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Harris, Sr. et al.

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[45] **Sept. 11, 1973**

[54] **VALVES AND VALVE NEEDLE SYRINGES**

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[22] Filed: **Nov. 18, 1970**

[21] Appl. No.: **90,603**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 879,232, Nov. 24, 1969, Pat. No. 3,603,471.

[52] **U.S. Cl.** ..... **215/37 R**, 215/48, 215/74, 215/DIG. 3, 222/545

[51] **Int. Cl.** **B65d 51/00**

[58] **Field of Search** ..... 128/218 G, 218 NV, 128/215, 274, 272; 222/545; 251/324, 325; 215/38, 40, 37 R

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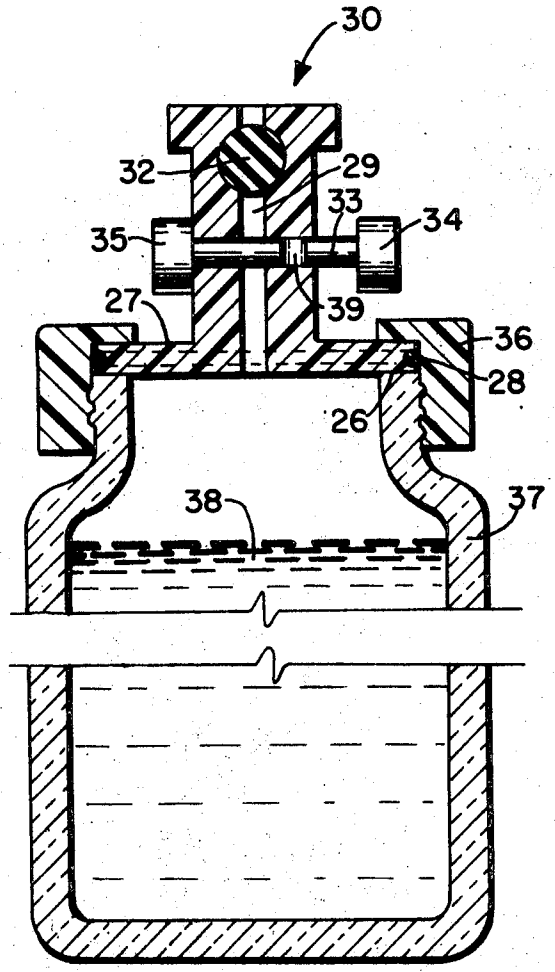
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Assistant Examiner—John P. Shannon
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[57] **ABSTRACT**

A valve, particularly in combination with a needle syringe, for containing fluids, i.e., liquids or gases, within a confined space. The valve per se includes a body comprising a tubular member (e.g., the barrel of a syringe), which contains an inner resilient tubular member within its axial opening. A lateral opening is provided within the walls of both the tubular members and a stem, containing a cut-away portion or lateral opening, is slidably mounted within the laterally oriented wall opening of the tubular members for opening and closing the valve. In another embodiment, the valve is employed in combination with a container. In this combination, the valve body contains, additionally, a cylindrically shaped septum mounted in series with the stem. The septum, contained within an intersecting passageway, lies across the opening or passageway through the valve body to provide an effective leakproof seal. The valve can be opened to permit exposure of the septum to the valve exterior. Exposure of the septum in such manner permits withdrawal or injection of fluid from the enclosed container. The valve is also adaptable for use with conduits of various types, and can be employed, e.g., in sample inlet systems as conventionally used in modern analytical instruments.

