A piston pump in which, when the piston is stored or when the pump is not operative, the piston is received inside a portion of the chamber with the piston in a position having a larger diameter than portions of the chamber in which the piston is received when the piston is operative for pumping.
STEPPED CYLINDER PISTON PUMP

SCOPE OF THE INVENTION

[0001] This invention relates to piston pumps and, more particularly, to a stepped piston pump with a stepped cylinder to accommodate piston shrinkage or setting.

BACKGROUND OF THE INVENTION

[0002] Piston pumps are well known in which a piston reciprocally slides within a chamber. For many piston pumps, the piston includes an annular disc with an inherent resiliency biasing a periphery of the disc into engagement with an inner wall of the chamber to form a seal therewith. Frequently such discs may permit fluid flow in one direction therepast by a pressure differential across the disc urging the disc against its bias away from sealed engagement with the inner wall of the chamber and with the inherent bias of the disc causing the disc to assume a sealed position.

[0003] The present inventor has appreciated that under various conditions, the inherent resiliency of the disc may become impaired such that the disc will not adequately perform its function and the pump may have its performance reduced or fail. For example, the present inventor has appreciated that with pistons incorporating resilient discs which are made of plastic material, that the disc can be subject to setting and shrinkage. Setting arises, for example, when a disc is received in a chamber which disc has an initial inherent bias to assume a diameter larger than the diameter of the inner wall of the chamber such that the disc’s inherent bias urges the disc into engagement with the inner wall of the chamber. That is, the disc is compressed inside the chamber. If, however, such disc may be left in such compressed condition in the chamber for an extended period of time, then the disc may lose its inherent resiliency as, for example, tending to set and retain the shape in which it is held for an extended period of time and losing its bias to expand further outwardly. The extent to which setting or set may arise will determine the extent to which the disc member forms a functional seal with the inner wall of the chamber. Set is increased with the time during which the disc is retained in one position. Set with most plastic materials increases with increased temperature. For example, with many relatively inexpensive plastic materials as may preferably be used to form pistons for pumps, leaving a disc of a piston in a fixed condition within a cylinder for a number of days at temperatures in excess of 35°C and higher can significantly increase the extent to which a set is developed. Nevertheless, where the assembled pumps are left, for example, in storage in many climatic conditions, it may not be unrealistic for the pumps to be subjected for temperatures in the range of 35°C to 60°C for hours if not days as in transit, storage and the like.

[0004] The present inventor has also appreciated that set and the reduced inherent resiliency of a disc may arise when the disc may be subjected to certain fluids to be dispensed by the pump including chemicals which negatively affect the properties of the plastic with the time that they are left in a particular position.

[0005] The present inventor has also appreciated that there are plastic materials which may be preferred for use with pistons in pumps which can be subject to shrinkage when exposed to increased temperatures for periods of time. Thus, many plastic discs in piston pumps will also be subject to shrinkage when exposed to temperatures above, say, 35°C for an extended period of time which shrinkage can be enhanced and rendered more permanent as when a disc is retained in a compressed condition within the cylinder during the time that it is subjected to the elevated temperatures.

SUMMARY OF THE INVENTION

[0006] To at least partially overcome these disadvantages of previously known devices, the present invention provides a piston pump in which, when the piston is stored or when the pump is not operative, the piston is received inside a portion of the chamber with the piston in a position having a larger diameter than portions of the chamber in which the piston is received when the piston is operative for pumping.

[0007] An object of the present invention is to provide an improved piston pump assembly to overcome difficulties which may arise due to setting, the loss of resiliency or shrinkage of a piston-forming member.

[0008] Another object is to provide a piston pump which provides for useful operation of the pump even after a piston sealing member may have shrunk or become set to adopt an effectively smaller diameter.

