(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 999 348 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.05.2000 Bulletin 2000/19

(51) Int Cl.[7]: **E21B 49/08**

(21) Application number: **99308659.4**

(22) Date of filing: **01.11.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **02.11.1998 US 106752 P**
20.07.1999 US 357416

(71) Applicant: **Halliburton Energy Services, Inc.**
Dallas, Texas 75381-9052 (US)

(72) Inventors:
- **Schultz, Roger L.**
  Denton, Texas 76205 (US)
- **Benge, James F.**
  Longview, Texas 75604 (US)
- **Stout, Christopher A.**
  Janesville, WI 53545 (US)

(74) Representative: **Wain, Christopher Paul et al**
A.A. Thornton & Co.
235 High Holborn
London WC1V 7LE (GB)

(54) Fluid sample chamber with non-reactive lining

(57) An apparatus for retaining a well-fluid sample and a method for using the same. The apparatus comprises a variable volume sample chamber having interior surfaces of a nonreactive material, such as a ceramic, the interior surfaces defining a cavity (222). The sample chamber comprises a tubular member, a piston (226) slidingly engaged in the tubular member operable in response to fluid pressure within the sample chamber, a passageway (260) defined in the sample chamber and adapted for providing fluid communication between the cavity (222) and an area exterior the sample chamber, and a valve assembly (254) operable for selectively opening and closing the passageway (260).

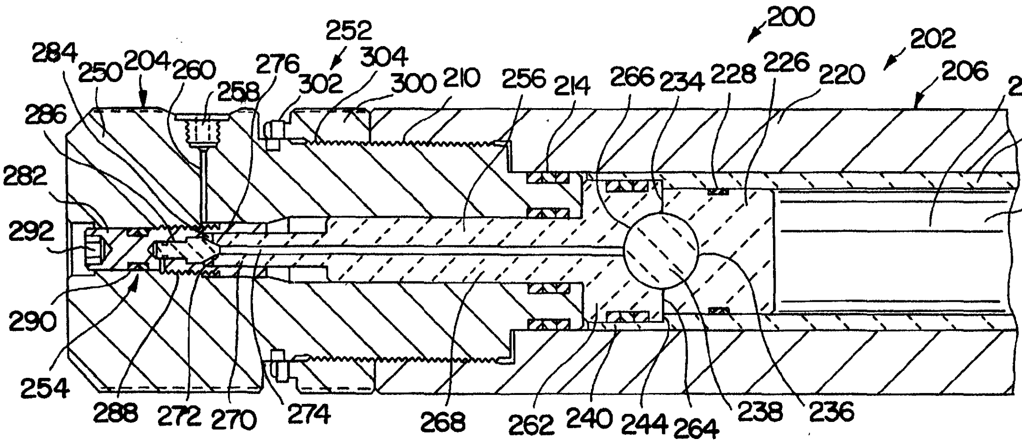

FIG. 2A

EP 0 999 348 A2

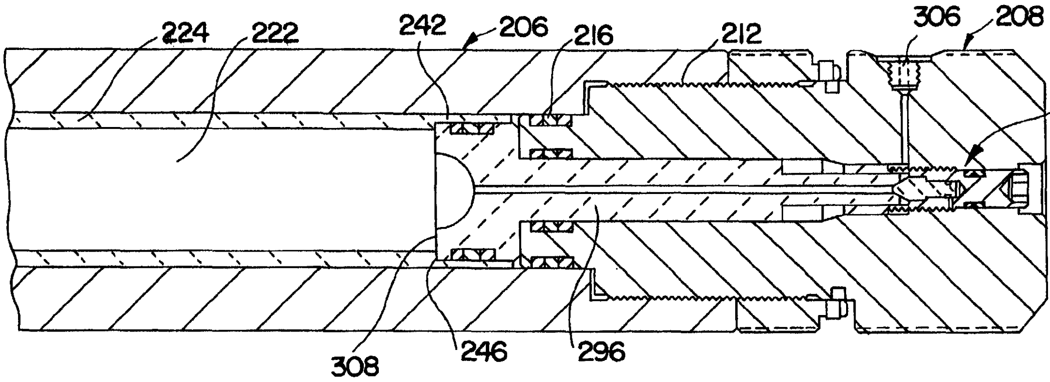

FIG. 2B

Description

[0001] The invention relates to a well fluid sample retaining or storing device, and more particularly to a sample chamber for use in a sampler module or sample bottle having a non-reactive lining.

[0002] A common operation in reservoir evaluation operations is to collect reservoir fluid samples. These samples are generally trapped in the sample chamber of a well fluid sampler module which is retrieved to surface. A single sampling tool may hold a single or a plurality of sampler modules each having a sample chamber. Measuring instruments such as pressure and temperature gauges, may also be mounted in the sampling tool for evaluation of the well parameters. When the tool is at a desired depth in the well bore, the sampler module is opened or exposed to the well fluid, and the case is filled. The tool and sampler module may open in response to a signal from the surface or pressure exerted by the well fluid. Once filled, the sampler module is sealed and brought to the surface. At the surface, the sample is usually transferred into a sample bottle which is designed to contain high pressure samples in a safe manner, although the sample may remain in the sample module. The sample is stored, often for long periods of time, for later laboratory analysis. Typical sampling tools and methods are described in U.S. Patent 4,878,538 issued to Christensen, U.S. Patent 4,903,765 issued to Zunkel, U.S. Patent 4,883,123 issued to Zunkel, and U. S. Patent 5,240,072 issued to Schultz, et al., each of which is assigned to Halliburton, the assignee of the present invention.

[0003] Typically sample bottles and sampler modules are made of metallic alloys which are compatible with common hydrocarbon mixtures. Although the chamber materials are relatively non-reactive, there is still a very high probability that some amount of chemical reaction and absorption will occur between the chamber material and some of the sample constituents. This poses a problem in that if the reaction portion of the sample is in a very small concentration, most, if not all, of this component will be depleted through the chemical reaction and absorption. This will produce erroneous results when a lab analysis is performed on the sample. This problem can be very severe when samples are left in sample chambers for long periods of time. One object of this invention is to present a sample chamber, for use in a sampler module or sample bottle, which is virtually nonreactive with most of the chemicals encountered in a typical well fluid sample.

[0004] There are also difficulties in thoroughly cleaning metallic sample chambers. Contaminants tend to be absorbed into the pores of these materials. Once absorbed, the contaminants are difficult to clean out of the sample chambers. Incomplete cleaning can result in inaccuracies in testing of later samples, and the damage to the sample chamber shortens the life of the sampling tool or sample bottle. Another object of the invention is to present a sample chamber which is easy to clean and has a longer useful life than typical sample chambers.

