A piston-type irrigating syringe, in which the piston shaft, sliding in the syringe barrel with the resilient piston, is hollow and extends into and communicates with an integral resilient hollow bulb and in which the resilient piston has a restricted passage providing continuous communication between the hollow shaft and bulb and the barrel and nozzle opening of the syringe, whereby the suction and positive pressures applied to a body cavity are applied gradually at a controlled rate and can be varied over a wide gradient, as compared to standard bulb-type syringes and standard piston-type syringes, whereby such pressures and suction can be controlled to avoid harmful effects, whereby the necessity of employing more than one kind of syringe, i.e., a bulb-type syringe for mild pressures and suction and a piston-type syringe for greater pressures and suction, is avoided, whereby the fluid reservoir capacity is greatly increased over standard syringes, and whereby greater maximum suction and pressures can be achieved compared to standard syringes.
COMBINATION BULB-PISTON SYRINGE

SUMMARY OF INVENTION

This invention relates to a combined bulb and piston-type medical irrigating syringe for irrigating body cavities and wounds. There are two basic types of irrigating syringes presently being used by the medical profession. One is the conventional bulb-type syringe for mild irrigations employing a flexible, resistent bulb at the end of a hollow syringe stem. The syringe is used to irrigate body cavities such as the urinary bladder, or wounds during surgery, by alternately squeezing and releasing the bulb to expel irrigating fluid out of the syringe and into the cavity or wound and to aspirate such fluid into the syringe and out of the cavity or wound, respectively, in a conventional manner. As used herein, including the claims hereof, the word "bulb" refers to any chamber connected to the hollow syringe stem, usually at the end opposite the syringe nozzle, and having a resilient, flexible and squeezable wall, whereby the volume of the chamber can be changed to provide a pumping action to expel a fluid from, and drain or aspirate a fluid into, the syringe. It includes not only the conventional rounded enlarged flexible and resistent bulb but also a cylindrical flexible and resistent enlargement or an accordion type bellows or even a nonelongated flexible and resistent extension of the syringe stem.

The second type of conventional syringe is the piston or plunger-type syringe. This is used for relatively strong irrigations where greater force is required. This type of syringe comprises a conventional syringe barrel, usually rigid, containing a rubbery piston which is in peripheral sealing, but sliding, contact with the internal barrel wall and which is moved axially within the barrel by a solid piston shaft secured thereto to expel irrigating fluid from the barrel into the body cavity or wound and draw it out of the cavity or wound into the barrel.

A serious disadvantage of the bulb-type syringe is that the maximum pressures and suction which can be developed are often insufficient to cope with obstructions in the body cavity or difficult-to-remove debris, e.g., clots, mucous, calculi, cells, etc., or to cope with required flushing in the case of wound irrigations. Although the piston syringe provides much greater pressures and suction to deal with these difficulties, these pressures and suction, because they are positive and direct, are difficult to control and may result in exceeding those pressures and suction which are safe with resulting possible serious harmful effects, e.g., rupturing a vascular bed of a mucous membrane. For example, in the case of a stubborn obstruction in the body cavity a solid noncompressible liquid column is apt to be built up between the obstruction and the piston. In such a case, only a slight movement of the piston into the barrel can build up a dangerously large force, which because of the aforesaid solid column of unyielding liquid, is transmitted directly and instantaneously without reduction or cushioning to the body cavity. By the same token, where there is such a stubborn obstruction only a slight retraction movement of the piston can provide a relatively large and dangerous suction force which is transmitted unabated to the body cavity. Although such pressures and suction can be controlled to a degree by controlling the rate and magnitude of movement of the piston, nevertheless this is at best an exceedingly gross control even for those skilled in the art. A particular problem often encountered is that upon applying sufficient force to the piston to build up sufficient pressure or suction to dislodge stubborn debris forming an obstruction, when the debris becomes dislodged, a sudden surge of pressure or suction is apt to occur because of the difficulty of relieving the force applied to the piston immediately upon dislodgement of the debris.

In practice, as a matter of safety, a bulb-type syringe is often employed first and if it is not sufficient, the next step would be to use a piston-type syringe, which necessitates the additional cost, storage, time and handling of two syringes in two operations, thereby adding to the complexity of the procedure, further risk of contamination and to the inconvenience of hospital personnel and patients.

