor system quantifies the concentration of a component of the fluid system.

20

13. The analytical apparatus of Claim 1, wherein the sensor system is selected from the group consisting of an optical system, an electrochemical system, and electrical system, a gravimetric system, a mass loading system, an ion trap system, a molecular trap system, and a particle trap system.

25

14. The analytical system of Claim 1, wherein the apparatus further comprises a burst reservoir containing one or more means for enhancement of the detection of the component of interest.

30

15. The analytical system of Claim 1, wherein the apparatus further comprises a pre-extractor positioned upstream of the fluid intake.

16. An analytical apparatus for analysis of a component contained in a fluid medium comprising:

a. a fluid inlet;

b. a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway;

c. an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway, and wherein the analysis chamber has a proximal and a distal end;

d. a reagent system capable of isolating the component of interest, wherein said reagent system is located within the analysis chamber;

e. a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and

f. a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium.

17. The analytical apparatus of Claim 16, wherein the conveyance system comprises a propulsion system connected to said analytical apparatus.

18. The analytical apparatus of Claim 17, wherein the propulsion system comprises power support for said analytical apparatus and comprises power for secondary communication equipment.

19. The analytical apparatus of Claim 17, wherein the propulsion system is renewable.

20. The analytical apparatus of Claim 17, wherein the propulsion system is detachable.

21. The analytical apparatus of Claim 16, wherein the apparatus further comprises a means for transferring data.

22. The analytical apparatus of Claim 16, wherein the sensor system determines a threshold concentration of the component of interest.

23. The analytical apparatus of Claim 16, wherein the sensor system quantifies the concentration of the component of interest.

5 24. The analytical apparatus of Claim 16, wherein the sensor system is selected from the group consisting of an optical system, an electrochemical system, and electrical system, a gravimetric system, a mass loading system, an ion trap system, a molecular trap system, and a particle trap system.

10 25. The analytical apparatus of Claim 16, wherein the apparatus further comprises a burst reservoir containing one or more means for enhancement of the detection of the component of interest.

15 26. The analytical apparatus of Claim 16, wherein the apparatus further comprises a pre-extractor positioned upstream of the fluid intake.

27. A method of analyzing a component of interest in a fluid medium using an analytical apparatus comprising;

a. providing an analytical apparatus comprising

20 i. a fluid inlet;

ii. a fluid outlet, wherein said fluid inlet is connected to said fluid outlet via a fluid conduit that defines a fluid pathway;

25 iii. an analysis chamber, wherein said analysis chamber is located intermediate to said fluid inlet and said fluid outlet in said fluid pathway and connected to said fluid conduit, and wherein the analysis chamber has a proximal and a distal end;

iv. a first separator, wherein said first separator is located at the proximal end of said analysis chamber in said fluid pathway;

30 v. a second separator, wherein said second separator is located at the distal end of said analysis chamber in said fluid pathway;

vi. a sensor system, wherein said sensor system is located within said analysis chamber and in communication with said fluid pathway; and

vii. a conveyance system, wherein said conveyance system is adapted to propel said analytical apparatus through the fluid medium and propel the fluid through the fluid conduit by movement of the analytical system; and

5 b. introducing the apparatus into the fluid medium to permit the flow of the fluid medium through said apparatus to thereby analyze a component of interest in said fluid medium.

10 28. The method of Claim 27, wherein the conveyance system comprises a propulsion system connected to said analytical apparatus.

29. The method of Claim 28, wherein the propulsion system is renewable.

15 30. The method of Claim 28, wherein the propulsion system is detachable.

31. The method of Claim 28, wherein the propulsion system comprises a power source for said analytical apparatus and comprises a power source for secondary communication equipment.

20 32. The method of Claim 31, wherein the apparatus further comprises a second power source for transmitting power to the analytical apparatus and transmitting data from the analytical system.

25 33. The method of Claim 27, wherein the apparatus further comprises a means for transmitting data.

