NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

SEP 28 1977

REPLY TO ATTN OF: GP

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code KSI, the attached NASA-owned U.S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 4,046,012

Government or Corporate Employee : U.S. Government

Supplementary Corporate Source (if applicable) : ~

NASA Patent Case No. : GSC-12,143-1

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:

YES ☐ NO ☒

Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of column No. 1 of the Specification, following the words "...with respect to an invention of ..."

Bonnie L. Henderson

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Enclosure

GSC-12,143-1

United States Patent [19]

Studenick

[11] **4,046,012**

[45] **Sept. 6, 1977**

[54] **FLUID SAMPLING DEVICE**

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[73] Assignee: **The United States of America as represented by the United States National Aeronautics and Space Administration**, Washington, D.C.

[21] Appl. No.: **743,249**

[22] Filed: **Nov. 19, 1976**

[51] **Int. Cl.**[2] **G01N 1/24**

[52] **U.S. Cl.** ..... **73/421.5 R**; 250/288

[58] **Field of Search** ..... 73/421.5 R, 421.5 A; 250/288

[56] **References Cited**

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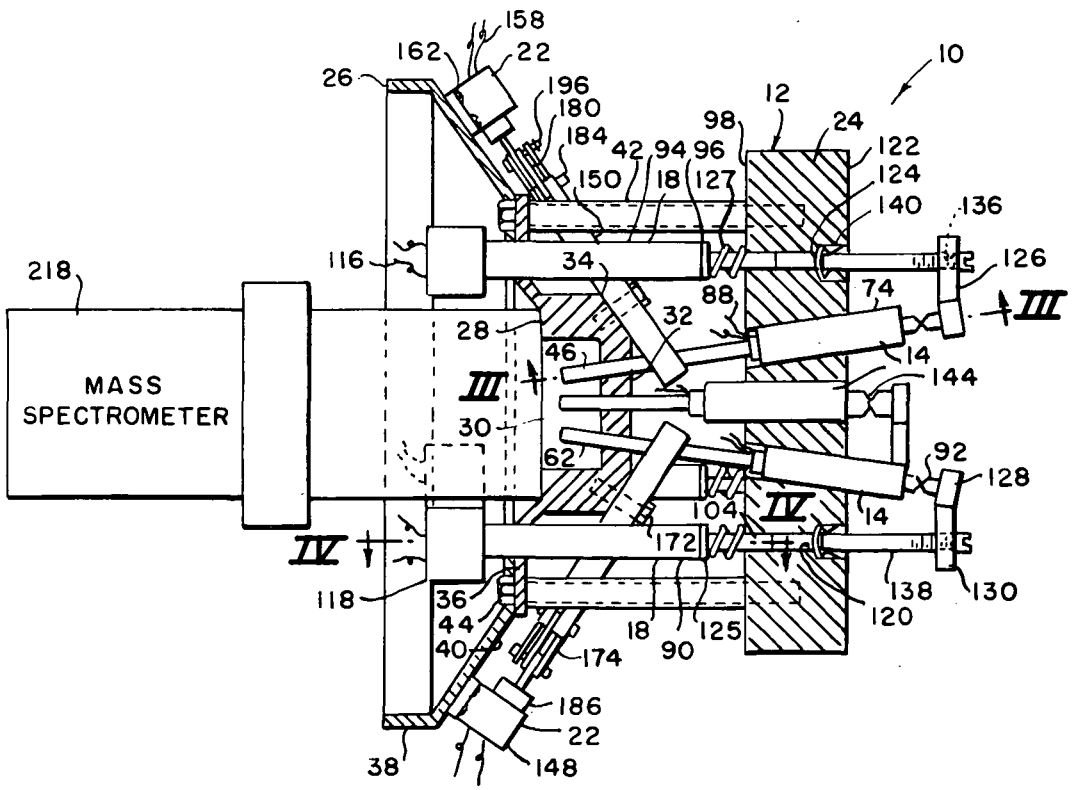
Primary Examiner—S. Clement Swisher

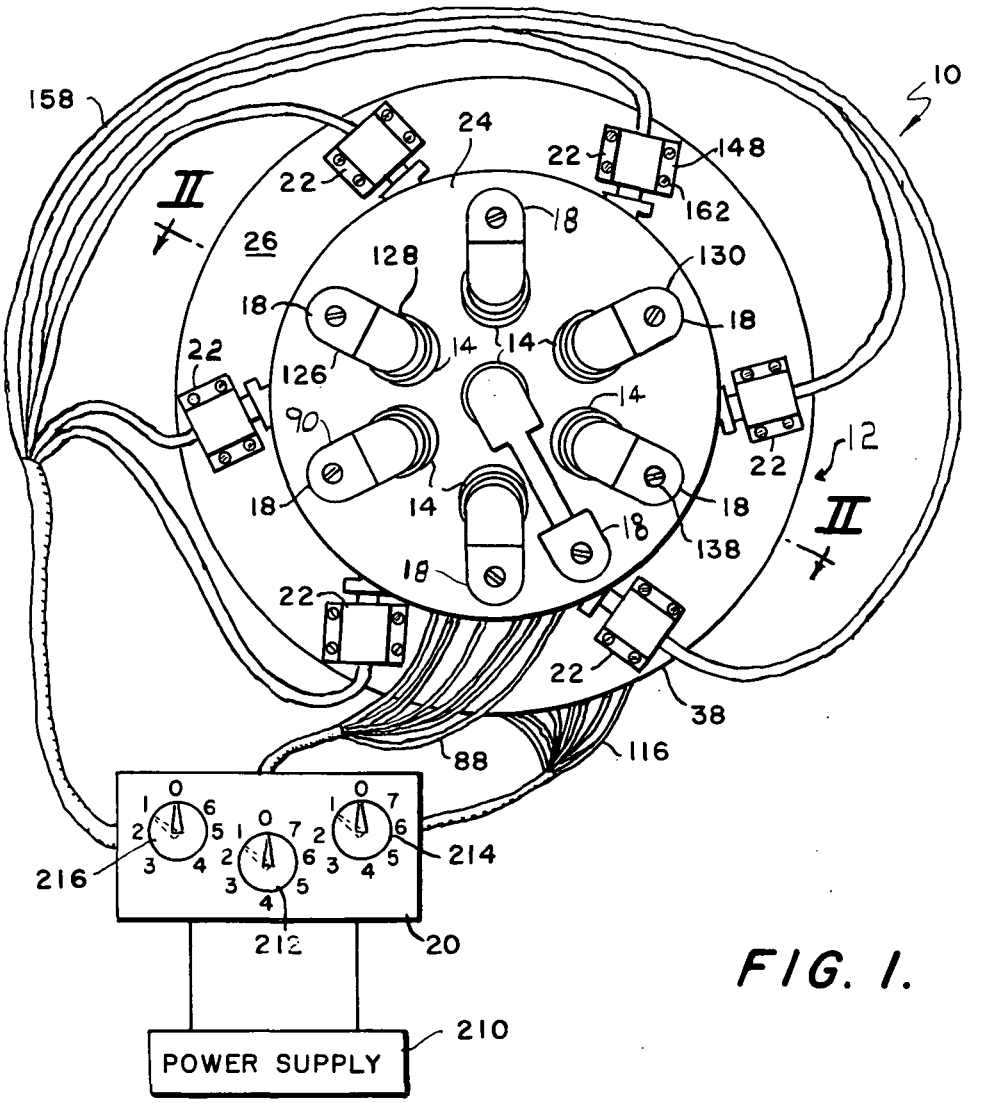
Attorney, Agent, or Firm—John O. Tresansky; Robert D. Marchant; John R. Manning