[0009] A pump in accordance with the present invention has a piston reciprocally axially slidably within a chamber, with the piston assuming an axial set position within the chamber when the piston is not in use or when it is stored as after initial assembly. While the piston is in such set position, the piston is received within a set portion of the chamber having a larger circumference than other portions of the chamber into which the piston will slide when moved for pumping. The piston may, due to engagement in the larger diameter set portion of the chamber, become set to assume the diameter of the larger diameter set portion of the chamber or may shrink as to assume the diameter of the larger diameter set portion of the chamber which may impair the engagement of the piston in the larger diameter set portion. However, on movement of the piston in use into the other portions of the chamber having smaller diameters, the effects of set or shrinkage of the piston on engagement with the chamber will be reduced. Preferably, when the piston is in the set portion of the chamber, even after reasonably expected setting or shrinkage, the piston will continue to engage the wall of the chamber. It is within the scope of the invention, however, that when the piston is in the set position and the disc does not engage the wall of the chamber. Pumps in accordance with the present invention provide a stepped chamber with a larger diameter set portion of the chamber to be a portion or portions in which the piston is received when not operative and/or is being in storage preferably with the set position or positions being a fully retracted position or a fully withdrawn position. Preferably, the difference between the diameter of the larger diameter set portion and the other portion of the chamber is selected to be as small as possible to reasonably accommodate expected set or shrinkage.

[0010] Piston pumps may have pistons with more than one disc to engage the inner walls of a piston chamber and a separate stepped arrangement may be provided for each disc although this may not be necessary and merely to provide a
stepped configuration for one of the discs may be adequate to ensure reasonable operation of the pump.

[0011] The present invention provides by use of a stepped chamber a mechanism for accommodating adequate function of the pump notwithstanding set or shrinkage and, as well, permits the piston for the pump to be made from more easily handled and less expensive materials as, for example, plastics having lower melting and increased likelihood of set and shrinkage.

[0012] The invention is for use not only with pistons which have discs which extend radially outwardly to engage an inner wall of the chamber but also with arrangements in which a chamber may have a annular disc which extends radially inwardly as to engage a cylindrical surface on a piston. In the latter case, the diameter of the piston to be engaged by the radially outwardly extending disc should be reduced when the piston is in a set position it assumes when not in use.

[0013] In one aspect, the present invention provides a pump for dispensing fluid from a reservoir comprising:

[0014] a piston-chamber forming member having an inner cylindrical chamber and an outer cylindrical chamber, the inner chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end,

[0015] the diameter of the inner chamber being different than the diameter of the outer chamber,

[0016] the inner chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the outer chamber,

[0017] the inner chamber in fluid communication with the reservoir,

[0018] a piston forming element received in the piston-chamber forming member axially slidable inwardly and outwardly therein,

[0019] a disc on the piston forming element extending radially outwardly,

[0020] the piston forming element slidable received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a pump outlet,

[0021] intermediate positions between the extended position and the retracted position,

[0022] one of the extended position and the retracted position being a set position,

[0023] in the set position and between the set position and the intermediate positions, the disc is in the one of the inner chamber and outer chamber having the larger diameter,

[0024] when the disc is in the one of the inner chamber and outer chamber having the smaller diameter, the disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in that chamber past the disc in at least one of an inward direction and an outward direction,

[0025] the pump, after assembly of the piston-chamber forming member and the piston forming element, being in the set position or between the set position and the intermediate positions: (a) when the pump is stored prior to initial use, (b) when the pump is, after initial use, between cycles of operation, or, (c) when the pump is stored prior to initial use and when the pump is, after initial use, between cycles of operation.

[0026] In another aspect, the present invention provides a pump for dispensing fluid from a reservoir comprising:

[0027] a piston-chamber forming member having an inner cylindrical chamber, an intermediate chamber and an outer cylindrical chamber, the inner chamber, intermediate chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end,

[0028] the diameter of the inner chamber being less than the diameter of the intermediate chamber,

[0029] the diameter of the intermediate chamber being less than the diameter of the outer chamber,

[0030] the inner chamber, intermediate chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the intermediate chamber and with the outer end of the intermediate chamber opening into the inner end of the outer chamber,

[0031] the inner chamber in fluid communication with the reservoir,

[0032] a piston forming element received in the piston-chamber forming member axially slidable inwardly and outwardly therein,

[0033] an inner disc on the piston forming element extending radially outwardly,

[0034] an outer disc on the piston forming element extending radially outwardly,

[0035] the outer disc located on the piston forming element axially outwardly from the inner disc,

[0036] the piston forming element slidable received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a pump outlet,

[0037] intermediate positions between the extended position and the retracted positions,