[0005] The invention discloses a sample chamber with a non-reactive lining, preferably of ceramic. The sample chamber may take many forms depending on the vessel in which it is disposed, and the invention is not limited to the specific embodiments disclosed. For the purposes of explanation, sample chambers are explained in detail as disposed in a sampler module and a sample bottle. This disclosure describes a sampler module and a sample bottle having sample chambers which are constructed with non-reactive linings and parts, preferably of ceramic, which are nonporous and virtually nonreactive with most chemicals encountered in well fluids. A sampler module and a sample bottle are presented in which the well fluid sample is contained entirely by a ceramic liner, inserts, valves, and pistons. Inside the sample chamber there may be a ceramic ball for agitating the sample as it is drained.

[0006] A ceramic-to-ceramic seal is made between each of the chamber inserts and the ceramic liner, and between each valve dart and seat, as necessary. This allows the sample to be contained entirely within the chamber contacting only ceramic. The sample chamber may be used for shipping and storage purposes without degradation of the well fluid sample from chemical reaction with the sample chamber. This allows the sample to be stored for long periods of time in an inert chamber. The nonreactive nature of the lining makes sample degradation through absorption by or reaction with the sample chamber almost nonexistent. This allows for obtaining critical samples and makes long-term sample storage more feasible. Thorough cleaning of the wetted ceramic parts of the bottle is much easier and more efficient since ceramic does not absorb contaminants into its pores as will metallic surfaces.

[0007] According to another aspect of the invention there is provided an apparatus for retaining a well-fluid sample, the apparatus comprising a variable volume sample chamber having interior surfaces of a non-reactive material, the interior surfaces defining a cavity, the sample chamber comprising a tubular member, a piston slidingly engaged in the tubular member operable in response to fluid pressure within the sample chamber, a passageway defined in the sample chamber and adapted for providing fluid communication between the cavity and an area exterior the sample chamber, and a valve assembly operable for selectively opening and closing the passageway.

[0008] The non-reactive material is preferably ceramic. The tubular member preferably has a ceramic lining. Preferably, the piston is ceramic. Preferably, the passageway has a passageway lining of ceramic.

[0009] In an embodiment the sample chamber further comprises an endpiece sealingly disposed in the tubular member, the passageway being defined by the endpiece. The end piece is preferably ceramic.

[0010] In an embodiment, the valve assembly is a manually operable valve assembly comprising a valve element and a valve actuator for moving the valve element selectively between a closed position wherein the valve element seals the passageway and an open position wherein the passageway provides fluid communication between the cavity and an area exterior the sample chamber. The valve element is preferably ceramic. In this embodiment the sample chamber preferably forms part of a sample bottle.

[0011] In an embodiment, the passageway is defined in the tubular member.

[0012] In an embodiment, the valve assembly is a metering valve assembly operable in response to fluid pressure within the sample chamber, the metering valve assembly comprising a metering valve element having a sealing element attached thereto, the metering valve element slidingly disposed in the tubular member and moveable between a closed position wherein the sealing element seals the passageway and an open position wherein the passageway provides fluid communication between the cavity and an area exterior the sample chamber. The metering valve element is preferably ceramic. In this embodiment, the sample chamber preferably forms part of a sampler module.

[0013] According to another aspect of the invention there is provided a method for retaining a well-fluid sample in an apparatus having a sample chamberwith interior surfaces defining a cavity therein, the method comprising the steps of: placing the sample chamber proximate a well-fluid sample, the sample chamber comprising a tubular member, a piston slidingly engaged in the tubular member operable in response to fluid pressure within the sample chamber, a passageway defined in sample chamber and adapted for providing fluid communication between the cavity and an area exterior the sample chamber, and a valve assembly operable for selectively opening and closing the passageway; opening the passageway to provide fluid communication of the well-fluid sample between an area exterior the sample chamber and the cavity; transferring a well-fluid sample via the passageway from an area exterior the sample chamber to the cavity; and sealing the sample chamber by closing the passageway.

[0014] In an embodiment the step of opening the passageway (to provide .fluid communication of the well-fluid sample between an area exterior the sample chamber and the cavity) further comprises the step of manually opening the valve assembly by actuating a valve actuator to move a valve element from a closed position wherein the valve element seals the passageway to an open position wherein the passageway provides fluid communication between the cavity and an area exterior the sample chamber.

[0015] In an embodiment wherein the step of sealing the sample chamber by closing the passageway further comprises the step of manually closing the valve assembly by actuating the valve actuator to move the valve element from an open position wherein the passageway provides fluid communication between the cavity and an area exterior the sample chamber to a closed position wherein the valve element seals the passageway.

[0016] In another embodiment, the step of transferring a well-fluid sample via the passageway from an area exterior the sample chamber to the cavity further comprises the step of transferring the well-fluid sample from a sampler module to the cavity of the sample chamber.

[0017] In another embodiment, the valve assembly is a metering valve assembly operable in response to fluid pressure within the sample chamber, the metering valve assembly comprising a metering valve element having a sealing element attached thereto, the metering valve element being slidingly disposed in the tubular member and moveable between a closed position wherein the sealing element seals the passageway and an open position wherein the passageway provides fluid communication between the cavity and an area exterior the sample chamber, the step of sealing the sample chamber by closing the passageway further comprises the step of moving the metering valve element to the closed position.

[0018] Reference is now made to the accompanying drawings, in which:

Figure 1A-D comprise a longitudinal sectional view of a preferred embodiment of a sampler module of the present invention;

Figure 2A-B comprise a longitudinal sectional view of a preferred embodiment of a sample bottle of the present invention wherein the bottle is in an empty condition; and

Figure 3A-B comprise a longitudinal sectional view of a preferred embodiment of a sample bottle of the present invention wherein the bottle valves are in an open position.

[0019] Numeral references are employed to designate like parts throughout the various figures of the drawing. Terms such as "left", "right", "clockwise", "counterclockwise", "horizontal", "vertical", "up" and "down" when used in reference to the drawings, generally refer to orientation of the parts in the illustrated embodiment and not necessarily during use. The terms used herein are meant only to refer to relative positions and/or orientations, for convenience, and are not to be understood to be in any manner otherwise limiting. Further, dimensions specified herein are intended to provide examples and should not be considered limiting.

[0020] Presented are embodiments of a sample chamber exemplified in use in a sampler module and a sample bottle with non-reactive ceramic linings. The sampler module is seen in Figures 1A-D. Although only one embodiment of the sampler module is described in detail, it is understood that the invention may be practiced using any sampler module desired. The particular sampler module described herein is for use alone or as one of a plurality of sampler modules in a larger sampling tool. The sampler module is designed such that the sample chamber, which contains the well fluid sample, is entirely of non-reactive material, namely ceramic. The chamber lining, the piston, metering valves and the like are all of ceramic such that the well sample is entirely encased in a non-reactive lining. Similarly, the invention may be practiced on other particular embodiments of sampler modules or sampling tools, whether with single or multiple sampling chambers, by lining the sample chambers thereof with ceramic or other suitable material.