[57] **ABSTRACT**

A fluid sampling device for selectively sampling multiple fluids including a support frame. A plurality of fluid inlet devices extend through the support frame and each of the fluid inlet devices include a longitudinal aperture extending therethrough. An opening device that is responsive to a control signal selectively opens the aperture for passing the fluid therethrough. A closing device that is responsive to another control signal selectively closes the aperture for terminating further fluid flow therethrough.

21 Claims, 6 Drawing Figures

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POWER SUPPLY
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FIG. 1.

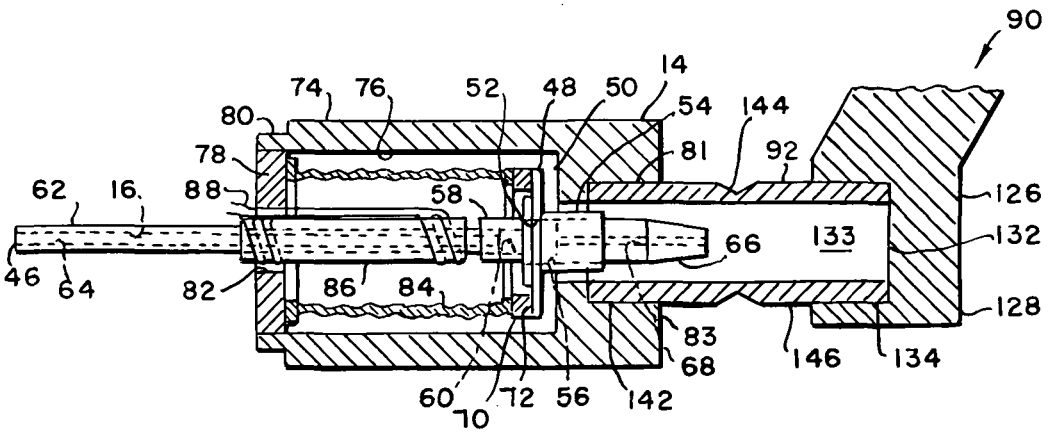
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FIG. 3.