34. The method of Claim 33, wherein data is transmitted from the analytical apparatus to a remote location.

30 35. The method of Claim 27, wherein the sensor system determines a threshold concentration of a component of the fluid system.

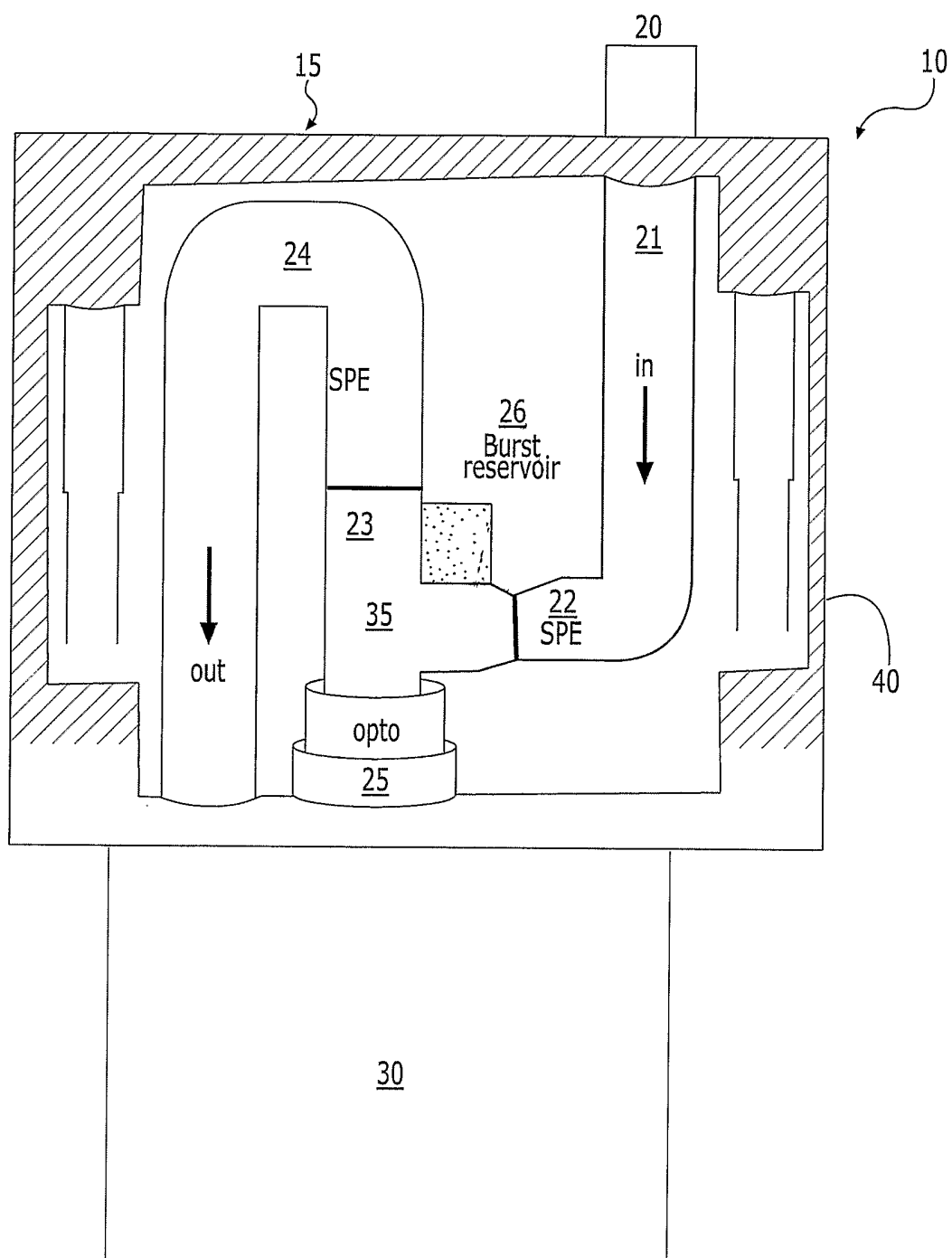
36. The method of Claim 27, wherein the sensor system quantifies the concentration of a component of the fluid system.