10 Claims, 8 Drawing Figures



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2 Sheets-Sheet 1

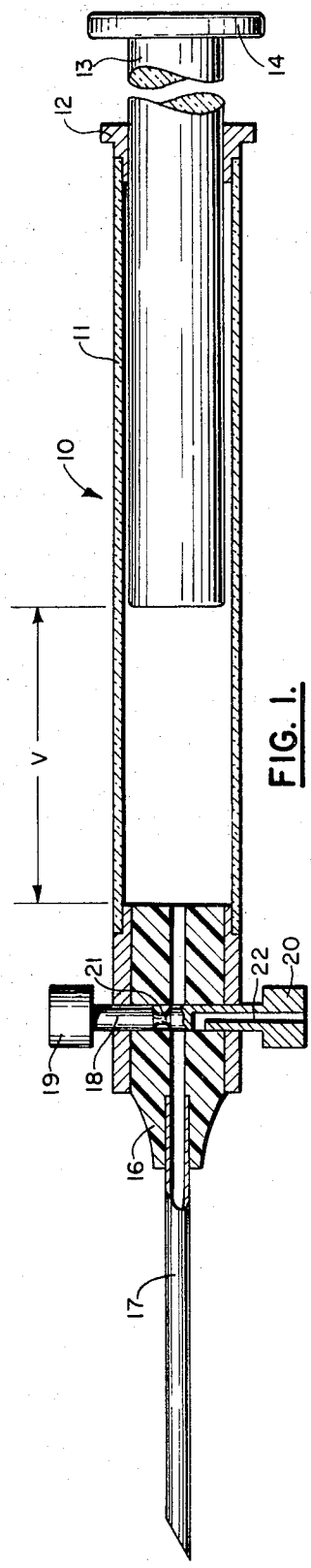


FIG. 1.

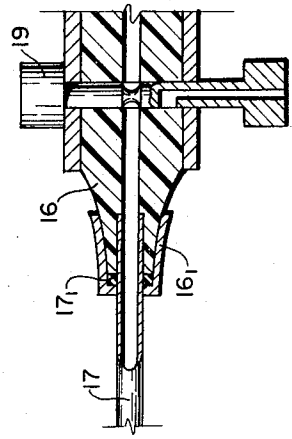


FIG. 2.

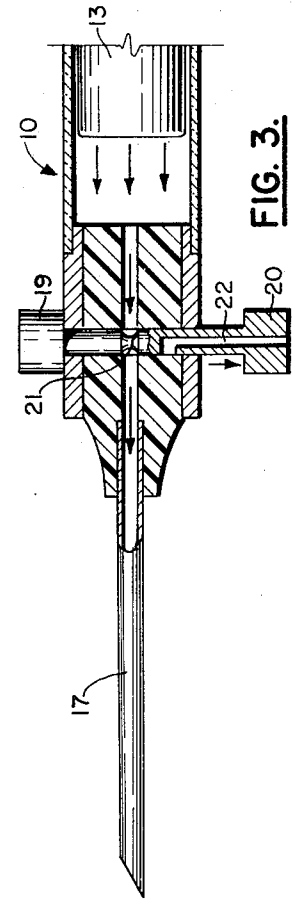


FIG. 3.

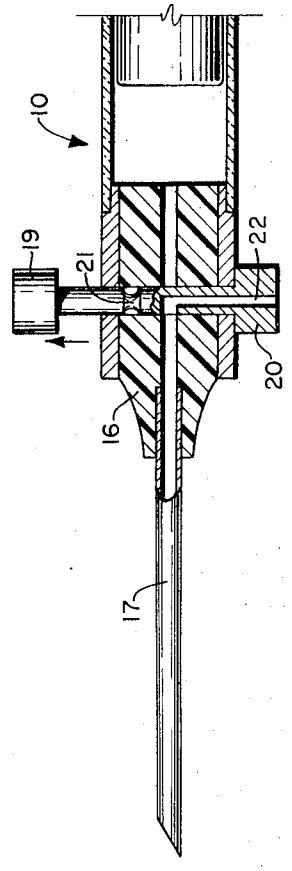


FIG. 4.

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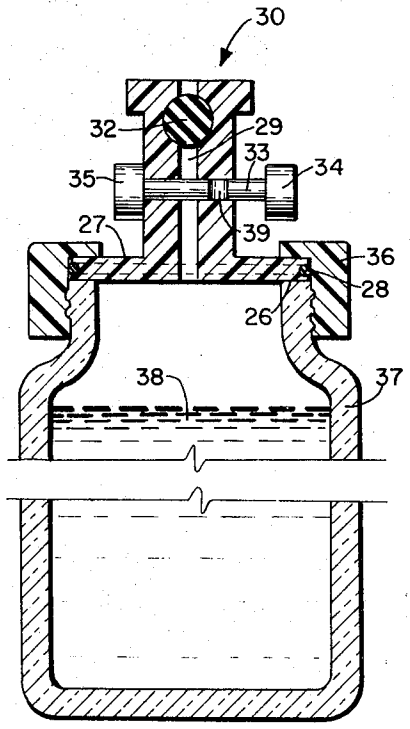


FIG. 5.

