

**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 confined 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 truly 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 the 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