It is an object of the present invention to provide a medical syringe which avoids these difficulties. It is a further object of the invention to provide in a single simple, convenient and inexpensive unit, a medical syringe which can be used as a conventional bulb-type syringe and as a conventional piston-type syringe to thereby avoid the necessity of using two separate syringes with the aforesaid disadvantages thereof. In addition, the syringes of the present invention permits the use of a wide gradient of controlled, cushioned, gradually applied median maximum pressures and suction between the mild pressures and suction of a bulb-type syringe and the greater forceful positive pressures and suction of the piston-type syringe, whereby the sudden buildup of dangerous, excess pressures and suction upon sudden dislodgement of an obstruction in the body cavity or for any other reason, is avoided. Regardless of the size of the obstruction, and hence the resistance to flow, and regardless of the magnitude and rate of movement of the piston, the pressures and suction applied to the body cavity can only be built up gradually to a safe maximum, the excess pressures and suction which might normally be developed under such circumstances being absorbed or cushioned. Only that pressure or suction required to displace the obstruction is built up gradually, and upon dislodgement, liquid is ejected into the body cavity or withdrawn from the body cavity without substantially exceeding such required pressure or suction. On the other hand, the syringe of the invention can be used to provide even stronger irrigation than is possible with the piston-type syringe. In addition, it permits a substantial increase in syringe capacity without increasing the physical size of the syringe.

This is achieved in accordance with the invention by replacing the piston shaft of the piston-type syringe with a bulb-type syringe having a hollow stem with the bulb (preferably the bulb and stem are integral) at one end portion and the resilient piston attached to the other end portion and with a passage, preferably a restricted passage or orifice, through the piston providing continuous communication between the barrel and nozzle of the piston syringe and the interior of the hollow stem and bulb. Thus, the bulb and stem function as the piston shaft and also as a bulb-type syringe, as will be more fully described hereinafter.

DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following description and the accompanying drawings describing and showing for illustrative purposes a preferred embodiment of the invention.

In the drawings FIG. 1 is a view in elevation of a syringe embodying the present invention.
FIG. 2 is a view in perspective of the syringe in FIG. 1.
FIG. 3 is a view in perspective from another direction of the syringe of FIG. 2.
FIG. 4 is a section taken along the line 4-4 of FIG. 1.

DETAILED DESCRIPTION

With reference to the drawings, 2 is a syringe embodying the present invention and comprising (a) a hollow cylindrical syringe barrel 4, which is made of a rigid or semi-rigid material such as polypropylene, which has a tapered hollow nozzle tip 5 at one end forming a nozzle opening 7 of restricted cross section and the other open end 9 of which is of the same diameter as the internal diameter of the syringe barrel proper. (b) a generally cylindrical, hollow, rubber piston or plunger 6, the periphery of which engages the inner wall of the barrel 4 in a fluidtight manner but which is slidable longitudinally in the barrel to draw fluid into, and expel fluid from, the barrel and (c) a piston or plunger shaft 8, which is secured to the piston 6.
for sliding the piston back and forth in the barrel and which is in the form of a hollow bulb-type syringe 8 of flexible and resilient plastic such as an ethylene-vinyl acetate copolymer, comprising a hollow, cylindrical stem 10, removable secured at one end to piston 6 and extending out of the open end 9 of the barrel and integrally at its other end into a rounded, hollow, flexible and resilient bulb 12 adapted to be squeezed and released to, respectively, expel fluid from and draw fluid into the stem 10 and bulb 12. The piston 6 and the bulb syringe 8, i.e., the bulb 12 and stem 10, are slidable as a unit back and forth within the barrel 4.

The upper end of barrel 4 is provided with a pair of laterally extending lugs 14 to provide finger holds during operation of the syringe.

The periphery of the rubber piston 6 has a pair of axially spaced annular sealing ribs 16 and 18, extending laterally from the upper and lower ends thereof, as shown, and compressed into sealing relationship with the inside wall of the barrel 4 to form a pair of axially spaced annular fluid tight seals with an annular space 20 formed by the two sealing ribs 16 and 18, the two adjacent fingers and the adjacent finger under the lip 22 and the inner wall of the barrel 4. Thus a double, balanced sealing effect is achieved while still permitting the piston 6 to be reciprocated in the barrel as a unit with the bulb-type syringe 8 without difficulty.