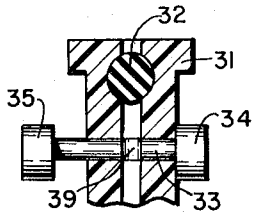


FIG. 6.

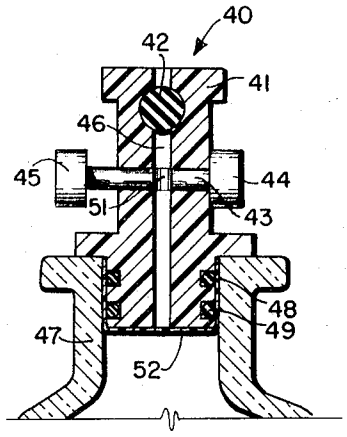


FIG. 7.

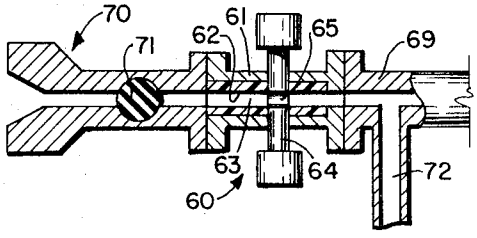


FIG. 8.

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VALVES AND VALVE NEEDLE SYRINGES

This is a continuation-in-part of application S.N. 879,232 filed Nov. 24, 1969 now U.S. Pat. No. 3,603,471, covering septum valves, the disclosure of which is hereby incorporated by way of reference.

This invention relates to in-line valves or apparatus for containing fluids, i.e., liquids and gases, or both, within a confined space prior to passage of the fluid through the valve at the desired time. In the most preferred combination, the valve is employed as an integral part of a needle syringe, and in other combinations the valve is employed with a container, or in a line, conduit, or sample inlet system. In these latter usages, the valves are provided with seal features, especially adapted for use in confining fluids until such time as it is desired to withdraw fluid from or inject other fluid into the confined space, e.g., as in a container or sample inlet system of the type such as is widely used in modern analytical instruments.

Numerous problems and difficulties are associated with various prior art valves used to contain liquids and gases, especially at considerable pressures, e.g., ranging several hundred pounds per square inch. Leakage is commonplace and hence most valve designs cannot be employed with the high accuracy and precision required for use in modern analytical instruments, e.g., mass spectrographs or gas chromatographs. Moreover, most valves cannot be opened substantially instantaneously, i.e., within a fraction of a second, as required in such instrumentation. Failure in this regard inevitably results in poor analyses.

Accordingly, it is among the objects of this invention:

To obviate these and other problems and difficulties and to provide reliable valves, i.e., valves which do not readily leak and which are capable of retaining fluids under pressure ranging from several hundred to a thousand pounds per square inch, and higher, but which fluids can be readily quickly released through the valves when desired.

To provide a valve which makes the confinement of even highly volatile fluids feasible, without adverse effect or change caused by the external environment.

To provide a valve not only effective for preventing such adverse effect of change, or loss of fluid from a conined space when closed, but yet one which can be very rapidly effectively opened--viz., within only a fraction of a second--to permit injection (or withdrawal) of fluid therethrough.

To provide unique valve-container (or valved syringe) combinations by virtue of which even highly volatile fluids can be contained without adverse effect, change or loss of contents from the container (or valve syringe), even after repeated usage, and wherein the fluid withdrawn therefrom is truely representative of that originally supplied to the container (or valved syringe).

To provide unique valve-sample inlet system combinations by virtue of which fluid specimens can be injected therein conveniently, easily and without loss of fluid.

To provide such valve-container, and valve-sample inlet combinations which are readily adapted for reuse by virtue of easily changeable septum portions.

To provide valves and valve-combinations, the valve portions of which contain stems, of uniform diameter, readily freely slidable within ultra-uniformly smooth bores within the valve, or valve body, and a valve which

is compact and readily continuously opened and closed with great rapidity, without need for lubrication.

To provide valves of this character which are relatively simple, easily assembled or disassembled, and relatively inexpensive to manufacture.