[0021] A sampler module **10** is seen in Figures 1A-D. The sampler module **10** is for use in a sampling tool as described in U.S. Patent 4,787,447 to Christensen which is hereby incorporated in its entirety by reference, or may be used in a sampling tool such as described in U.S. Patent 5,687,791 to Beck, et al. The sampler module **10** comprises a housing **12** having a drain cover **14**, drain nipple **16**, sample case **18**, metering case **20**, metering nipple **22** and air case **24**.

[0022] Referring to Figures 1A and B, a drain cover **14** is connected to the drain nipple **16** at the threaded connection **30** and a seal **32** provides sealing engagement therebetween. The drain cover **14** has a threaded portion **34** extending therefrom for attachment to an adapter, hanger or connector of a sampling tool, as known in the art. The drain cover **14**, as well as the nipples **16** and **22** and air case **24,** have radially spaced spanner wrench indentations **36** for gripping by a spanner wrench or other appropriate tool for tightening and loosening the threaded connections between the housing parts.

[0023] The lower end of the drain nipple **16** is connected to the sample case **18** at the threaded connection **38** with a seal **40** providing sealing engagement therebetween. A longitudinal drain nipple passageway **42** is defined through the drain nipple **16.** The passageway **42** is part of an autoclave system, as is known in the art.

[0024] The sample case **18**, as seen in Figure 1A-B, is sealingly connected to the drain nipple **16** as described, and at the other end the sample case **18** is connected to the metering case **20** at the threaded connection **44** with a seal providing sealing engagement therebetween. The sample case **18** defines an elongated central cavity **48** therein bounded at its upper end by the lower face **50** of the drain nipple **16**. The central cavity **48** of the sample case **18** is lined with a cylindrical sample case liner **52** of non-reactive material, preferably ceramic. Preferably the sample case liner **52** is pressure fit into the sample case **18**. As seen in Figure 1B, a piston **54** is originally disposed at the lower end of the central cavity **48** in the sample case **18.** Sealing engagement is provided between the piston **54** and the sample case **18** by a piston ring **56**. The piston **54** is preferably of non-reactive material, namely ceramic. It will be thus seen that the portion of the central cavity **48** above the piston ring **56** is separated from the portion of the central cavity **48** below the piston ring **56.** The portion of the central cavity **48** above the piston ring **56** defines an air chamber **60.**

[0025] Preferably the piston **54** includes a recess **58** allowing for the disposal therein of the mixing ball **62.** The mixing ball **62** is also preferably of non-reactive material such as ceramic.

[0026] Referring to Figures 1B-C, the metering case **20** defines an elongated metering central cavity **74** therein. A transverse port **76** provides communication between the metering central cavity **74** and the exterior of the sampler module housing **12**, seen in Figure 1C. A countersink in the exterior wall of the metering case **20** forms a flat shoulder **78** which extends adjacent the port **74**. The metering case **20** defines a first bore **80** in its upper end and a larger diameter second bore **82** in its lower end. The first bore **80** is lined with a metering case liner **84** made of non-reactive material, preferably ceramic. The ceramic liner **84** is preferably pressure fit into the first bore **80.** The upper face **86** of the first bore **80** abuts the lower face **88** of the piston **54** as seen in Figure 1B.

[0027] Slidably disposed in the metering central cavity **74** is a metering valve **90**. The metering valve **90** has a cylindrical first end **92** slidably disposed in the first bore **80** and an enlarged cylindrical second end **94** slidably disposed in the second bore **82.** The metering valve **90** is preferably of non-reactive ceramic material.

[0028] The first end **92** of the metering valve **90** defines a longitudinal valve passageway **100** therein, forming an opening **102** at the upper face **96** of the first end **92** of the metering valve **90.** The valve passageway **100** is in fluid communication, via one or more access ports **104**, with an annular space **106** defined between the inner wall of the first bore **80** and the first end **92** of the metering valve **90.** It will thus be seen that the valve passageway **100** provides fluid communication between the annular space **106** and the lower face **88** of the piston **54**, and that the annular space **106** and valve passageway **100** provide fluid communication between the central cavity **48** in the sample case **18** and the central cavity **74** in the metering case **20**. Above the access ports **104** a pair of spaced sealing rings **108** and **110** are carried on the exterior of the metering valve **90**. The importance of the spacing of these sealing rings will be explained hereinafter. The metering valve **90** is held stationary in the metering cavity **74** by a plurality of shear pins **112** extending between the first end **92** of the metering valve **90** and the walls of the first bore **80**.

[0029] The second end **94** has a valve ring **114** sealingly engaging the second bore **82** of the metering valve **90** below the port **76,** seen in Figure.1C. It will be thus seen that the portion of the metering cavity **74** above the valve ring **114** is separated from the portion of the metering cavity **74** below the valve ring **114.** The portion of the metering cavity **74** below the valve ring **114** defines a transfer fluid cavity **116** which may initially be filled with oil or any other desired transfer fluid as is known in the art. The second end **94** of the metering valve **90** has a cylindrical extension **98** extending therefrom into the second bore **82.** It will be seen that an annular area differential is defined between the first and second ends **92** and **94** of the metering valve **90.**

[0030] It is apparent that a fluid area is defined between the piston ring **56** of the piston **54** and the valve ring **114** of the metering valve **90**. This area is the sample chamber **120** and is completely enclosed by non-reactive ceramic parts, namely, the ceramic liners **52** and **84**, piston **54**, mixing ball **62** and metering valve **90.** It is in the ceramic lined sample chamber **120** that the well fluid sample is stored in a non-reactive environment.

[0031] Referring to Figures 1C-D, the lower end of the metering case **20** is connected to a metering nipple **22** at a threaded connection **124** and a seal **126** provides sealing engagement therebetween. At the juncture of the metering nipple **22** and the metering case **20**, the nipple **22** defines a shoulder **128.** The metering nipple bore **130**, defined by the metering nipple **22**, is of sufficient size to receive the extension **98** of the second end **94** of the metering valve **90**. The metering nipple **22** defines a longitudinal passageway **132** therethrough, seen in Figure 1D, with orifice means **134** such a Visco-jet disposed across the lower end thereof. The Visco-jet is of a kind known in the art and has a small, precisely sized, orifice therethrough which provides restricted communication between the transfer fluid cavity **116** and the air case **24.**

[0032] The lower end of the metering nipple **22** is connected to the air case **24** through a threaded connection **136** with a seal **138** providing sealing engagement therebetween. The air case **24** defines an elongated air cavity **140** therein which is in communication with the passageway **132** in the metering nipple **22.** The air cavity **140** in the air case **24** has a closed lower end **142.** The air case **24** has a downwardly extending stud portion **144** which is designed to extend into a hole on a die plate in a multi-chambered sampling apparatus such as is known in the art.