The rubber piston 6 is removable secured to the end of the stem 10 by means of a radially outwardly extending annular lip 22 at the end of the stem protruding radially from the lower end of a reduced diameter end portion 24 of the stem 10 into an internal, undercut, annular groove 26 in the hollow piston 6, with a portion of the piston proper located between the lip 22 and the ledge 31 formed by the reduced portion 24, as shown in FIG. 4.

Piston 6 has a lower tapered end wall 28 having a central reduced passage or orifice 30 therein of circular cross-sectional shape and which, in the embodiment shown, is of the same diameter as the nozzle opening 7 and is axially aligned with such nozzle opening.

The external lower surface of end wall 28 commences at the bottom of lower rib 18 and tapers downwardly and inwardly to 29 at the lower end of the orifice 30, as shown. Internally, the end wall 28 commences at the lower edge of the internal groove 26 (which is located at a height slightly below the upper rib 16 and substantially above the lower rib 18) and tapers downwardly and inwardly at 33 at a steeper inclination than the external taper 29, whereby the thickness of the end wall 28 diminishes in a radially inward direction.

The taper of the lower external surface 29 of end wall 28 of the piston 6 is the same as the taper 35 of the end wall 32 of the syringe barrel so that when the piston is pushed fully into the barrel, the lower surface 29 of end wall 28 of the piston mates in close contact with the end wall 32 of the barrel along their areas.

The upper end of the bulb 12 is out-of-round slightly at 34 to form a flattened zone for standing the syringe in an upright manner on a relatively flat surface. The flattened zone 34 has a shallow concavity 36 therein for locating the thumb (with the index finger and the adjacent finger under the lugs 14) to squeeze the bulb vertically during use, to thereby provide a more controlled irrigating action, and also to locate the thumb for moving the piston into the barrel.

The syringe is shipped with an internally tapered plastic protective cap (not shown) frictionally but removable secured over the lip 5.

Although the invention is not limited to any particular dimensions a commercial syringe embodying the invention has the following dimensions: Internal diameter of barrel—1 1/4 inch, internal length of barrel to the lower end of end wall 32—5 3/4 inches, length of stem 1 inch, diameter of opening 7 and orifice 30—three-sixteenths inch, internal diameter of stem—1 inch, height of stem—4 inches, diameter of bulb 2 1/2 inches, height of piston—one-sixteenth inch, thickness of stem wall—one-thirty-seconds inch, thickness of bulb wall one-thirty-seconds ± one sixty-fourth inch.

The normal diameters of the ribs 16 and 18 are slightly greater than the internal diameter of the barrel in order to achieve lateral sealing compliance.

The annular juncture 38 of the wall between the bulb 12 and stem 10 is slightly enlarged in thickness as compared to the bulb proper and stem to prevent roll over of the bulb onto the upper end of the stem when the bulb is pushed vertically downwardly by the thumb (with the index finger and the next adjacent finger under lugs 14) for piston-type operation and when it is squeezed downwardly by the thumb (with the same fingers under lugs 14) for bulb-type operation. Also the thickness of the bulb wall at the upper end 40 near and where it flattens out, is slightly less than the thickness of the rest of the bulb wall to permit maximum flexure at this area by squeezing down on the top of the bulb with the thumb with the index finger and next adjacent finger under the lugs 14, as aforesaid.

The plastic from which the bulb and stem are made can be any plastic or rubber or other elastomer (preferably transparent or translucent) which possesses the properties of being highly flexible, highly resilient, elastic and rubbery with a good memory so that when the bulb is squeezed to deform it, it will immediately spring back or recoil to its original shape when the squeezing pressure is released. Furthermore, it should be highly stable, inert, nontoxic, impervious, resistant to stress cracking and capable of being sterilized. There are a large number of such plastics and rubbers and combinations thereof which are suitable, such as silicone rubber, natural and synthetic rubbers, e.g., styrene-butadiene copolymer rubber, low density polyethylene, plasticized polyvinyl chloride, ethylene-vinyl acetate copolymer, styrene-butadiene thermoplastic elastomers, such as those sold under the trade name "Kratos" by Shell Chemical Company, etc.