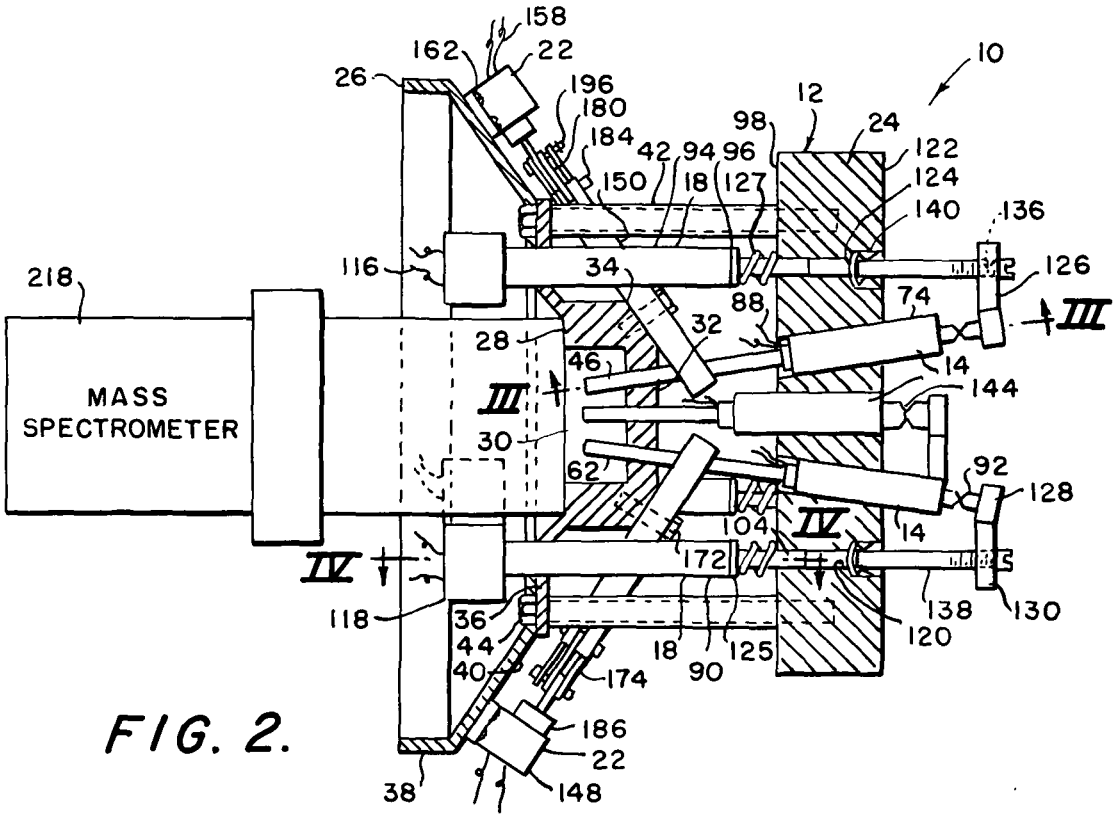

FIG. 2.

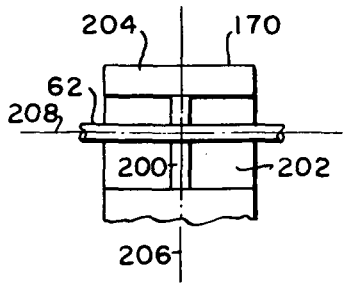

FIG. 6.

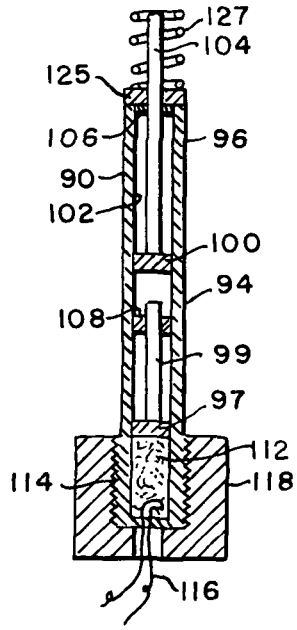

FIG. 4.

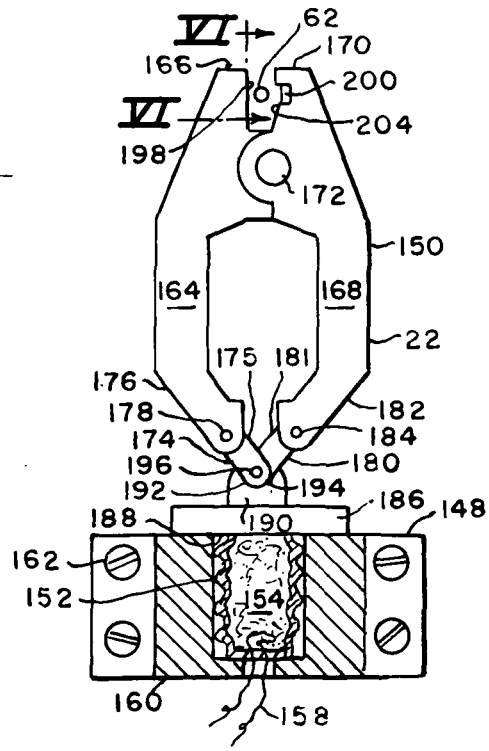

FIG. 5.

FLUID SAMPLING DEVICE

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to inlet leaks for sampling gases and more particularly to a fluid sampling device for selectively sampling multiple fluids.

2. Description of the Prior Art

Inlet leaks are highly useful and extensively used for introducing a fluid such as, for example, a gas into a mass spectrometer or other devices for analyzing a gas in a particular environment.

Present day devices utilize a single inlet leak tube constructed of glass having a capillary opening extending through the glass tube. The inlet leak is inserted into a mass spectrometer or other gas analyzers. The apparatus is placed within the gas to be analyzed and the gas is allowed to flow through the inlet leak into the gas analyzer where the characteristics of the gas can be broken down and studied. This device works exceptionally well where a single particular gas is to be analyzed.

In certain environmental situations the above device has many disadvantages because a single inlet tube can only be used once since it is contaminated by the gas that has been sampled. A use where such prior art devices is unsuitable involve sampling of multiple gases at different locations. If the above prior art devices are used, the sample taken at the first location can be analyzed correctly, however, subsequent samples taken at different locations will be contaminated by the residue gas from the first location. This will prevent a true analysis of the gases at the subsequent locations. Thus, the inlet leak tube can only be used once or only be used to analyze the same gas again and once the inlet leak tube is opened gases will continue to flow into the analyzer.

To take multiple samples of gases without contamination by the previously sampled gas it is necessary to replace the used inlet leak tube with an unused inlet leak tube and the analyzer must be pumped out to remove the residual gases or a plurality of gas analyzers may be used having a single uncontaminated inlet leak tube. In many situations the above multiple sampling technique cannot be used or are impractical and expensive. An exemplary situations is where the gas samples in a planets atmosphere must be taken at different heights above the planets surface. Since planet probes are unmanned, it would be difficult to provide for the replacement of the inlet leak tube after each gas sample is taken, and because of size and weight limitations on a spacecraft multiple gas analyzers having a single one-shot inlet leak tube cannot be used.

Another situation where the above prior art devices are unfeasible is in analyzing the different gases emitted by a volcano at various heights and at different times within the volcano. Time is of the essence when working around an active volcano and it is therefore desirable to obtain and analyze the gas samples as quickly as possible. The above prior art devices do not lend themselves to such rapid sampling.

OBJECTS OF THE INVENTION

Accordingly, one object of this invention is to provide a novel apparatus for sampling a fluid.

Another object of the present invention is to provide a novel fluid sampling device capable of sampling multiple fluids.

Still another object of this invention is to provide a novel fluid sampling device capable of sampling multiple fluids without becoming contaminated.

A further object of the instant invention is to provide a new and improved fluid sampling device for selectively sampling different fluids without removing used inlet leak tubes.

A still further object of this invention is to provide a new and improved fluid sampling device that selectively and accurately samples multiple fluids with a single gas analyzer.