[0038] in the retracted position and between the retracted position and the intermediate positions, the inner disc is in the inner chamber and the outer disc is in the intermediate chamber,

[0039] in the extended position and between the extended position and the intermediate position, the inner disc is in the intermediate chamber and the outer disc is in the outer chamber,

[0040] when the inner disc is in inner chamber, the inner disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the inner chamber past the inner disc in at least one of an inward direction and an outward direction,

[0041] when the outer disc is in intermediate chamber, the outer disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the
In another aspect, the present invention provides a device for dispensing fluid from a reservoir comprising:

- a piston-chamber forming member having an inner cylindrical chamber, an intermediate chamber and an outer cylindrical chamber, the inner chamber, intermediate chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end,
- the inner chamber, intermediate chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the intermediate chamber and with the outer end of the intermediate chamber opening into the inner end of the outer chamber,
- the inner chamber in fluid communication with the reservoir,
- a piston forming element received in the piston-chamber forming member axially slidably inwardly and outwardly therein,
- a disc on the piston forming element extending radially outwardly,
- the piston forming element slidably received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a outlet,
- when the disc is in the intermediate chamber, the disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the intermediate chamber past the disc in at least one of an inward direction and an outward direction,
- in the retracted position the disc is in the inner chamber,
- in the extended position the disc is in the outer chamber,
- the pump, after assembly of the piston-chamber forming member and the piston forming element, being in a position that the disc is in the inner chamber or in the outer chamber: (a) when the pump is stored prior to initial use, (b) when the pump is, after initial use, between cycles of operation, or (c) when the pump is stored prior to initial use and when the pump is, after initial use, between cycles of operation.

Further aspects and advantages of the present invention will become apparent from the following description taken together with the accompanying drawings in which:

- FIG. 1 is a schematic cross-sectional side view of a piston pump in accordance with a first embodiment of the present invention in an extended position;
- FIG. 2 is a view the same as in FIG. 1, however, with the piston in an intermediate position;
- FIG. 3 is a view the same as in FIG. 1, however, with the piston in a retracted position;
- FIG. 4 is a schematic cross-sectional side view of a piston pump in accordance with a second embodiment of the present invention in an extended position;
- FIG. 5 is a view the same as in FIG. 4, however, with the piston in an intermediate position;
- FIG. 6 is a view the same as in FIG. 4, however, with the piston in a retracted position;
- FIG. 7 is a schematic cross-sectional side view of a piston pump in accordance with a third embodiment of the present invention in a retracted position;
- FIG. 8 is a schematic cross-sectional side view of a piston pump in accordance with a fourth embodiment of the present invention in a retracted position;
- FIG. 9 is a schematic cross-sectional side view of a piston pump in accordance with a fifth embodiment of the present invention in a retracted position;
- FIG. 10 is a schematic cross-sectional side view of a piston pump in accordance with a sixth embodiment of the present invention in a retracted position;
- FIG. 11 is a view the same as in FIG. 10, however, with the piston in an intermediate position;
- FIG. 12 is a view the same as in FIG. 10, however, with the piston in an outer intermediate position; and
- FIG. 13 is a view the same as in FIG. 10, however, with the piston in an extended position.

Reference is made to FIGS. 1 to 3 which show a liquid dispenser having a pump assembly attached to a reservoir in accordance with the present invention.

The reservoir is a container with a threaded neck. The pump assembly has a piston chamber-forming body defining a chamber therein in which a piston forming element or piston is slidable disposed for reciprocal movement to dispense fluid from the reservoir. The chamber is defined inside side walls of an inner tube. The chamber is closed at an inner end wall and open at an outer end. Openings in the end wall of the chamber are in communication with the fluid in the reservoir. A one-way valve across the opening.
permits fluid flow outwardly from the reservoir 13 into the chamber 18 but prevents fluid flow inwardly.

[0074] Fluid from the reservoir 13 is in communication with the piston chamber 18 via the opening 22.

[0075] The one-way valve 25 has a shouldered button 30 which is secured in a snap-fit inside a central opening in the end wall 23 of the chamber 18. A flexible annular rim 31 is carried by the button 30 and extends radially outwardly to the side wall 42 of the inner tube 26. When the pressure in the chamber 18 is less than that in reservoir 13, the rim 31 is deflected away from the walls of the inner tube 26 and fluid may flow from the reservoir 13 through exit openings 22 and past the rim 31 into the chamber 18. Fluid flow in the opposite direction is blocked by rim 31, which is biased radially outwardly into the side wall 42 of the inner tube 26.