[0033] Turning to the operation of the sampler module **10**, the components of the sampler module **10** are in the configuration shown in Figure 1A-D when the tool is run into a well bore. In this run-in position, the transfer fluid chamber **116** is filled with a viscous fluid such as oil. The air cavity **140** is initially filled with atmospheric air. Also initially empty is the central cavity **48** in the sample case **18.**

[0034] Once at the desired well depth, the sampler module **10** is exposed to fluid from the well bore. It will be seen that the port **76** in the metering case **20** is in fluid communication with the exterior of the sampler module **10.** Thus, as the sampler module **10** is exposed to the well environment, well fluid enters the port **76**, flowing through the annular space **106** and longitudinal valve passageway **100,** coming into contact with the lower face **88** of the piston **54,** as best seen in Figure 1B. The fluid pressure forces the piston **54** upwardly in the central cavity **48** of the sample case **18,** compressing the air in the central cavity **48** into the drain nipple **16**. The piston **54** continues to move upwardly until it contacts the lower face **50** of the drain nipple **16**, as best seen in Figure 1A, until the sample case **18** is filled with well sample fluid.

[0035] Fluid pressure also forces the metering valve **90** downwardly in the metering case **20**, but the shear pins **112** maintain the metering valve **90** in place until the sample case **18** is filled. Once the sample case **18** is filled, pressure will build in the central cavity **48** and downward pressure on the metering valve **90** will increase. When a predeetermined critical pressure is reached, the shear pins **112** shear away and the metering valve **90** is free to move downwardly in the metering case **20.** The oil present in the transfer fluid chamber **112** provides resistance to this downward motion of the metering valve **90**, since the oil must past through the small orifice **134** in the Visco-jet before being discharged into the air cavity **140** in the air case **24.** Eventually, the metering valve **90** moves all the way downwardly until it contacts the lower shoulder **128**, best seen in Figure 1C, in the metering case **20** with the extension **98** slidingly engaged in the bore **130**, thus displacing all of the oil out of the transfer fluid chamber **116** and compressing the air in the air cavity **140**.

[0036] Once the metering valve **90** has reached its downwardmost position, the spaced sealing rings **108** and **110** close off the port **76** in the metering case **20**. Thus, once the sample chamber **120** is completely filled with a sample fluid, the sampler module **10** is closed. Thus, a metering means is provided for automatically closing the sampler module **10** when a predetermined fluid volume is in the sample chamber **120.**

[0037] Once the oil well tool is out of the well bore, the sample fluid in the sampler module may be drained. Alternately, the sampler module may act as the storage device. Because each sampler module is a self-contained unit, the sampler modules are easily transported and may be drained or stored where desired, such as in a laboratory.

[0038] The sampler module may be drained using methods known in the art. One example of a draining method without the use of mercury, commonly used in such operations, is described in U.S. Patent 5,423,229 to Schultz, et al. which is hereby incorporated by reference. The fluid may be drained into a sample bottle such as seen in Figures 2A-B and 3A-B.

[0039] The sample bottle presented here is by way of example only and is not intended to be limiting. The sample bottle comprises a sample chamber which is entirely comprised of non-reactive parts such that the fluid sample contained therein does not contact any reactive surfaces or materials. Preferably the non-reactive material is ceramic. The invention may be practiced in any sample bottle of any configuration and is not limited to the particular sample bottle described herein.

[0040] A sample bottle is seen in Figures 2A-B and 3A-B. The sample bottle **200** comprises a housing **202** having a first endcap **204**, a sample case **206,** and a second endcap **208**. The first and second endcaps **206** and **208** are attached to the sample case **206** at threaded connections **210** and **212,** respectively, and sealingly engaged to the sample case by seals **214** and **216,** respectively.

[0041] The sample case **206** comprises a cylindrical sample case body **220** defining a sample cavity **222** therein. The sample cavity **222** is lined with a tubular ceramic liner **224.** A piston **226,** preferably of ceramic, is slidingly mounted in the liner **224** and sealingly engages the liner **224** at piston ring **228.** The piston **226** thus divides the sample cavity **222** into a transfer fluid chamber **230** and a sample chamber **232,** seen in Figures 3A-B, as will hereinafter be described. The piston **226** has a sample face **234** having a semi-spherical recess **236** defined therein. A mixing ball **238,** preferably of ceramic, is disposed in the sample fluid chamber **232** of the sample cavity **222**. The ceramic liner **224** is preferably pressure fit into the sample case body **220** and at opposite ends comprises flanges **240** and **242.** The connection between the flanges **240** and **242** and the liner **224** define shoulders **244** and **246,** respectively.

[0042] The first endcap **204** comprises an endcap body **250**, a lock-nut assembly **252,** a valve apparatus **254** and a ceramic insert **256.** The endcap body includes a port **258** and tranverse port passageway **260.** It is understood that the second endcap **208** has similar parts.

[0043] The ceramic insert **256**, preferably pressure fit into the endcap body **250**, comprises an end portion **262** having an end face **264** with a semi-spherical recess **266** defined therein, an intermediate portion **268** and a tip portion **270** having a tip face **272.** An insert passageway **274** is defined through the insert **256** and has a tapered valve seat **276** opening at the tip face **272**. The recess **266** of the insert **256** is aligned with the recess **236** of the piston **226** to create a spherical opening for disposal of the mixing ball **238** when the piston **226** is positioned such that the sample face **234** abuts the end face **264** of the insert, as seen in Figure 2A-B.

[0044] A valve apparatus **254** having a valve actuator **282**, a valve chamber **284** and a valve dart **286,** is disposed in the first endcap **204** and is attached to the endcap by a threaded connection **288.** Seal **290** sealingly engages the endcap **204** and valve apparatus **254**. The valve chamber **284** is defined by the valve apparatus **254** and provides fluid communication between the insert passageway **274** and the port passageway **260** when the valve is in the open position seen in Figure 3B. The valve apparatus may be longitudinally moved between the open position, seen in Figure 3B, and the closed position, seen in Figure 3A, by rotating the valve apparatus upon the threaded connection **288**. The apparatus may be rotated by using the appropriate tool inserted into the valve socket **292** as is known in the art. In the closed position, the tapered valve dart **286**, preferably made of ceramic, is in sealing engagement with the tapered valve seat **276** of the ceramic insert. The valves on each end of the sample bottle **200** are area-balanced so there is no compression of fluid when the valves are opened or closed.

[0045] The port **258,** the port passageway **260,** the valve chamber **284,** and the insert passageway **274** combine to provide fluid communication between the area exterior the sample bottle **200** and the sample case cavity **222** when the valve apparatus is in the open position seen in Figure 3B. In the closed position of Figure 3A, the valve apparatus **254** prevents fluid communication and seals the sample cavity **222** and insert passageway **274** from the port passageway **260** and exterior of the bottle.