5 37. The method of Claim 27, wherein the sensor system is selected from the group consisting of an optical system, an electrochemical system, and electrical system, a gravimetric system, a mass loading system, an ion trap system, a molecular trap system, and a particle trap system.

10 38. The method of Claim 27, wherein the apparatus further comprises a burst reservoir containing one or more means for enhancement of the detection of the component of interest.

15 39. The method of Claim 27, wherein the apparatus further comprises a pre-extractor positioned upstream of the fluid intake.

1/4

**FIGURE 1**

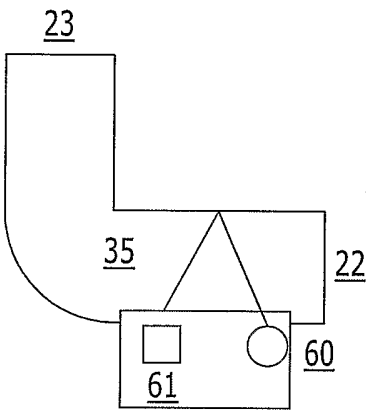


FIGURE 2

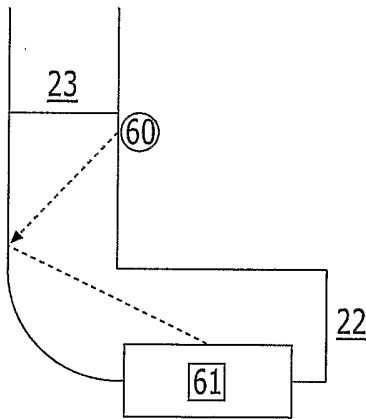


FIGURE 3

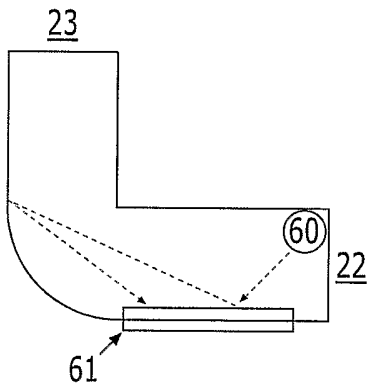


FIGURE 4

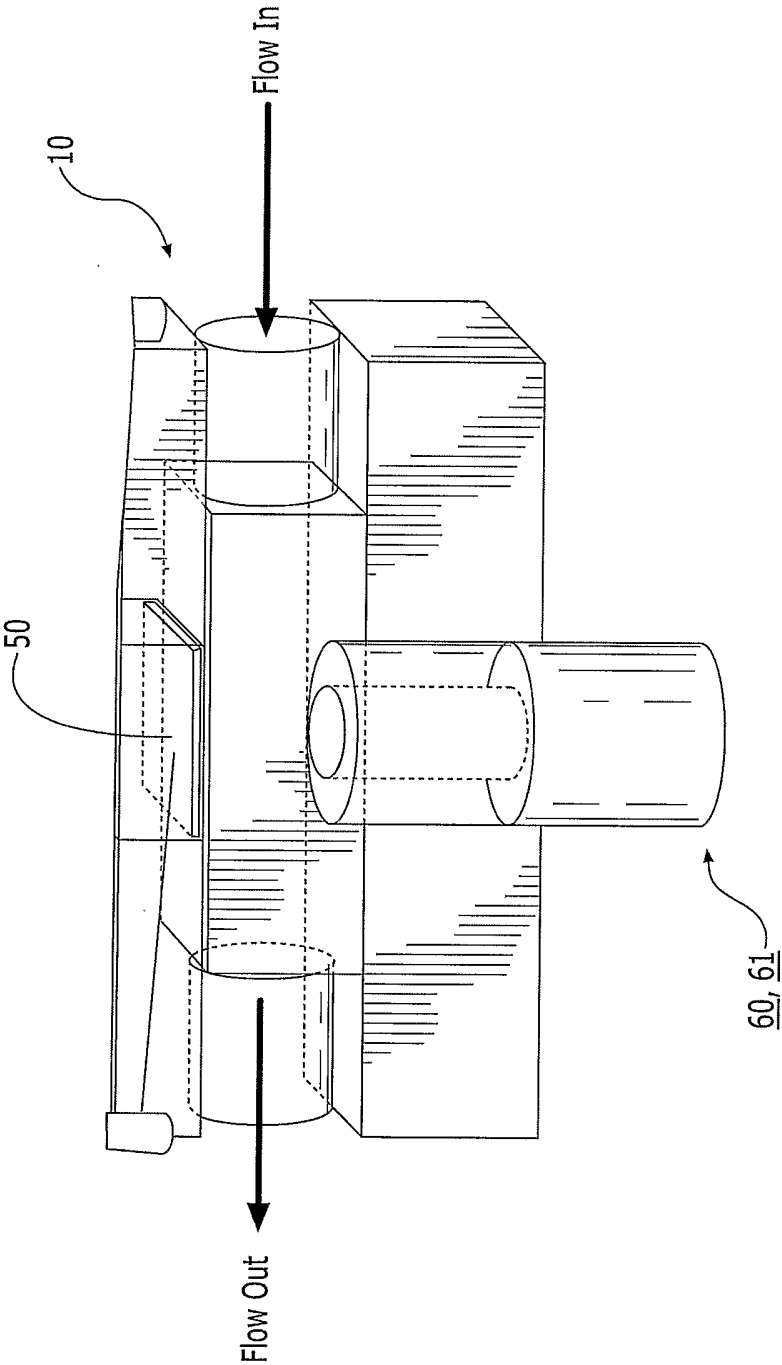


FIGURE 5

Lab on a Projectile

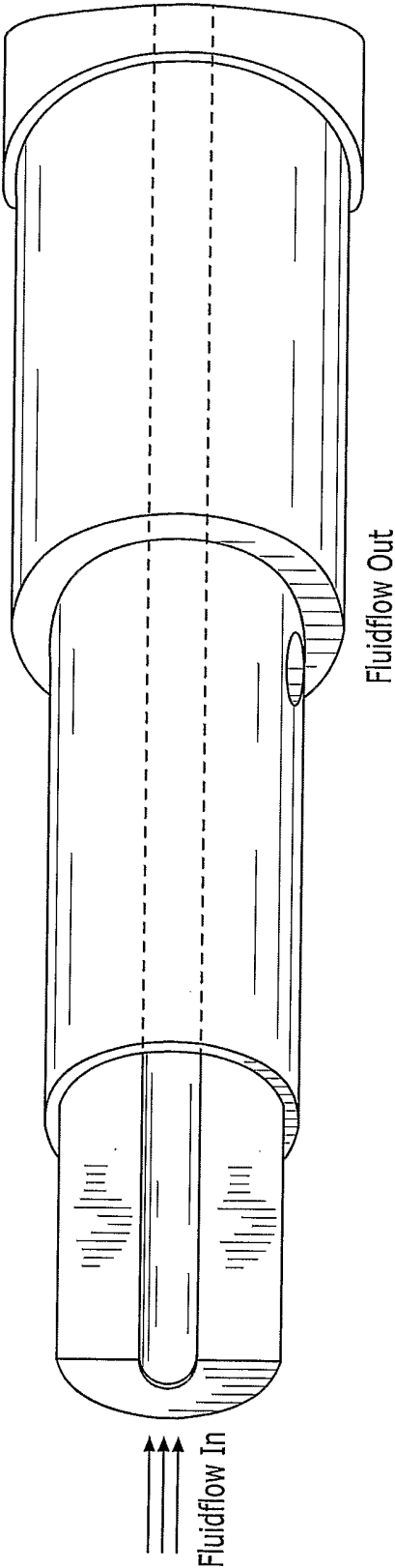


FIGURE 6