[0076] The piston-forming element or piston 20 is preferably a unitary element formed of plastic. The piston 20 has a hollow stem 32.

[0077] Two circular inner and outer discs 33 and 34 are located on the stem 32 spaced from each other. The inner disc 33 resiliently engages the side wall of the chamber 18 to permit fluid flow outwardly therefrom by resilient deflection away from the side wall when the pressure in the chamber 18 inward of the disc 33 is greater than the pressure outward of the disc 33. Inner disc 33 prevents fluid flow inwardly therefrom. Thus, the inner disc 33 functions as a second one-way valve. The outer disc 34 engages the side wall of the chamber 18 to prevent fluid flow outwardly therefrom.

[0078] The piston stem 32 has a hollow passageway 35 extending along the axis 40 of the piston 20 from a blind inner end 38 to an outlet 36 at an outer end. Inlets 37 to the passageway 35 are provided on the stem 32 between the inner disc 33 and outer disc 34. By reciprocal movement of the piston 20 in the chamber 18, fluid is drawn from reservoir 13 through exit openings 22 past the inner disc 33 and via the inlets 37 into the passageway 35 and along the passageway 35 to the outlet 36.

[0079] The piston chamber-forming body 16 is preferably injection moulded as a unitary element. The one-way valve 24 and the piston forming element 20 are separate elements.

[0080] In FIGS. 1 to 3, the piston 20 is reciprocally moveable in a single stroke of operation from an extended position as shown in FIG. 1 to the retracted position shown in FIG. 3 and then back to the extended position of FIG. 1. In moving between the extended position of FIG. 1 and the retracted position of FIG. 3, the piston moves through the intermediate position shown in FIG. 2.

[0081] In accordance with the first embodiment illustrated in FIGS. 1 to 3, the piston 20 is, after each stroke of operation, to be retained in the extended position until next activated. In this regard, in accordance with the first embodiment, a spring member (not shown) biases the piston 20 to the extended position with a stop mechanism (not shown) preventing further outward movement of the piston than the extended position of FIG. 1. Such spring biased soap dispensers are well known in which a user will move the piston from the extended position to the retracted position against the bias of a spring and the spring will return the piston to a fixed extended position in which position the piston will remain until next activation by a user.

[0082] As seen in FIGS. 1 to 3, the side wall 42 of the chamber has three portions, an inner chamber portion 44 of a constant diameter, an outer chamber portion 48 of a constant diameter greater than the diameter of the inner portion and a transition portion 46 which decreases in diameter outwardly from the inner portion 44 to the outer portion 48. As seen, a first transition line 45 is disposed between the inner chamber portion 44 and a transition portion 46. Another transition line 47 is disposed between the transition chamber portion 46 and the outer chamber portion 48.

[0083] In the extended position as shown in FIG. 1, the outer disc 34 is received in the outer chamber portion 48 and the inner disc 33 is in the inner chamber portion 44. In moving the piston inwardly from the extended position shown in FIG. 1, the outer disc passes through the transition portion into the intermediate position illustrated in FIG. 2 in which the outer disc 34 is first received within the inner chamber portion 44. In moving between the intermediate position shown in FIG. 2 and the retracted position in FIG. 3, the outer disc 34 is maintained within the inner chamber portion 44. A pump may be left in the extended position shown in FIG. 1 for long periods of time and under elevated temperature conditions. In the extended position as seen in FIG. 1, the outer disc 34 preferably, at least when initially constructed, has an inherent bias such that the peripheral edges of the disc 34 are, due to the inherent bias of the disc, urged outwardly into the inner wall of the outer chamber portion 48. With the passage of time, the outer disc 34 may become subject to set or shrinkage such that it loses its resiliency and is biased outwardly with reduced force. Notwithstanding any setting or shrinkage of the outer disc 34, on movement of the outer disc 34 to the intermediate position of FIG. 2, the outer disc 34 becomes received within the inner chamber portion 44 having a reduced diameter increasing the extent to which the outer disc 34 engages the inner wall of the chamber, thus providing for improved pumping as contrasted with a pump in which the entirety of the chamber had the diameter of the outer chamber portion 48.