Another still further object of this invention is to provide a new and improved relatively inexpensive and compact fluid sampling device for selectively sampling multiple fluids.

SUMMARY OF THE INVENTION

Briefly, in accordance with one embodiment of this invention, these and other objects are attained by providing a fluid sampling device that selectively samples multiple fluids. The fluid sampling device generally includes a support frame which is attached to a single fluid analyzer such as a mass spectrometer. A plurality of fluid inlet devices extend through the support frame. Each fluid inlet device has a longitudinal aperture extending therethrough into the fluid analyzer. An opening device is responsive to a control signal for selectively opening the aperture for passing the fluid therethrough. A closing device is responsive to another control signal for selectively closing the aperture for terminating further fluid flow therethrough.

The above and further objects of the invention will appear more fully from the following detailed description when the same is red in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are not intended as a definition of the invention but are for the purpose of illustration only.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings where like parts are designated by like references:

FIG. 1 is a top view of the fluid sampling device of the present invention showing the plurality of fluid inlet devices, opening devices, closing devices, control panel, and signal generating device.

FIG. 2 is a side view, in cross section, of the fluid sampling device taken along the lines II — II of FIG. 1 showing the interconnections between the fluid inlet devices, opening devices and closing devices.

FIG. 3 is a side view, in cross section, of the fluid inlet devices taken along the lines III — III of FIG. 2 showing the internal components of the fluid inlet devices and shearing device of the opening device.

FIG. 4 is a side view, in cross section, of the actuator device taken along the lines IV — IV of FIG. 2 showing the cylinder, piston, rod, and expander.

FIG. 5 is a side view of the closing device of FIG. 2 showing the moveable clamping mechanism and the actuator device, in cross section.

FIG. 6 is a top view of one arm of the moveable clamping mechanism taken along the lines VI—VI of

FIG. 5 showing the land extending transverse to the deformable tube.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the invention generally includes a fluid sampling device, denoted generally by numeral 10, for selectively sampling multiple fluids. Fluid sampling device 10 includes a support frame, denoted generally by numeral 12, with a plurality of fluid inlet devices 14 extending through the support frame 12. Each fluid inlet device 14 has a longitudial aperture 16 (FIG. 3) extending longitudinally therethrough. An opening device 18 is responsive to a control signal supplied by control panel 20 for selectively opening aperture 16 for passing the fluid therethrough. A closing device 22 is responsive to another control signal supplied by control panel 20 for selective closing aperture 16 for terminating further fluid flow therethrough.

Referring now to FIGS. 1 and 2, support frame 12 of fluid sampling device 10 includes a first flange 24 and a second flange 26 spaced from and connected to flange 24 so that the flanges are axially aligned. Flange 24 is preferably, circular, however, any shape may be used depending on the specific design criteria. Flange 26 is formed of a central circular support 28 having an outer diameter substantially smaller than the outer diameter of flange 24 and having an inner cavity 30. An outer surface 32 of support 28 includes a beveled surface 34 of the outer periphery. Flange 26 further includes an outwardly extending flange 36 having an outer diameter less than the diameter of flange 24. Flange 26 additionally includes a support disc 38 having an outer diameter substantially greater than the diameter of flange 24 and a central opening having a diameter substantially greater than circular support 28 and less than the diameter of outwardly extending flange 36. Support disc 38 is connected to flange 36, in a conventional manner such as by bolting or welding (not shown) so that surface 40 forms an acute angle to outwardly extending flange 36. Although support disc 38 is preferably a separate part from outwardly extending flange 36 it should be understood, that it may be formed integrally with flange 36, if desired.

Second flange 26 is spatially secured to first flange 24 by spacer sleeves 42 and bolts 44 which extend between flange 36 and flange 24. Bolts 44 extend through outwardly extending flange 36, sleeves 42 and screw into flange 24. Sleeves 42 separate flanges 24 and 26 while bolts 44 hold them rigidly together.

The plurality of fluid inlet devices 14 are shown as extending through flange 24 and circular support 28 of flange 26. As shown in FIG. 1 six fluid inlet devices 14 are spaced in a circular configuration around flange 24 and a seventh is centered in flange 24. It should be understood, that the number and configuration of fluid inlet devices 14 shown is for illustrative purposes only. It is preferred that the six fluid inlet devices 14 be inclined at an angle so that the lower portion 46 of each fluid inlet device 14 extends through circular support 28 and into inner cavity 30.

As more clearly shown in FIG. 3 each fluid inlet device 14 includes a circular holder 48 having a circular disc 50 with an opening 52 extending therethrough. A first cylindrical shoulder portion 54 is secured to disc 50, such a by welding, so that an opening 56 is in axial alignment with opening 52 in disc 50. A second cylindrical shoulder portion 58 is secured to the opposite side of disc 50, such as by welding, to position an opening 60 in axial alignment with opening 52 in disc 50 and opening 56 in shoulder portion 54. A deformable tube 62 is inserted within opening 60 of shoulder portion 58 and secured therein, such as by welding. Deformable tube 62 includes an opening 64 extending therethrough and in axial alignment with opening 60 of shoulder portion 58. End 46 of tube 62 extends through support 28 of flange 26 and into inner cavity 30 and is secured to support 28, such as by welding. A fluid receiving insert 66 having a capillary opening 68 extending therethrough is inserted within opening 56 of shoulder portion 54 and secured thereto in any well known and conventional manner.