These and other objects will be apparent in view of the present invention which relates to an in-line valve for use in various combinations, preferred among which is a valve needle syringe. The valve per se comprises, in combination, a valve body, or tubular member, within the axial opening of which is snugly fitted a tubular resilient member. A lateral opening or passageway is provided through both of the tubular members, this opening intersecting with the axial opening extending through the tubular members, and a slidable stem is provided therein. The laterally slidable stem is provided with a cut-away portion or lateral opening which, when aligned with the axial opening through the tubular member, provides a passageway for transfer of fluids therethrough. In a most preferred combination, the valve is provided on the forward end of the barrel of a needle syringe. In other preferred combinations, the valve is mounted upon various kinds of containers, or even in a line or conduit, including especially sample inlet systems such as employed in modern analytical instruments.

A feature of the invention is that the lateral opening or bore in which the slidable stem is mounted is of uniform cross-sectional diameter from end-to-end, as is the stem which is mounted therein. Both the bore and the stem are ultra-smooth, with the exception of the cut-away portion or opening in the latter, by virtue of which the valve can be opened to the transfer of fluid. The bore itself is ultra-smooth from end-to-end, and the stem mounted therein is preferably of slightly larger external diameter to provide a tight leak-proof fit. In general, it is preferable that the external diameter of the stem range from about 0.005 to about 0.025 inch, and more preferably from about 0.005 to about 0.015 inch, larger than the internal diameter of the lateral opening or bore. The larger the diameter of the stem employed, the greater the tolerable oversize. Generally, stems of about one-sixteenth inch diameter are oversized about 0.005 inch whereas stems of about three-sixteenths inch diameter are oversized about 0.015 inch to assure free movement, while yet providing an effective leak-proof seal against pressures ranging up to about 1,000 psig, and higher. In this manner of mounting the stem, very fast movement is permitted in opening and closing the valve. The stem slides freely, and uniformly, without binding. The "squeeze" on tthe stem is thus uniform. In most syringes of ordinary size, it is thus quite feasible to open and close a valve of this type used in combination therewith in a small fraction of a second, generally no more than about 0.1 to about 0.5 second, or even less. This provides a considerable advantage over typical prior art valves, e.g., in the introduction of fluid specimens or samples to modern analytical instruments such as mass spectrographs or gas chromatographs.

These and other features and advantages will be better understood by reference to the following detailed description and to the accompanying drawings to which reference is made in the description.

Referring to the drawings:

FIG. 1 is a side elevation view, in section, showing an especially preferred type of valved needle syringe. The

valved portion of the syringe, shown in closed position, is provided with a laterally movable stem for opening and closing the syringe for withdrawal or injection of fluid; and a wash port or opening for cleaning the needle.

FIG. 2 depicts a modification of the apparatus as may be desirable for mounting of the needle at the forward end of the syringe.

FIG. 3 is a fragmentary sectional side elevation view identical to FIG. 1 except that the valve is shown in open position.

FIG. 4, also a fragmentary sectional side elevation view, is the same as FIG. 1 except that the stem has been moved in the opposite direction for opening of the wash port which is used in cleaning the needle.

FIGS. 5 and 6 depict a valve generally similar, at least in part, to that described by reference to the preceding figures except that, in this instance, the valve is employed on a screw-cap valve or container provided with a septum.

FIG. 7 depicts a valve-container apparatus combination much as described in the foregoing figures except that in this instance the container is in the form of a septum bottle.

FIG. 8 depicts the valve as used with a line or conduit, or in a sample inlet system, as conventionally used in modern analytical instruments.

Referring to the sequence represented by FIGS. 1–4, there is shown generally a preferred type of valve needle syringe 10. The barrel of the needle syringe is formed by an enclosing well 11 of substantially uniform cross-sectional diameter, generally constructed of transparent material bearing indicia marks, if desired. One end of the barrel 11 is provided with a flanged member 12, generally constructed of metal, and within the barrel 11 there is snugly fitted a slidable plunger 13 movable throughout substantially the length of the barrel 11. A valve is provided at the opposite or forward end of the barrel. The valve body comprises a collar 15, generally constructed of metal, and within the internal portion thereof is fitted a tubular shaped member 16. The latter member is generally constructed of a rigid or semi-rigid plastic or other type of resilient material. The forward portion of the member 16 is generally tapered to provide a male luer mount for containing a hollow or tubular needle 17. Optionally, as shown in FIG. 2, the male luer mount 16 can support an additional female luer mount 16_1, for better stabilization and support of the needle 17. A stop 17_1 can also be provided, if desired, to prevent overinsertion of the needle 17 within the luer mount 16. There are various other ways and means known to the art in which the needle 17 can be mounted at the forward end of the barrel.