[0046] It is apparent that the sample bottle **200,** when filled as seen in Figure 3A-B, comprises a sample chamber **232** completely comprised of non-reactive ceramic parts. The ceramic liner **224,** piston **226**, mixing ball **238,** insert and valve dart **286** completely enclose the fluid sample. The sample is not exposed to reactive materials and so the sample is not contaminated and does not react effecting the purity of the sample.

[0047] For purposes of discussion, the lock-nut assembly **252** of the first endcap **204** will be described, but it is understood that the second endcap **208** has similar parts. To ensure a proper contact pressure between the ceramic liner **224** of the sample case **206** and the ceramic insert **256** at shoulder **244**, a lock-nut **300** is shear-pinned onto the body of the endcap so that only a certain amount of torque may be applied to the lock-nut **300** before the shear pins **302** shear. No increase in contact pressure between the ceramic parts can be made by further turning of the lock-nut **300.** Explained another way, the lock-nut **300** is attached to the endcap body **250** by a threaded connection **304.** A plurality of radially spaced shear pins **302** maintain the lock-nut **300** and endcap body **250** in stationary relative positions. The shear pins **302** are designed to shear or break when a pre-selected torque is applied to the lock-nut **300.** The endcap **204** is screwed onto the sample case **206** using the lock-nut **300.** As the lock-nut **300** is turned, the endcap body **250** is threadedly connected to the sample case **206**. The endcap body **250** is rotated until the end face **264** of the ceramic insert **256** is seated tightly against the shoulder **244,** thus creating a ceramic-to-ceramic seal. Placing continued torque on the lock-nut **300** shears the shear pins **302** such that the lock-nut **300** is free to turn in relation to the endcap body **250** about the threaded connection **304**. That is, the lock-nut 300 continues to turn about its threaded connection **304** with the endcap body **250** while the endcap body **250** ceases to turn about its threaded connection **210** with the sample case **206.** The torque necessary to shear the shear pins **302** is selected such that tightening the lock-nut **300** and endcap body **250** will not result in damaging or cracking of the ceramic insert **256** or ceramic liner **224.**

[0048] The second endcap **208** is similarly attached to the sample case **206** at threaded connection **212** and sealingly engaged at seal **216.** The ceramic liner **224** of the sample case **206** and the ceramic insert **296** of the endcap **208** fit together at shoulder **246** in a ceramic-to-ceramic seal. The second endcap **208** is of similar construction to the first endcap **204** for ease of manufacture, but it is understood that the second endcap **208** may take another design and not depart from the spirit of the invention.

[0049] Filling of the sample bottle **200** will now be discussed. In Figures 2A-B, the sample bottle **200** is in condition to receive a well fluid sample, such as from the sampler module **10.** Initially the piston **226** is in the position seen in Figure 2A, such that the sample face **234** of the piston **226** abuts the end face **264** of the insert **256.**

[0050] The mixing ball **238** is disposed in the spherical opening defined by the semi-spherical recesses **236** and **266.** Both the valve apparatus **254** and **294** are closed. A transfer fluid, such as water, glycol, nitrogen or other material as is known in the art, is disposed in the transfer fluid chamber **230**.

[0051] Drain collars, nipples and lines, with appropriate valving, are attached to the sample bottle **200**, as is known in the art. The drain lines and valving connect the sample bottle **200** to the sampler module **10** or other source which has a well fluid sample disposed therein.

[0052] The valve apparatus **254** and **294** are moved to their open positions, as seen in Figures 3A-B, to provide fluid communication between the cavity **222** and the drain lines attached to the ports **258** and **356.** From the drain lines, the fluid sample enters the first encap port **258**, flows through the port passageway **260**, the valve chamber **284** and the insert passageway **274**, and into the sample chamber **232** coming into contact with the sample face **234** of the piston **226**. The fluid pressure forces the piston **226** toward the second endcap **208** enlarging the sample fluid chamber **232** and contracting the transfer fluid chamber **230**. The transfer fluid in the transfer fluid chamber **230** provides resistance to the motion of the piston **226.** This resistance may be regulated by the valve and drain line assembly attached to the second endcap port **306** as the transfer fluid is drained out of the transfer fluid chamber **230.** Eventually, the piston **226** moves all the way through the cavity **222** until it contacts the end face **308** of the insert **296,** thus displacing the transfer fluid and filling the sample chamber **232** with sample fluid.

[0053] Once the sample chamber **232** is filled with sample fluid, the valve apparatus **254** and **294** are moved to the closed position, seen in Figures 2A-B, sealing off the sample bottle **200.** The sample bottle **200** is self-contained and is easily transportable. The sample bottle may be stored at any desired location for any length of time. Because the bottle is ceramic lined and all of the portions of the bottle which are in contact with the fluid sample are of non-reactive material, such as ceramic, the fluid sample will not corrode or react with the sample bottle thereby contaminating the fluid sample. Further, the bottle is easily cleansed for later reuse as the ceramic parts do not absorb the sample as metallic parts are prone to do.

[0054] It will be appreciated that the invention described above may be modified.

Claims

1. An apparatus for retaining a well-fluid sample, the apparatus comprising: a variable volume sample chamber having interior surfaces of a non-reactive material, the interior surfaces defining a cavity (48,222), the sample chamber comprising a tubular member, a piston (54, 226) slidingly engaged in the tubular member operable in response to fluid pressure within the sample chamber, a passageway (76, 260) defined in the sample chamber and adapted for providing fluid communication between the cavity (48, 222) and an area exterior the sample chamber, and a valve assembly (90, 254) operable for selectively opening the closing the passageway.

2. Apparatus according to claim 1, wherein the non-reactive material is ceramic.

3. Apparatus according to claim 1 or 2, wherein the sample chamber further comprises an endpiece (204) sealingly disposed in the tubular member, the passageway defined by the endpiece (204).

4. Apparatus according to claim 1, 2 or 3, wherein the valve assembly (254) is a manually operable valve assembly (254) comprising a valve element (286) and a valve actuator (282) for moving the valve element (286) selectively between a closed position wherein the valve element (286) seals the passageway (260) and an open position wherein the passageway (260) provides fluid communication between the cavity and an area exterior the sample chamber.

5. Apparatus according to claim 1, 2 or 3, wherein the valve assembly (90) is a metering valve assembly (90) operable in response to fluid pressure within the sample chamber, the metering valve assembly (90) comprising a metering valve element (92) having a sealing element (108,110) attached thereto, the metering valve element (92) slidingly disposed in the tubular member and moveable between a closed position wherein the sealing element (108, 110) seals the passageway (76) and an open position wherein the passageway (76) provides fluid communication between the cavity and an area exterior the sample chamber.