It is important when bonding metal to glass, especially in inlet leaks, that a proper seal between the glass and metal be made and that the integrity of the seal be maintained over a wide temperature range and under other hazardous environmental conditions. It is therefore necessary that a metal and glass be used that have substantially the same coefficient of expansion characteristics. KOVAR metal and certain glass compositions have been found to posses substantially the same coefficient of expansion and not to degrade under harsh environmental conditions. It is preferable that circular holder 48 be made from the metal KOVAR being composed of substantially 54% Fe, 29% Ni, and 17% Co and that fluid receiving insert 66 be composed of glass having a composition range of 65 - 70% $Si O_2$, 3 - 7% $Al_2 0_3$, 17 - 18% $B_2 0_3$, 1% $Li_2 O$, 1% - 2% $Na_2 O$, and 2 - 8% $K_2 O$. Although a glass insert made in the composition range above is acceptable the preferred composition of the glass insert is 70% SiO_2, 3% $Al_2 0_3$, 17% $B_2 0_3$, 1% $Li_2 O$, 1% $Na_2 O$ and 8% $K_2 O$. Further, it is preferred that deformable tube 62 be made from conventional stainless steel since it may be subjected to harsh environmental conditions. Although the above compositions are preferred it should be understood, that other materials may be used as long as the integrity of the seal is maintained over a wide temperature range and the material does not degrade under harsh environmental conditions.

Fluid inlet devices 14 further include a metal flange or ring 70 having an outer diameter substantially the same as the outer diameter of circular disc 50 and secured to surface 72 of disc 50, such as by welding. A sleeve 74 surrounds glass insert 66, holder 48, and a portion of tube 62, and has an inner diameter substantially greater than the outer diameter of disc 50 thereby forming an annular space 76. Sleeve 74 is affixed to first flange 24 of support frame 12, such as by welding, and includes an inwardly extending flange 78 secured to end 80 such as by welding. Flange 78 includes an inner diameter substantially greater than the outer diameter of tube 62 forming a space 82 therebetween. Although flange 78 is shown as a separate ring, it may also be formed integrally with sleeve 74. Sleeve 74 further includes a recessed opening 81 in end 83. A metal cylinderical bellows 84 surrounds tube 62 within space 76 and extends between flange 78 and ring 70. Bellows 84 is secured to flange 78 and ring 70 as by welding and provides a rigid base for supporting tube 62, holder 48, and glass insert 66 within sleeve 74.

Fluid inlet devices 14 further includes an insulating coating 86 surrounding the portion of tube 62 which is surrounded by sleeve 74. If desired, insulating coating 86 may extend beyond flange 78, as shown in FIG. 3. Insulating coating 86 may be a conventional type hav-

ing electrical insulating properties and may be applied in any conventional manner. It is preferred, however, that insulating coating **86** be formed of ceramic and plasma sprayed on tube **62**. The thickness of insulating coating **86** should be sufficient for space **82** to remain between insuating coating **86** and flange **78**. An electrical heating wire **88** is wound on insulating coating **86** and the ends thereof extend through space **82** for connection to control panel **20**. If desired, additional ceramic insulating coating may be applied on top of heating wire **88** to provide for additional electrical insulation. Any type of electrically conducting wire may be used as a heating element, however, it is preferred that heating wire **88** be made of tungsten. When activated by control panel **20** heating wire **88** heats tube **62** to a temperature above the evaporation point of the fluid to be sampled to thereby drive off any fluid clinging to tube **62** prior to the fluid flowing through aperture **16**. In addition to supporting tube **62**, holder **48**, and glass insert **66**, bellows **84** provides thermal isolation for fluid inlet devices **14** to reduce the rate of heat loss from heating wire **88**. More specifically, bellows **84** provides a high resistance thermal path through tube **62** which reduces the heat loss from heater wire **88**.

The opening device **18** associated with each fluid inlet device **14** is selectively activated by a control signal from control panel **20** so that each opening device **18** exposes aperture **16** of each fluid inlet tube **14** only when a specific fluid sample is to be taken.

Opening device **18** includes an actuator device, generally indicated by numeral **90**, which is connected to and extends through first and second flanges **24** and **26** and is connected to control panel **20** and a shearing device **92** which severably interconnects and is insealing engagment with actuator device **90** and fluid inlet device **14**.

Actuator device **90** includes a cylinder **94** which extends through outwardly extending flange **36** of flange **26** adjacent to each fluid inlet device **14**. Cylinder **94** is secured to flange **36**, as by welding, so that end **96** thereof is spaced below surface **98** of flange **24**. As more clearly shown in FIG. **4** a first piston **97** is in sliding engagement with inner surface **102** of cylinder **94**. A first rod **99** is secured to piston **97** such as by welding. A support rod **108** secured to surface **102**, as by welding, surrounds rod **99** and is in sliding engagement therewith. A second piston **100** is spaced from rod **99** and support ring **108** and is in sliding engagement with surface **102**. A second rod **104** is secured to piston **100**, as by welding, and extends above end **96**. A seal ring **106** is secured to surface **102** at end **96**, as by welding, so that rod **104** is in sliding engagement therewith. An expander **112** is contained within cylinder **94** below piston **97**. Preferably expander **112** is formed of a pyrotechnic material which when heated burns to cause a gas to be formed which expands and pushes piston **97** until it contracts support ring **108**. As piston **97** moves, rod **99** contracts piston **100** causing piston **100** to move toward end **96** of cylinder **94**. Although the preferred actuator device **90** includes a dual piston and rod arrangement as shown, it should be understood, however, that other arrangements can also be used. For example, actuator device **90** can have a single piston and rod in which case support ring **108** is replaced with an orifice ring and expander material **112** occupies the space below the orifice ring.

Expander **112** is electrically connected by an igniter wire **116** extending through end **114** to control panel **20** so that actuator device **90** may be selectively activted by a control signal from control panel **20**. Although expander **112** is preferably a pyrotechnic material it should be understood that any type of device may be used such as, for example, a compressed spring wherein upon activation by control panel **20** a release mechanism releases the compressed spring to expand in contact with piston **97** causing rod **99** to contact piston **100** and slide piston **100** toward end **96**. In the preferred device, a restrainer block **118** is screwed onto end **114** of cylinder **94** to prevent cylinder **94** from bursting upon ignition of expander **112**.