The forward portion of the needle syringe 10, as indicated, is valved. The openings through the tubular needle 17 and the tubular member 16 are thus contiguous and communicated with the opening through the barrel 11, and also lie upon a common axis. A uniform diameter, smooth bore, lateral opening is provided within the wall of the collar 15, and tubular member 16, this opening extending from wall-to-wall and therein is mounted a slidable stem 18. At one side of the stem 18 there is provided a cut-away portion or area of reduced cross-sectional diameter 21 (or lateral opening), and at the other side thereof a wash port or opening 22. The position of the cut-away portion 21 and opening 22 can be varied, as desired, by shifting the stem 18 as by inward movement of knobs 19,20, respectively.

A feature of this valve-syringe combination is that the stem 18 serves a dual function. Aside from its valve function, the stem 18 retains the tubular member 16 tightly in position, thus eliminating any need for creating a bond of some type between the tubular member 16 and collar 15.

In the position described in FIG. 1 the central portion of the stem 18 lies across and blocks the axial opening through the needle 17 and tubular member 16 so that the valve, and consequently the inside of the barrel itself, is closed to ingress or egress of fluid. Thus, a measured quantity or volume of fluid V, as may be desired, can be stored within the barrel 11. When it is required to quickly inject the quantity V of fluid, the valve is opened as shown by reference to FIG. 3. The stem 18 is thus pushed inwardly by action upon the knob 19, this causing the cut-away portion 21 of the stem to become aligned with the axial opening through the tubular packing 16. Inward movement of the plunger 13 (as shown by the direction of the large arrow) by action upon the handle 14, causes ejection of fluid through the tubular needle 17. In this same open position of the stem 18, the internal portion of the barrel 11 can be refilled from a fluid source by movement of the plunger 13 in the opposite direction. The valve is then closed and the fluid stored by movement of the stem 18 in the opposite direction, back to the position shown by reference to FIG. 1.

The tubular needle 17 can be cleaned or washed by movement of the stem 18 in the extreme opposite direction as shown by reference to FIG. 4. Thus, by movement of the stem 18 in the extreme opposite direction, the internal portion of the barrel 11 is closed to ingress or egress of fluid but now the lateral opening 22, which extends through the stem itself, communicates the forward portion of the tubular needle and packing opening to the exterior. Purging fluids can thus be introduced via the opening 22 to wash or clean the needle 17. As a last step, gas can also be introduced, if desired, to dry the inside of the needle 17.

In the series of figures shown by reference to FIGS. 5–6, a valve, similar in operation to that described by reference to the preceding figures, is flanged and shown in combination with a container or bottle 37, filled to a level 38 with a volatile liquid composition.

The body of the valve 30 is constructed of a tubular member formed by the enclosing wall 31, providing an axial opening 29 which leads into the vapor space above the liquid level 38. The passageway 29 is laterally intersected by a second passageway within which is contained a cylindrical shaped septum 32, constructed of a resilient or elastic material, e.g., rubber. The passageway 29 is thus sealed by a septum 32, and therebelow is provided a valved section. A stem 33, provided with knobs 34,35 and a lateral opening 39, is thus slidably mounted within a lateral or transverse opening through wall 31. The stem 33, in this embodiment, might also be a cut-away portion, or portion of reduced diameter, as shown by reference to the preceding figures. In the position described in FIG. 6, the stem 33 lies across, seals off, blocks, or closes the axial opening 29 so that the valve is closed.

In the screw-type valve, or valve-container combinations, the lower portions of the tubular member 31 is also provided with a flanged end portion containing a

peripheral groove within which rests a resilient packing or O-ring **28**. The O-ring **28** is pressed between the upper side **27** and the lower side **26** of the flanged end portion and pressure is maintained on the O-ring **28** by tightening down on the open-centered screw-cap or cover **36** which is threadably engaged to the top of bottle **37**. It is thus to be observed that the upper side **27** of the flanged member is pressed downwardly by the cap **36** and the O-ring **28** is compressed between member **26,27** shown as an integral construction in this instance, which rests atop the upper rim of bottle **37**. In this fashion, the O-ring **28** is thrust downwardly against the lower side **26** of the flange portion, which is pressed downwardly against the bottle rim to form an effective leakproof seal.