6. A method for retaining a well-fluid sample in an apparatus having a sample chamber with interior surfaces defining a cavity (48,222) therein, the method of comprising the steps of: placing the sample chamber proximate a well-fluid sample, the sample chamber comprising a tubular member, a piston (54, 226) slidingly engaged in the tubular member operable in response to fluid pressure within the sample chamber, a passageway (76, 260) defined in the sample chamber and adapted for providing fluid communication between the cavity (48, 222), and an area exterior the sample chamber, and a valve assembly (90, 254) operable for selectively opening and closing the passageway (76, 260); opening the passageway (76, 260) to provide fluid communication of the well-fluid sample between an area exterior the sample chamber and the cavity (48, 222); transferring a well-fluid sample via the passageway (76, 260) from an area exterior the sample chamber to the cavity (48, 222); and sealing the sample chamber by closing the passageway.

7. A method according to claim 6, wherein the non-reactive material is ceramic.

8. A method according to claim 6 or 7, wherein the sample chamber further comprises an endpiece (204) sealingly disposed in the tubular member, the passageway (260) defined by the endpiece (204).

9. A method according to claim 6, 7 or 8, wherein the step of opening the passageway (26) further comprises the step of manually opening the valve assembly (254) by actuating a valve actuator (282) to move a valve element (286) from a closed position wherein the valve element (286) seals the passageway (260) to an open position wherein passageway (260) provides fluid communication between the cavity (222) and an area exterior the sample chamber.

10. A method according to claim 6, 7, 8 or 9 wherein the passageway (76, 260) is defined in the tubular member.

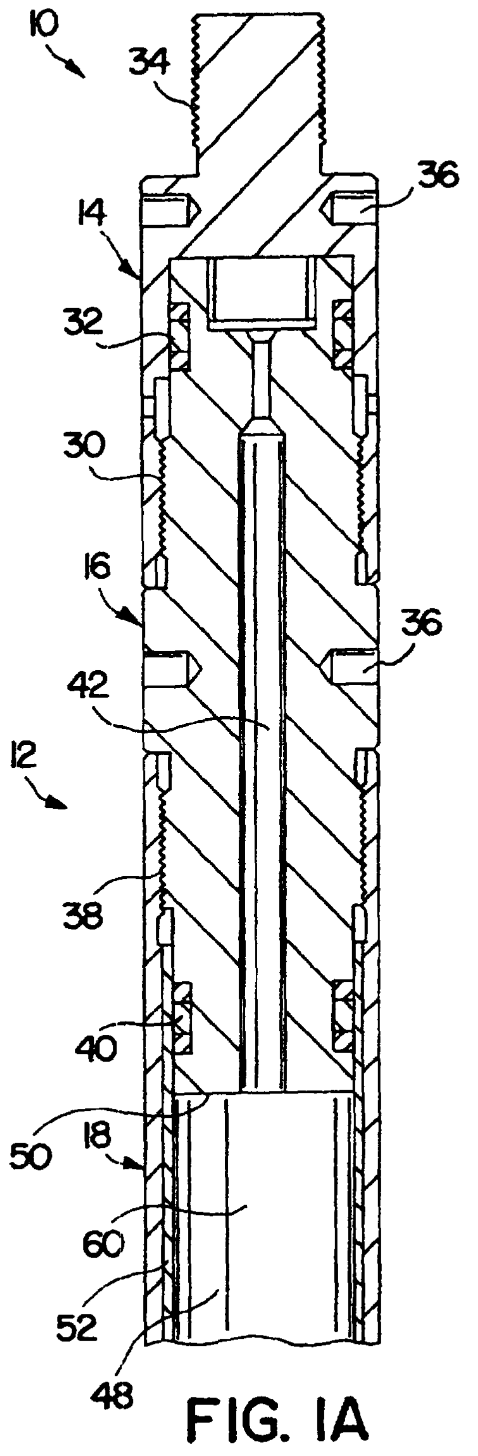
10
34
36
14
32
30
16
36
42
12
38
40
50
18
60
52
48

FIG. 1A

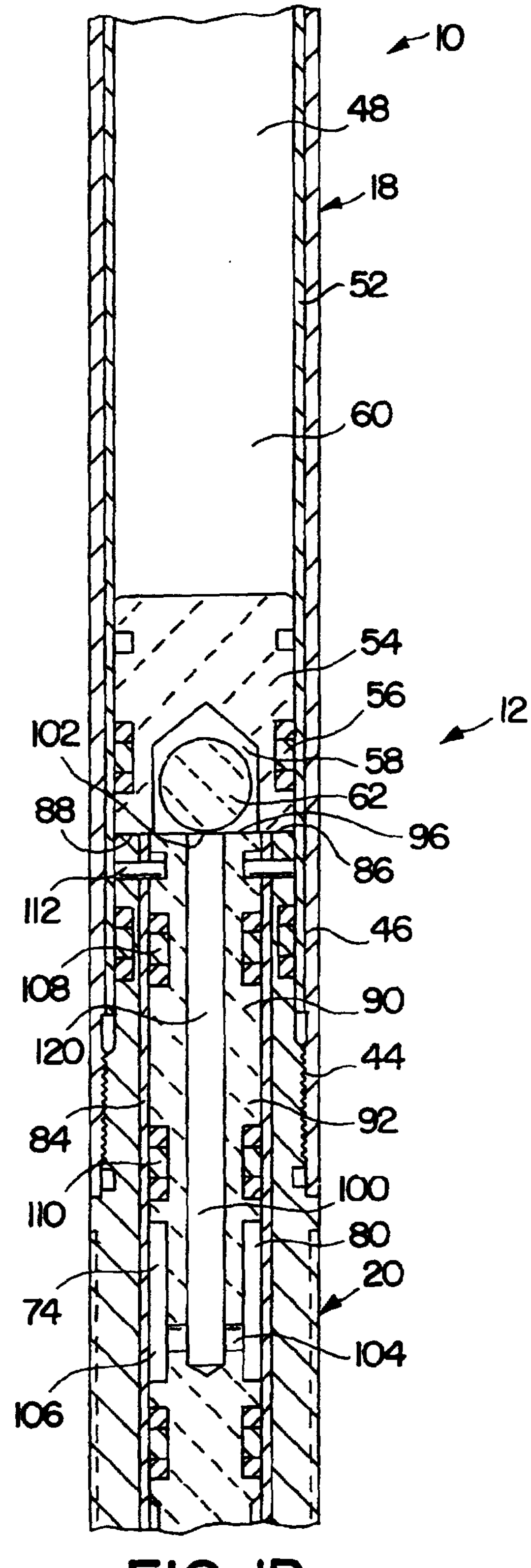
10
48
18
52
60
54
56
12
102
58
62
88
96
86
112
46
108
90
120
44
84
92
110
100
80
20
74
104
106