Flange **24** contains a plurality of openings **120** extending therethrough and in axial alignment with each rod **104**. In the relaxed position, that is, before activtion of expander **112**, rod **104** extends into opening **120** and is in sliding engagement with flange **24**. As opening **120** approaches surface **122** of flange **24** the diameter thereof is substantially increased to enable a flexible diaphragm **124** to be seated therein thereby sealing opening **120** between surfaces **98** and **122**. To prevent rod **104** from puncturing diaphragm **124** when actuator device **90** is activated a collar **125** is secured to rod **104**, as by welding, between end **96** of cylinder **94** and surface **98** of flange **24**. Colar **125** is positioned so that when actuator device **90** is activated rod **104** will slide within opening **120** and flex diaphragm **124** but collar **125** will contact surface **98** and stop further movement of rod **104** before rod **104** punctures diaphragm **124**. Further, a flexible spring **127** surrounds rod **104** between surface **98** and collar **125** to maintain tension on collar **125** to keep it in contact with end **96** prior to activation of actuator device **90**. Thus, rod **104** will not slide in and out of cylinder **94** prior to activation of actuator device **90**.

Actuator device **90** further includes a contact plate **126** having a first end **128** connected to shearing device **92** and a second end **130** spaced from and in alignment with opening **120**. End **128** includes a recess **132** wherein one end **134** of shearing device **92** is seated. End **130** has a threaded opening **136** extending therethrough and in axial alignment with opening **120** in flange **24**. For fluid inlet device **14** which are placed in a circle around surface **122** of flange **24**, end **128** is formed at an angle to end **130** to be in alignment with shearing device **92** and opening **120**, respectively, since these fluid inlet tubes **14** are formed at an angle to cylinder **94**. The center fluid inlet device **14** is not formed at an angle to cylinder **94** and thus end **128** is not formed at an angle to end **130**. Contact plate **126** further includes an adjusting screw **138** threated into opening **136** and extends into opening **120** in flange **24** and is adjusted until it touches diaphragm **124**. A guide ring **140** is secured such as by a press fit, within opening **120** above diaphragm **124** and is in sliding contact with adjusting screw **138**. Guide ring **140** guides adjusting screw **138** within the enlarged portion of opening **120**.

Shearing device **92** is preferable tubular having a central opening **133** extending therethrough and is connected between contact plate **126** of actutor device **90** and sleeve **74** of fluid inlet device **14**. One end **134** of shearing device **92** fits within recess **132** of end **128** on contact plate **126** and is secured and sealed therein as by brazing. The other end **142** of shearing device **92** fits within recessed opening **81** of end **83** on sleeve **74** so that glass insert **66** extends within opening **133** and is secured and sealed therein as by brazing. Shearing device **92**, preferable includes a V-shaped notch **144** sub-

stantially midway between ends **134** and **142** and circumferentially extending around the outer periphery **146** thereof so that upon activation of actuator device **90**, shearing device **92** will shear at the V notch. Shearing device **92** is preferably made from a hard and brittle material such as ceramic so that it is easily snapped at V notch **144** when a shearing force is applied thereto. Other hard and brittle materials may also be used such as, for example, glass, brick, and porcelain.

Closing device **22** is associated with each fluid inlet device **14** that is circularly spaced and inclined to surface **122** of flange **24**. Preferably, the central fluid inlet device **14** does not have an associated closing device **22** as will be explained hereinafter. As clearly shown in FIG. **5** closing device **22** includes an actuator **148** and a movable clamp **150**. Actuator **148** includes an expandable bellows **152** wherein an expander **154** is contained. Expander **154** is preferably made of a material such that when ignited a gas is formed to expand bellows **152**. An igniter wire **158** extends from expander **154** to control panel **20** so that upon command a control signal from control panel **20** passes through igniter wire **158** and ignites expander **154** which expands bellows **152**. A housing **160** surrounds bellows **152** in a manner whereby the sides of bellows **152** are in contact with the sides of housing **160**. This causes bellows **152** to expand along its longitudinal axis rather than expanding laterally. Housing **160** is secured to surface **40** of support disk **38**, such as by screws **162**, so that the longitudinal axis of bellows **152** substantially intersects deformable tube **62** between circular support **28** and flange **24**.

Movable clamp **150** includes a first arm **164** having a first end **166** adjacent to and overlapping tube **62**. A second arm **168** has a first end **170** adjacent to and overlapping tube **62** oppositely positioned from end **166** of arm **164**. First and second arms **164** and **168** are pivotably connected together below ends **166** and **170**, respectively, by bolt **172**. A first linking bar **174** is pivotably connected at one end **175** to a second end **176** of arm **164** by a pivot pin **178**. A second linking bar **180** is pivotably connected at one end **181** to a second end **182** of arm **168** by a pivot pin **184**. A support platform **186** abuts actuator **148** so that surface **188** is in contact with bellows **152**. Support platform **186** includes a flange **190** extending therefrom. Flange **190** and the other ends **192** and **194** of linking bars **174** and **180**, respectively, are pivotably connected together by a pivot pin **196**. Arms **164** and **168** abut beveled surface **34** of circular support **28** and are secured thereto by pivot bolt **172**.

End **166** of arm **164** includes a substantially flat surface **198** adjacent to tube **62**. As shown in FIG. **6** end **170** of arm **168** includes a land **200** and a pair of grooves **202** on each side of land **200**. Land **200** is formed on surface **204** of end **166** which is adjacent to tube **62** and formed such that the longitudinal axis **206** thereof is transverse to the longitudinal axis **208** of tube **62**. When bellows **152** expands it causes support plate **186** to move which causes linking bars **174** and **180** to expand outwardly thereby causing arms **164** and **168** to pivot about bolt **172** closing ends **166** and **170** against tube **62**. Land **200** deforms and pinches tube **62** against surface **198** closing opening **64** in tube **62**.