In the closed position of the valve **30**, as shown by reference to FIG. **5**, the fluid contents of the bottle **37** are maintained completely isolated from the external environment. Highly volatile fluids, and mixtures of such fluid components, will retain their original composition and condition without significant change as would be expected even when such fluids are loaded and contained in ordinary bottles or containers. Such high degree of isolation can even be maintained in accordance with the present invention, however, even after the bottles have been once opened, or repeatedly opened.

The valve structure, in combination with the septum, permits removal of contents of the bottle **37** without exposure to the atmosphere. Stem **33** can thus be moved to the left by action on knob **34** or **35** as shown by specific reference to FIG. **6**. The contents of the bottle **37** nonetheless remain protected from exposure to the atmosphere because of the presence of the septum **32**. In this position of the valve stem, however, the needle of a syringe (e.g., needle **17** of syringe **10**) can be passed through the septum **32** and into the liquid for withdrawal of a fluid specimen. The needle can be withdrawn back through the septum which in itself tends to return to its original unstretched, unruptured position to minimize or prevent leakage of fluid from the bottle **37**. Immediately after the withdrawal of fluid, the valve **30** is again closed as again shown by reference to FIG. **5** to protect the fluid content. This process can be repeated ad infinitum until the bottle **37** has been emptied. The elimination of changes brought about by entry of air into such containers, escape of highly volatile components as by diffusion and pressure increases, particularly as occurs after such bottles or containers are once opened, is striking. This is particularly important with regard to standard fluid used in highly accurate modern analytical instruments.

Another type of valve-container combination is shown by reference to FIG. **7**, though the principle of operation of the valve per se is identical to that shown and described by reference to preceding FIGS. **5** and **6**. Thus, there is shown a valve **40**, the body of which is formed by an enclosing wall **41**, which provides a passageway or opening **46** wherein there is mounted, within an intersecting passageway, a cylindrical shaped septum **42** and a stem **43**, provided with knobs **44,45** and a lateral opening **46**, the operation and function of which in opening and closing the valve **40** is as described by reference to the preceding figures. Knobs **44,45** are thus actuated to shift the position of stem **43** to align and misalign the opening **51** (or cut-away portion) with passageway **46** to open and close the valve. The lower portion of the valve is enlarged to provide a cylindrical portion of external diameter substantially equal to the internal diameter of the neck of the bottle **47**. O-rings **48,49** are mounter within laterally oriented periperhal grooves, these being contained within an outer jacket **52** which, when compressed within the restricted opening of the neck of bottle **47**, provides an effective leak-proof seal.

Referring to FIG. **8** there is shown a valve **60** suitably mounted via flanged connections upon a conduit **69**, constituting in this instance a sample inlet system. The valve **60** is formed of an enclosing wall **61** within which is provided a tubular member **62**, containing an internal opening or passageway **63** which is communicated with the opening through the conduit **69**. The valve **60** is also provided with a lateral opening or passageway within which is mounted a movable stem **64**. The stem **64** is provided with an opening **65** for alignment or misalignment with the passageway **63** to open and close the valve.

The valve, a one-piece assembly, provides a sample injection station **70**. The entire assembly is secured by suitable connection to the conduit **69**. A cylindrical shaped septum **71** is provided within a passageway laterally intersecting the passageway **63**. The needle portion of a syringe (e.g., needle **17** of syringe **10**), containing a measured fluid specimen, can be passed through the septum **71** and sample injected into the passageway where it can be picked up by carrier gas fed into the sample inlet system via conduit **72**. Escape of fluid is minimized, and essentially completely eliminated upon closure of valve **60**. A feature of this embodiment for application to sample inlet system, as in all the foregoing combinations, is that the septum can be readily changed without disassembly of the sample inlet system.