FIG. 1B

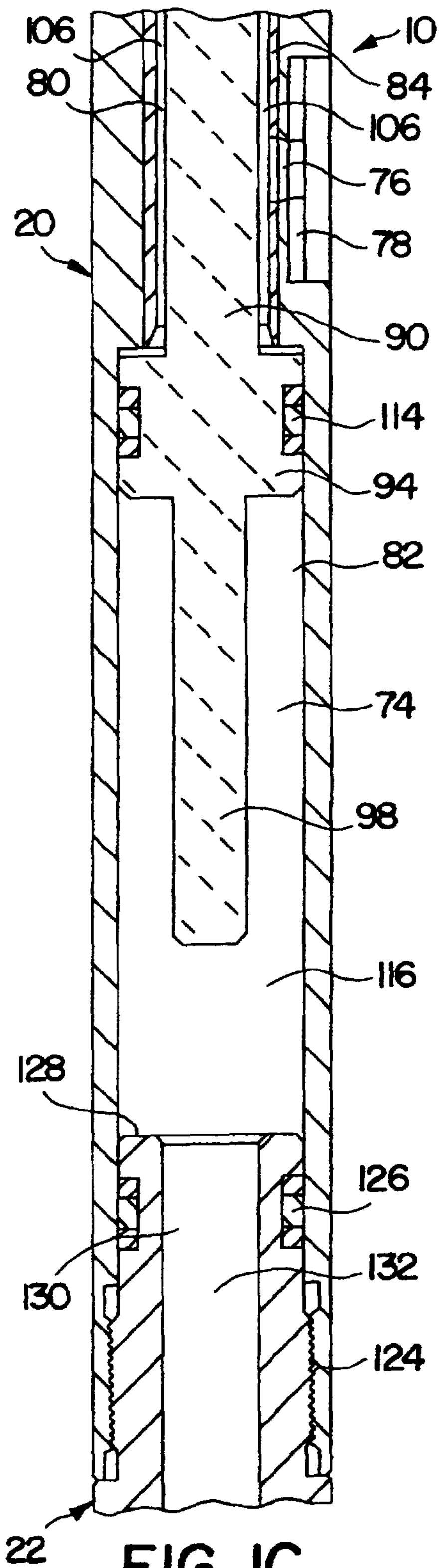
106
10
80
84
106
76
20
78
90
114
94
82
74
98
116
128
126
130
132
124
22

FIG. 1C

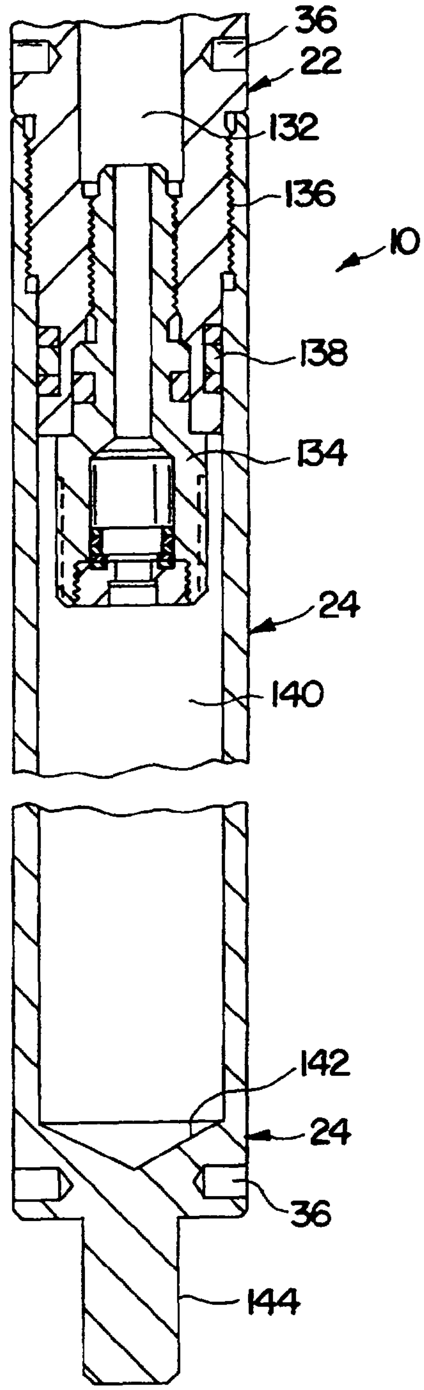
36
22
132
136
10
138
134
24
140
142
24
36
144

FIG. 1D

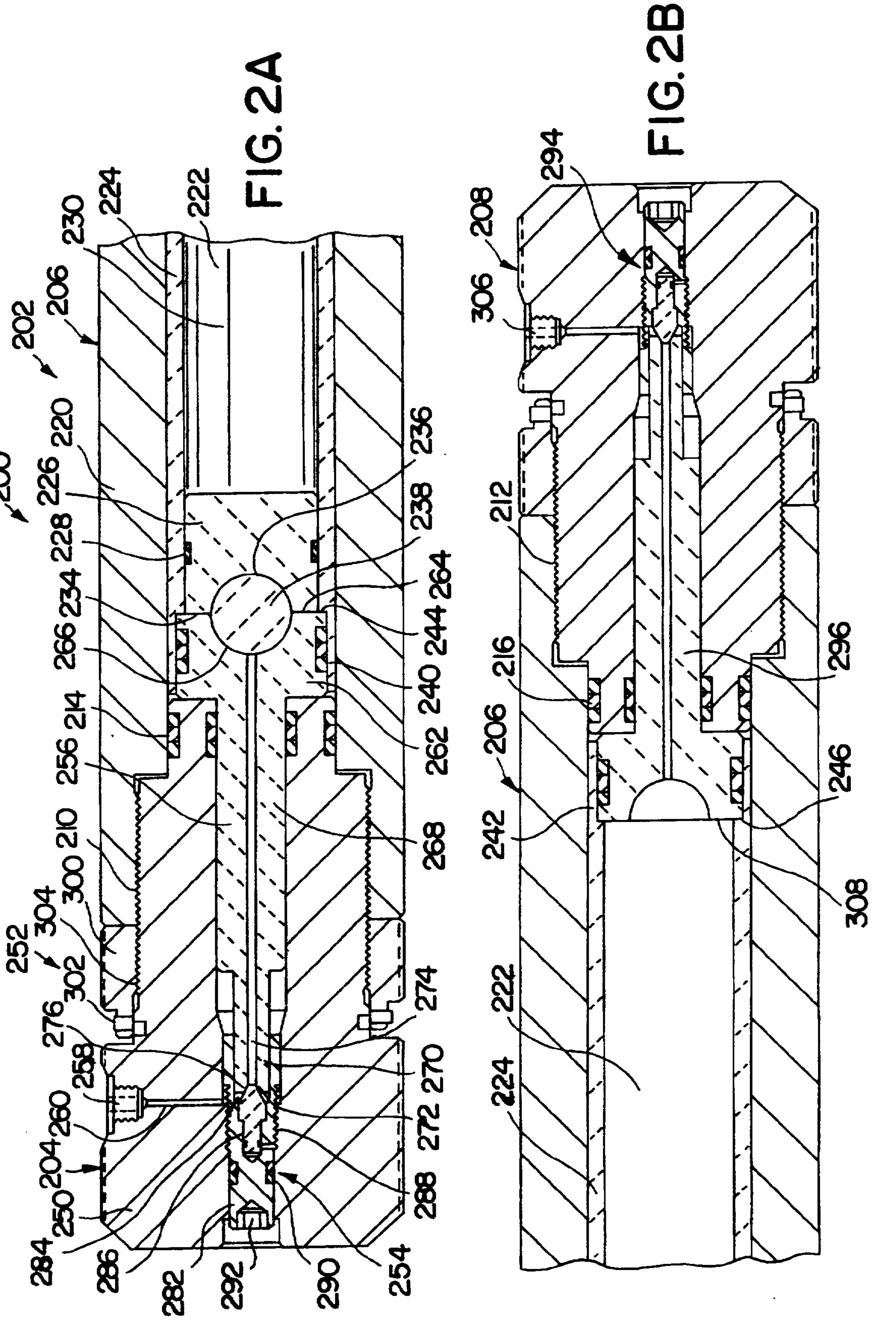
200
202
204
206
208
210
212
214
216
220
222
224
226
228
230
234
236
238
240
242
244
246
250
252
254
256
258
260
262
264
266
268
270
272
274
276
282
284
286
288
290
292
294
296
300
302
304
306
308