Also the piston may be made of natural or synthetic rubber, including styrene-butadiene, or any of the other plastics from which the stem and bulb are made. However, because it has a substantially greater thickness it is stiffer, although still elastic, flexible and resilient for sealing purposes.

The piston may be easily secured on and pulled off the end of the stem merely by snapping the lip 22 into and out of the undercut groove 26. However, the piston may be integral with the stem, and the bulb may be separable from the stem. When the bulb is separate from the stem it may be made from the same or a different material.

Preferably, the stem and bulb unit is injection blow molded. The barrel 4 may be made of any rigid or semirigid plastic (preferably transparent or translucent) conventionally used for making syringe barrels, or even glass or metal.

Preferably the barrel is provided with graduation marks and amounts in conventional manner.

The syringe shown in the drawings may be used as a true bulb-type syringe by squeezing and releasing the bulb 12 with the stem 10 at all times pushed fully into the barrel 4 so that tapered end wall 29 is snug against the tapered end wall 32 of the barrel. This serves to expel liquid out of and draw liquid into the interior 42 and 46 of the stem and bulb through the nozzle opening 7 and orifice 30.

Also, the syringe shown in the drawings may be used as a true piston-type syringe by reciprocating the piston 6 with the stem 10 and bulb 12 full of liquid at all times, e.g., by the bulb action, so that they act as a solid piston shaft. This is effective to expel liquid out of and draw liquid into the interior 44 of the barrel 4 through nozzle opening 7.

Thus, if the operator, in applying the syringe to the patient, finds that the bulb procedure, as described aforesaid, does not provide a vigorous enough action he can utilize the piston type procedure, as aforesaid, without the necessity of securing another syringe. Furthermore, if he, at the beginning, believes that a more vigorous type of irrigation is in order but finds that the action is too vigorous, he can utilize the less vigorous bulb type procedure, as aforesaid, without securing another syringe.
Aldo, the combined bulb and piston arrangement of the invention provides a much greater total liquid capacity without adversely increasing the overall bulk and size of the syringe by filling the barrel 4, the bulb 12 and the hollow stem 10 with the stem fully retracted during the irrigation procedure.

However, most importantly, in operating the syringe 2 as a piston-type syringe, by reciprocating the piston 6, stem 10 and bulb 12 units in the barrel with the bulb 12 and stem 10 initially empty or partially full of liquid, a wide gradient of controlled, cushioned and gradually applied maximum median pressures and suction can be achieved between the relatively high, positive unyielding pressures and suction achieved when the syringe is operated as a pure piston-type syringe, as aforesaid, and the milder pressures and suction achieved by operating the syringe as a pure bulb-type syringe, as aforesaid.

The particular maximum median pressure and suction achieved can be controlled by controlling the degree to which the stem 10 and bulb 12 are initially filled with liquid between empty and full.

By operating the syringe in this way, only that pressure or suction is gradually built up which is required to overcome the resistance in the body cavity and no more. A cushioning effect is achieved to cushion or absorb in a controlled manner excess pressures and suction which might be developed by movement of the piston to thereby prevent the development of sudden uncontrolled excess pressures and suction. In effect, the excess pressure and suction are dissipated at a controlled rate. Regardless of how much resistance there is to flow through the nozzle opening 7 and regarding the magnitude and rate of movement of the piston within reason, the pressures and suction developed by such movement can only be built up gradually at a controlled rate. On the other hand, there is no interference with free flow of liquid into and out of the body cavity where there is no obstruction causing flow restriction.

These advantages achieved by the aforesaid piston-type operation with an initially empty or partially full stem and bulb are made possible by (1) the entrapped dead air cushion spaces 42 and 46 in the stem and bulb, respectively, (entrapped by the liquid 47 in the barrel as shown in FIG. 4) and (2) the orifice or reduced passage 30 providing communication between such spaces and the syringe barrel interior 44 and reduced nozzle opening 7.

This permits positive or negative pressure from the piston action to escape or bleed or overflow through the orifice 30 into the dead spaces 42-46 at a rate dependent on the size of the orifice 30, to thereby cause a gradually increasing gradient of pressure or suction buildup in the dead spaces (by compression or decompression of the entrapped air), and hence at the nozzle opening 7, as the piston is moved, which is released when the resistance to flow in the body cavity or wound is suddenly overcome. Accordingly, this eliminates the necessity of the doctor or nurse guessing at the proper force to be applied to the piston to overcome such resistance and avoids harmful surges when the resistance is finally overcome.