The apparatus of the present invention can be constructed of conventional materials, or essentially any material subtantially inert to chemical or corrosive action by the fluid, or contained elements. The valve body, or the stem, can thus be conveniently constructed of various metals, e.g., ferrous metals such as iron, iron alloys, steel, stainless steels, and the like; or brass, copper, bronze, chrome, and the like. Plastics and plastic-like materials, e.g., polystyrene, polyvinylchloride, glass, and the like, can also be employed. The material can be solid or of laminar construction, and can be provided with a protective film, coated, plate, or the like, particularly those films known to be unreactive or impervious to known chemicals.

The tubular member, and all portions of the devices in contact with fluid, is preferably constructed of a rigid or semi rigid, resilient form of plastic or plastic-like material. The self-lubricated plastics are especially preferred in this capacity, and are also suitable for application in the form of protective films. The polyfluorinated ethylene polymers, notable among which is polytetrafluoroethylene (Teflon), are particularly outstanding.

The cylindrical shaped septums are constructed of conventional resilient or elastic-like materials, such as natural or synthetic rubbers, gasket materials, and the like.

It is apparent that various changes, such as in absolute or relative dimensions of the parts, materials used, and the like, as well as the suggested mode of withdrawing or delivering fluids, can be made without departing

the spirit and scope of the invention, as will be apparent to those skilled in this art.

Having described the invention, what is claimed is:

1. A valve suitable for fitting upon an enclosure within which fluid can be placed and contained comprising, in combination,
- a tubular member formed by an enclosing wall providing an axial opening therethrough,
- a lateral opening within the wall of said tubular member which intersects with the axial opening through the said tubular member,
- a stem, provided with a lateral opening therein, slidably mounted within the said lateral opening through the tubular member,
- a septum which lies across, covers and seals a section of the axial opening through the tubular member,
- whereby movement of said stem to align the lateral opening of the stem and the axial opening opens the valve such that penetration of the septum can be made for injection of fluid, and misalignment of the lateral opening and axial opening closes the valve and prevents ingress or egress of fluids through the valve.

2. The apparatus of claim 1 wherein the tubular member is comprised of a pair of members, one fitted snugly inside the other, the outer member is constituted of metal and the inner member is constituted of a resilient material.

3. The apparatus of claim 2 wherein the resilient material of which the inner member is composed is Teflon.

4. The apparatus of claim 1 wherein the tubular member contains a second lateral opening therethrough, and the septum is fitted therein.

5. A valve suitable for fitting upon the enclosing wall which forms the neck of a bottle to provide an enclosure therewith, such that fluids confined with said bottle can be permitted ingress and egress therefrom only through the opening and closing of said valve, comprising in combination
- a tubular member formed by an enclosing wall providing an axial opening therethrough,
- a flange formed by an outwardly flared wall portion of said tubular member, the flange being located at the lower end of said tubular member and adapted for contact with the enclosing wall which forms the neck of said bottle,
- a lateral opening within the wall of said tubular member which intersects with the axial opening through the said tubular member,
- a stem provided with a lateral opening therein slidably mounted within the lateral opening through said tubular member,
- a septum which lies across, covers and seals a section of the axial opening through the tubular member,
- whereby movement of said stem to align the lateral opening of the stem and the axial opening opens the valve that penetration of the septum can be made for withdrawal of fluids, and misalignment of said lateral opening and axial opening closes the valve and prevents ingress and egress of fluids from the bottle.

6. The apparatus of claim 5 wherein the tubular member is provided with a second lateral opening and the septum is located within said second lateral opening.

7. The apparatus of claim 6 wherein the septum is the outer member of the series constituting the septum and lateral opening within the stem.

8. The apparatus of claim 5 wherein the tubular member is constituted of Teflon.

9. The apparatus of claim 5 wherein the outer peripheral edge of the flange located on the lower portion of the valve is recessed and contains an O-ring, and the valve can be secured to the bottle via an open-centered cap, the tubular portion of the valve being extendable through the opening in the center of the cap, while the flanged portion is held in place atop the container via threadable engagement between the cap and the top of the container, and whereby the downward pressure exerted by the cap causes extrusion of the O-ring against the internal surfaces of the cap to seal the bottle.

10. The apparatus of claim 5 wherein that portion of the valve constituting the lowermost portion of the tubular member is projected below the flange and is provided with a circumferential groove within which an O-ring can be fitted, and the valve can thereby be fitted into and sealed within the bottle by pressing the lowermost portion of the tubular member into the neck of the bottle.

* * * * *