FIG. 2A

FIG. 2B

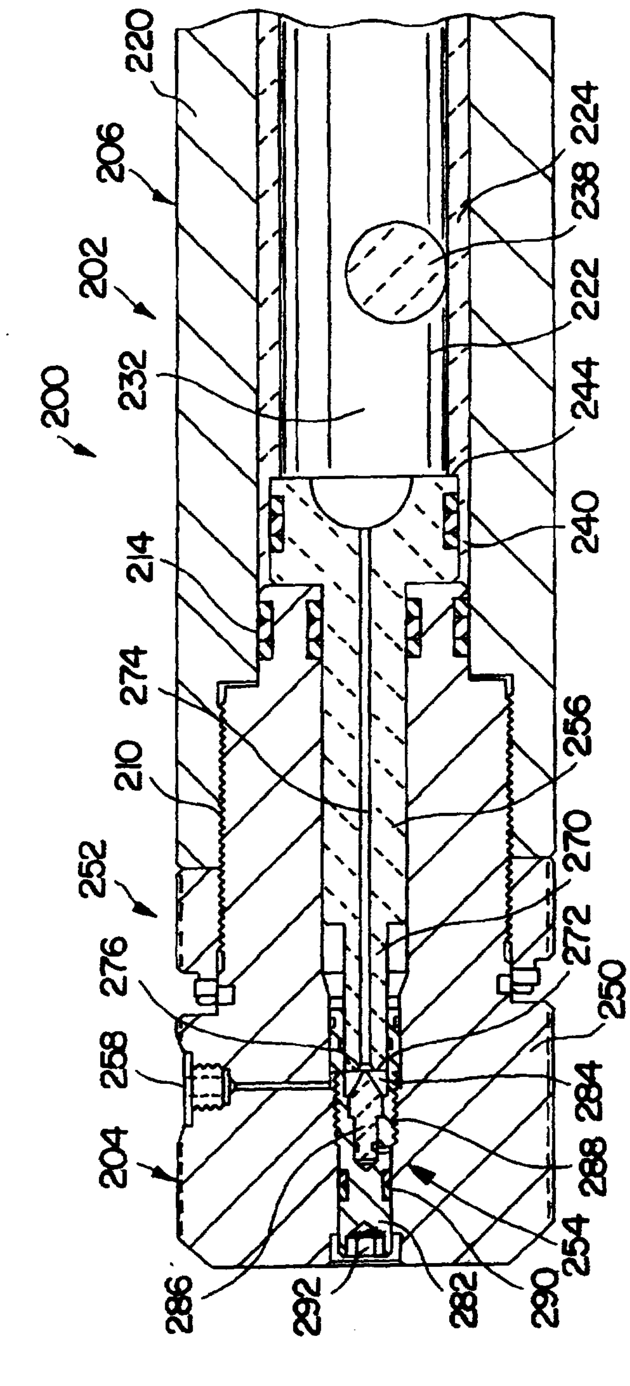
200
202
204
206
210
214
220
222
224
232
238
240
244
250
252
254
256
258
270
272
274
276
282
284
286
288
290
292

FIG. 3A

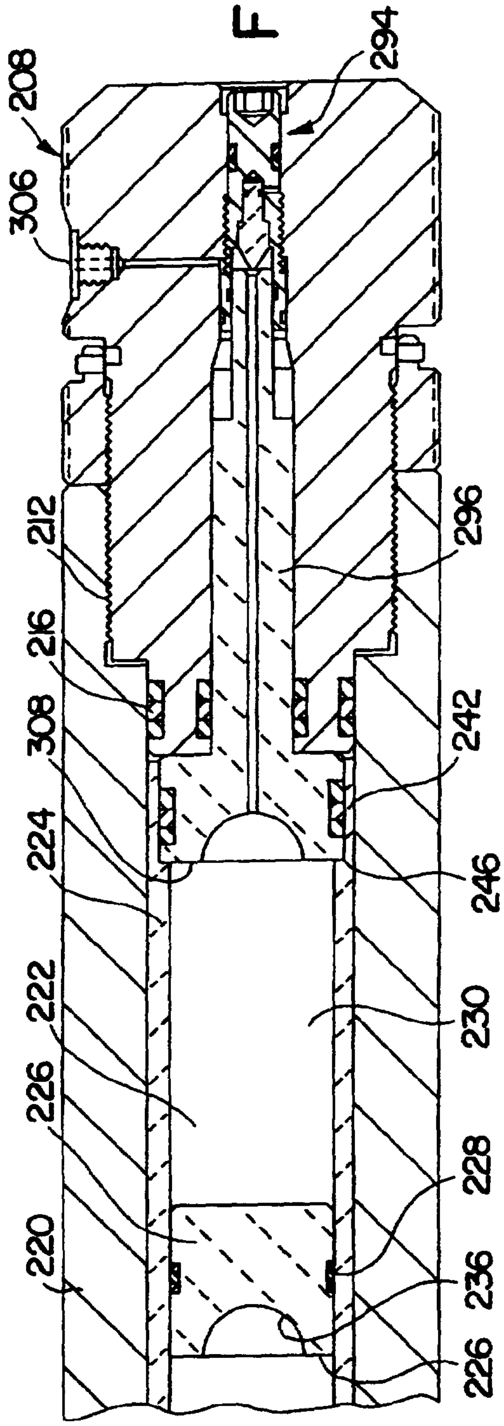
208
212
216
220
222
224
226
228
230
236
242
246
294
296
306
308

FIG. 3B