Referring to FIG. **1**, control panel **20** is any well known and conventional electronic control and power supply system **210** such as, for example, a D.C. power supply. Control panel **20** includes three selector switches **212, 214,** and **216**. When selector switch **212** is switched to position **1**, it completes an electrical circuit between power supply **210** and one heater **88** associated with the first fluid inlet device **14** to be activated for use. When selector switch **214** is switched to position **1**, it completes an electrical circuit between power supply **210** and one actuator device **90** of the opening device **18** associated with the first fluid inlet device **14** to be opened to the fluid to be sampled. When selector switch **216** is switched to position **1**, it completes an electrical circuit between power supply **210** and one actuator device **148** of the one closing device **22** associated with the first fluid inlet device **14** to be closed upon completion of the fluid sample taking. Selector switches **212** and **214** are switched sequentially from position **1** to **7** which selectively activates in sequence heaters **88** and actuator devices **90** for selectively opening at different times each of the seven fluid inlet devices **14**. Selector switch **216** is switched sequentially from positions **1** to **6** which selectively activates in sequence the first six actuator devices **148** for selectively closing each of the first six fluid inlet devices **14** before the next fluid inlet device **14** is opened. The last fluid inlet device **14** need not be closed since no further samples can be taken by fluid sampling device **10**. Selector switches **212, 214,** and **216** may be switched by conventional dial switches as shown in FIG. **1** or may be activated remotely by electromagnet signals such as radio waves or by light signals such as emitted by LASERS. The only requirement being that it having switching capabilities so that each fluid inlet device **14**, opening device **18**, and closing device **22** can be individually and selectively activated.

In operation, fluid sampling device **10** is connected in a conventional manner to a fluid analyzer such as, for example, a gas mass spectrometer **218** so that inner cavity **30** of flange **26** is opened to gas analyzing components of the mass spectrometer. It is preferred that a conventional gas cleaning device (not shown) be incorporated with mass spectrometer **218** to purge and remove the excess sampled gas therefrom prior to introducing a new gas sample. It is also preferred that fluid sampling device **10** and mass spectrometer **218** be enclosed within a gas tight structure (not shown) whereby only surface **122** of flange **24** will be exposed to the various gases to be sampled. This will protect the various components of fluid sampling device **10** from attack by harmful environmental conditions.

When a first sample is to be taken, switch **212** on control panel **20** is turned to position **1** which causes an electrical current to flow from power supply **210** only through the electrical heating wire **88** in the first fluid inlet device **14** to be used to take a gas sample. The electrical current heats heating wire **88** which, in turn, heats insulating coating **86** and metal tube **62**. The heat drives off any contaminated gases that may have adhered to opening **64** in metal tube **62**. The driven off gases are absorbed by the gas cleaning device in the conventional manner.

After metal tube **62** has been purged, switch **214** on control panel **20** is turned to position **1** which sends an electrical current from power supply **210** only through wire **116** associated with actuator **90** of the first fluid inlet device **14** to cause wire **116** to ignite expander material **112** causing it to release a gas. As the gas expands it pushes on piston **97** causing it and rod **99** to slide upward in cylinder **94** until piston **97** contacts support ring **108**. As rod **99** slides upward it contacts piston **100** causing it and rod **104** to slide upward in cylinder **94**. Rod **104** slides upward in opening **120** com-

pressing spring 127 between collar 125 and surface 98 until rod 104 contacts diaphragm 124. Diaphragm 124 provides a seal within opening 120 to prevent the outside gases from flowing through opening 120 and into the interior of fluid sampling device 10 while at the same time providing the flexibility to allow movement of adjusting screw 138 by rod 104. Diaphragm 124 flexes under pressure by rod 104 and pushes against adjusting screw 138 causing adjusting screw 138 to slide upward against guide ring 140. Rod 104 is prevented from rupturing diagragm 124 by collar 125 and spring 127 coming in contact with surface 98. This upward movement of adjusting screw 138 imparts a rotational moment to contact plate 126. This bending moment of contact plate 126 imparts a shearing force to tubular shearing device 92 causing it to shear or break at V notch 144 thereby exposing glass insert 66 and central opening 16 to the gas to be sampled. The gas to be sampled flows through central opening 16 in fluid inlet device 14 and into inner cavity 30 in flange 26. The gas thereupon flows into mass spectrometer 218. The gas is prevented from flowing into the interior of fluid sampling device 10 by bellows 84 since the gas can only flow between bellows 84 and sleeve 74.

Upon completion of the gas analysis by mass spectrometer 218, switch 216 is turned to position 1 which sends an electrical impulse from power supply 210 through wire 158 associated with actuator device 148 of the closing device 22 which is adjacent to the first fluid inlet device 14 to ignite expander 154. As expander 154 burns the gases developed expands bellows 152. Bellows 152 presses against support plateform 186 moving support plateform 186. The movement of of support platform 186 causes linking bars 174 and 180 to pivot about pivot pin 196 and about pivot pins 118 and 184, respectively. This pivoting action causes ends 176 and 182 of arms 164 and 168 respectively, to separate due to the arms pivoting about one another at pivot bolt 172. As ends 176 and 182 separate, ends 166 and 170 of arms 164 and 168, respectively, close causing flat surface 198 and land 200 to contact metal tube 62. Ends 166 and 170 continue to close until land 200 deforms metal tube 62 and pinches opening 64 shut to close central opening 16 and preventing any gas from flowing through central opening 16 into mass spectrometer 218. Preferably, linking bars 174 and 180 pivot to slightly over center to lock ends 166 and 170 in the closed position to ensure no leakage of gas through central opening 16. After central opening 16 is closed the conventional gas cleaning device (not shown) purges mass spectrometer 218.

When a second gas sample is to be taken, selector switch 212 of control panel 20 is turned to position 2 which heats a second heater wire 88 around a new fluid inlet device 14. The sequence of events for opening and closing the second fluid inlet device 14 is identical to that hereinbefore described for the first fluid inlet device 14. This cycle continues until all fluid inlet devices 14 have been used. When the seventh and last fluid inlet device 14 has been opened such as, for example, the central fluid inlet device 14 as shown in FIGS. 1 and 2, there is no need to close central opening 16 following the gas analysis since no further gas samples can be taken. Thus, closing device 22 can be elimiated for the last fluid inlet device 14.