By partially filling the stem and bulb with liquid to begin with, the volume of the dead spaces 42-46 available for compression or expansion is proportionately reduced as compared to an initially empty stem and bulb to decrease the cushioning or absorbing effect. By increasing the initial amount of liquid in the bulb and stem, the maximum obstruction release pressure which is built up is increased over a shorter gradient. The same is true for suction aspiration of the body cavity.

Accordingly, the doctor, by filling the stem and bulb more or less between empty and full, can control the maximum pressures and suction achieved and the pressure or suction gradient differential to achieve maximum control and safety.

The time-pressure gradient achieved using the syringe as a piston-type syringe with an initially empty or partially full stem and bulb can be varied by varying the size of the orifice 30. By decreasing its size, the rate of bleedoff of overpressure or suction is reduced. Thus, by varying orifice size, many versatile results can be achieved. It is preferred that the size of the orifice 30 be about equal to or less than the nozzle opening 7. Of course, if the orifice size continues to be decreased, a point will be reached where the action of the stem and bulb begins to approach that of a solid piston shaft.

For example, when an orifice one-half the diameter of the nozzle opening was used, the pressure gradient for a given piston movement was increased substantially. On the other hand, if the orifice is much larger than the nozzle opening, liquid will flow through the orifice into the stem and bulb, which offers the least resistance to such flow, before flowing through the nozzle opening until a point is reached where the entrapped air in the stem and bulb is compressed to a pressure which exceeds the resistance of the nozzle opening so that the aforesaid beneficial cushioning effects are not achieved during initial movement of the piston. For example, this was noted when the orifice diameter was twice the diameter of the nozzle opening.

Although in the drawings the lower open end of the stem 10 terminates in the piston 6 with the orifice passage 30 in the piston, the stem may extend entirely through the piston with the orifice 30 located at the reduced lower end of the stem (in such case it is preferred that the stem does not protrude downwardly substantially below the piston in a way to substantially limit the downward movement of the piston and thereby reduce its stroke). In stroke of the piston passage 30 may be considered from a functional standpoint as being through the piston. Accordingly, when reference is made herein to such passage through the piston both constructions are included.

Although the present invention is most suitable for medical irrigating syringes, as above described, the same principle can be used to advantage with hypodermic-type syringes.

It is not intended that the invention be limited to the specific embodiments described and shown, it being apparent that other modifications are included within the scope thereof. Rather the invention is limited only by the scope of the appended claims.

A search of the prior art revealed the following: U.S. Pat. Nos. 493,591; 2,698,015; 2,180,063; 1,542,777; 3,013,577; 812,686; 3,028,862; 743,743; 2,847,996; 2,058,516; 1,878,026 and 933,398, none of which are pertinent.

I claim:

1. A medical pressure regulating syringe comprising a cylindrical syringe barrel having at its nozzle end a restricting opening, a resilient and flexible piston having at least one external, annular sealing rib slidable in said barrel in a fluidtight manner to draw and expel fluid into and out of said barrel through said opening, a hollow tubular piston shaft connected to said piston for sliding movement with said piston and with respect to said barrel, said piston having a cylindrical sidewall portion embracing a portion of the shaft, the internal wall of said cylindrical sidewall portion having an annular groove therein, said portion of said shaft having a reduced neck and a flange extending radially outwardly into said groove, said hollow shaft being connected with a chamber communicating with the interior of said hollow shaft and having a resilient and flexible wall to change the volume of said chamber, said chamber comprising an enlarged, flexible, resilient, squeezeable bulb, said shaft and bulb being integral and of plastic, said piston having a passage therethrough providing continuous and uninterrupted communication between the interior of said hollow shaft and bulb and said barrel and opening, whereby fluid can be expelled from said hollow stem and chamber through said passage into said barrel and through said opening and can be drawn into said hollow stem and chamber from said barrel and opening through said passage by flexing said chamber wall.

2. A syringe according to claim 1, said integral shaft and bulb being formed from a resilient, flexible and elastic plastic of the group consisting of polyethylene, polyvinyl chloride, ethylene-vinyl acetate copolymer, natural rubber, synthetic rubber and combinations thereof.

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