[0084] Reference is made to FIGS. 4 to 6 which illustrate a pump assembly similar to that in FIGS. 1 to 3 and which the same reference numerals are used to refer to the same elements. One difference in the second embodiment in FIGS. 4 to 6 is that the inner wall 42 of the chamber 18 has five portions, an inner chamber portion 50, an inner transition chamber portion 52, an intermediate chamber portion 54, an outer transition chamber portion 56 and an outer chamber portion 58. Each of the inner chamber portion 50, intermediate chamber portion 54 and outer chamber portion 58 have a constant diameter, however, with the diameter of the inner chamber portion 50 being less than the diameter of the intermediate chamber portion 54 and the diameter of the intermediate chamber portion 54 being less than the diameter of the outer chamber portion 58. In the embodiment of
FIGS. 4 to 5, the pump is to remain in the extended position of FIG. 4 when not in use and is to be moved in a cycle of operation from the extended position of FIG. 4 through the intermediate position of FIG. 5 to the retracted position of FIG. 6 then back through the intermediate position of FIG. 5 to the extended position of FIG. 4. In the extended position, the outer disc 34 is in the outer chamber portion 58 and the inner disc 33 is in the intermediate chamber portion 54. From this position, the piston is initially moved inwardly to the intermediate position of FIG. 6 in which the outer piston 34 is in the intermediate chamber portion 54 and the inner disc 33 is in the inner chamber portion 50. In sliding between the intermediate position of FIG. 5 and the retracted position of FIG. 6, the outer disc 34 continues to remain in the constant diameter intermediate chamber portion 54 and the inner disc 33 remains in the constant diameter inner chamber portion 50.

[0085] With the embodiments of FIGS. 4 to 6, both the outer disc 34 and the inner disc 33, are in the extended position, in which they may remain when not in use in a larger diameter portion of the chamber than in a portion immediately inwardly therefrom in which they are substantially constantly retained during use of the pump in pumping. Thus, shrinkage or set by either of the outer disc 34 or the inner disc 33 is, to some extent, accommodated without performance reduction.

[0086] FIG. 7 illustrates a third embodiment of a piston pump in accordance with the present invention in which the same reference numerals are used to refer to the same elements as in FIG. 1. In the embodiment of FIG. 7, however, the pump is intended to be maintained in the retracted position, shown in FIG. 7, when not in use. In use, the piston 20 is to be moved from the retracted position to an extended position. In the retracted position, the outer disc 34 is received in an enlarged diameter inner chamber portion 44. With outward movement of the piston, the outer disc 34 moves over a transition chamber portion 46 to an intermediate position in which the outer disc 34 first enters the outer chamber portion 48 of reduced diameter. In reciprocal use of the pump, advantageous pumping occurs in sliding between an intermediate position and a fully extended position or in between such positions during which the outer disc 34 is maintained in the outer chamber portion and the inner disc 33 is maintained in the constant diameter inner chamber portion 44.

[0087] Reference is now made to FIG. 8 which illustrates a fourth embodiment in which in a manner analogous to that described with reference to FIGS. 4 to 6, but as in the embodiment in FIG. 7, the piston is to be retained in a retracted position when not in use. In FIG. 8, there are five portions in the chamber, namely, an inner chamber portion 50, an inner transition chamber portion 52, an intermediate chamber portion 54, an outer transition chamber portion 56 and an outer chamber portion 58 of the chamber with the inner chamber portion 50, intermediate chamber portion 54, outer chamber portion 58 having substantially constant but different diameters and with the diameter of the inner chamber portion 50 being greater than the diameter of the intermediate chamber portion 54 which is greater than the diameter of the outer chamber portion 58. In a fully retracted position as seen in FIG. 8 in which the piston pump assumes at rest, each of the outer disc 34 and the inner disc 33 are received in an enlarged diameter chamber portions compared to the diameter of the chamber portions in which the discs are to slide in operation of the pump from an intermediate position to an extended position.

[0088] The pump assembly in each of FIGS. 1 to 8 includes the one-way valve 25 and a piston 20 with two discs 33 and 34. FIG. 9 illustrates a pump assembly which avoids use of a separate one-way valve and the piston 20 carries three discs to provide, in effect, two one-way valves.