There has been disclosed a fluid sampling device for selectively sampling multiple fluids. The problems associated with taking and analyzing different fluids or fluids at different locations have been eliminated by providing a device with a plurality of fluid sampling inlet devices that are selectively opened and closed to surrounding fluids thereby permitting sampling of numerous fluids by a single fluid analyzer.

Accordingly, the invention having been described in its best embodiment and mode of operation, that which is desired to be claimed by Letters Patent is:

1. A fluid sampling device for selectively sampling multiple fluids comprising:
   - a support frame;
   - a plurality of fluid inlet means extending through said support frame, each of said inlet means having an aperture extending therethrough;
   - means responsive to a control signal for selectively opening said aperture for passing said fluid therethrough; and
   - means responsive to another control signal for selectively closing said aperture for terminating further fluid flow therethrough.

2. The fluid sampling device of claim 1 wherein said support frame includes:
   - a first flange having a plurality of openings extending thererthrough for receiving a portion of each of said fluid inlet means; and
   - a second flange spaced from and axially aligned with said first flange and having a plurality of openings extending therethrough for receiving another portion of each of said fluid inlet means.

3. The fluid sampling device of claim 1 wherein each of said fluid inlet means includes:
   - tube means having a portion of said aperture longitudinally extending therethrough;
   - fluid receiving means having another portion of said aperture longitudinally extending therethrough;
   - means for holding said tube means and said fluid receiving means for maintaining a substantially axial alignment of another portion of said aperture in said fluid receiving means; and
   - sleeve means surrounding said fluid receiving means, holding means and a portion of said tube means and forming an annular space therebetween.

4. The fluid sampling device of claim 3 wherein each of said fluid inlet means further includes:
   - an insulating coating surrounding said portion of said tube means within said sleeve means; and
   - an electrical heater surrounding a portion of said insultor coating and responsive to an additional control signal for removing contaminated fluids from said tube means.

5. The fluid sampling device of claim 4 wherein:
   - said holder means includes an outwardly and circumferentially extending flange within said annular space; and
   - said sleeve means includes an inwardly and circumferentially extending flange axially spaced from said flange on said holder means.

6. The fluid sampling device of claim 5 wherein each of said inlet means further includes a bellows within said annular space and surrounding said tube means, said bellows being connected between said outwardly extending flange and said inwardly extending flange for providing thermo isolation of said tube means to reduce heat loss from said electrical heater.

7. The fluid sampling device of claim 3 wherein said fluid receiving means and said holder means have substantially the same coefficient of expansion.

8. The fluid sampling device of claim 7 wherein said fluid receiving means is formed from a material having

a composition in the range of 65–70% SiO_2, 3–18% B_2O_3, 1% Li_2O, 1–2% Na_2O_1 and 2–8% K_2O.

9. The fluid sampling device of claim **7** wherein said fluid receiving means is formed from a material having a composition substantially of 70% S_iO_2, 3% $A1_2O_3$, 17% B_2O_3, 1% Li_2O, 1% Na_2O and 8% K_2O.

10. The fluid sampling device of claim **7** wherein said holder mans is formed from a material having a composition substantially of 54% Fe, 29% Ni, and 17% Co.

11. The fluid sampling device of claim **1** wherein each of said opening means includes:

actuator means adjacent to each of said fluid inlet means and responsive to said control signal; and

shearing means in sealing engagement between said actuator means and said fluid inlet means, said shearing means being separated upon activation of said actuator means by said control signal for exposing said aperture to said fluid.

12. The fluid sampling device of claim **11** wherein said actuator means includes:

a cylinder;

a first movable piston within said cylinder;

a first rod connected to said piston;

a second movable piston within said cylinder axially aligned with and spaced from said first rod;

a second rod connected to said second piston and having a portion thereof within said cylinder and another portion thereof extending from a first end of said cylinder;

an expander within said cylinder between said first piston and a second end of said cylinder and being responsive to said control signal; and

a contact plate having one end in sealing engagement with said shearing means and another end spaced from and in alignment with said second rod.

13. The fluid sampling device of claim **12** wherein said fluid inlet means and said shearing means are formed at an angle to each of said actuator means.

14. The fluid sampling device of claim **11** wherein said shearing means is tubular.

15. The fluid sampling device of claim **14** wherein said shearing means includes an intermediately located weakened portion.

16. The fluid sampling device of claim **15** wherein said shearing means is formed of ceramic.

17. The fluid sampling device of claim **1** wherein each of said closing means includes;

actuator means adjacent to each of said fluid inlet means and responsive to said another control signal; and

movable clamping means responsive to said actuator means and having a portion thereof overlapping a portion of said fluid inlet means for deforming said portion of said fluid inlet means and closing said aperture upon activation by said actuator means.

18. The fluid sampling device of claim **18** wherein said actuator means includes;

a bellows; and

an expander within said bellows which is responsive to said another control signal for expanding said bellows upon activation by said another control signal.

19. The fluid sampling device of claim **17** wherein said portion of said fluid inlet means is a deformable tube.

20. The fluid sampling device of claim **19** wherein said movable clamping means includes:

a first arm having a first end overlapping said deformable tube;

a second arm pivotably connected to said first arm and having a first end overlapping said deformable tube oppositely positioned from said first end of said first arm;

a first linking bar pivotably connected at one end to a second end of said first arm;

a second linking bar pivotably connected at one end to a second end of said second arm; and

a support platform abutting said actuator means and pivotably connected to the other ends of said first and second linking bars.

21. The fluid sampling device of claim **20** wherein said first end of said first arm includes a substantially flat surface adjacent to said deformable tube and said first end of said second arm includes a land adjacent to said deformable tube and having the longitudinal axis of said land transverse to the longitudinal axis of said deformable tube.

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