[0089] Referring to FIG. 9, the piston has three discs, namely, an outer disc 34, an intermediate disc 33 and an inner disc 70. The pump shown is intended to be maintained in the extended position shown in FIG. 9 when not in use. The outer disc 34 in the extended position is received in an enlarged diameter outermost chamber portion 58 such that on movement of the piston inwardly for pumping, the outer disc 34 comes to be engaged within the smaller diameter intermediate chamber portion 54. The intermediate disc 33 is always received in the constant diameter intermediate chamber portion 54. The inner disc 70 is always received in the constant diameter inner chamber portion 50. A step shoulder 52 is between inner chamber portion 50 and intermediate chamber portion 54. A transition chamber portion 56 is between intermediate chamber portion 54 and outer chamber portion 58.

[0090] Reference is made to FIG. 10 which illustrates a sixth embodiment in accordance with the present invention. As seen in FIG. 10, the inner tube 26 is shown to have an inner chamber portion 50 of a first constant diameter, an inner transition chamber portion 52, an intermediate chamber portion 54 of a constant diameter, an outer transition chamber portion 56 and an outer chamber wall portion 58 of constant diameter. The inner transition chamber portion 52 bridges between the inner chamber portion 50 and the intermediate chamber portion 54, and has a diameter less than the diameter of the intermediate chamber portion 54. The outer chamber portion 58 has a diameter less than the intermediate chamber portion 54. The pump is shown in four positions, a fully retracted position as illustrated in FIG. 10, an inner intermediate position as shown in FIG. 11, an outer intermediate position as shown in FIG. 12 and a fully extended position as shown in FIG. 13. The pump of FIGS. 10 to 13 is intended to be stored and shipped in the fully retracted position as illustrated in FIG. 10, for example, as (a) merely assembled and not coupled to a bottle reservoir or (b) assembled and coupled to a bottle but not engaged on a dispenser. In the fully retracted position, the outer disc 34 is received within the reduced diameter inner transition chamber portion 52. U.S. Pat. No. 5,975,360 issued Nov. 2, 1999 to Ophardt discloses in FIG. 8 a piston pump which is assembled and coupled to a bottle in a retracted position but which, when coupled to a dispenser as shown in FIG. 8 of that patent, is at rest in an extended position.

[0091] The pump, after being stored in the retracted position of FIG. 10, may then be coupled to a dispenser which dispenser firstly holds the pump in a rest position between strokes in the extended position of FIG. 13 and in use moves the piston inwardly and outwardly between the fully extended position of FIG. 13 and the inner intermediate position of FIG. 11. Thus, the operation of the pump is preferably selected such that after being placed in a dispenser, the piston 20 is not moved inwardly past the inner intermediate position of FIG. 11 and, hence, is not again
moved to the storage, retracted position of FIG. 10. In the operative stroking of the pump in use, the piston 20 is moved between the extended position of FIG. 13 and the inner intermediate position of FIG. 11. The pump is intended to be held when not in use in the extended position of FIG. 13 in which the outer disc 34 is engaged in the enlarged diameter outer chamber portion 58. In operation, the inner disc 34 substantially only engages and moves along the constant diameter inner chamber portion 50 in all movement between the retracted position and the extended position. The inner chamber portion 50 is shown to have a diameter the same as the intermediate chamber portion 54, however, it may have a diameter which is greater or lesser than the intermediate chamber portion 54 with the inner transition chamber portion 52 suitably modified.

[0092] This embodiment of FIG. 10 has the advantage that when the pump may be stored prior to use as, for example, in the stored retracted position of FIG. 10, the outer piston 34 is in the enlarged diameter inner chamber portion 50 of the chamber and, as well, when incorporated into a dispenser for use, when not in use, the outer disc 34 is in another enlarged diameter outer chamber portion 58 of the chamber.

[0093] In accordance with the present invention, pump arrangements are preferred wherein the position of the piston when stored or assembled, whether or not coupled to a bottle reservoir and whether or not coupled to a dispenser, is the same as the position of the piston when at rest in between cycles of operation. Storage of the piston can include storage as when a piston pump is assembled but before it may be coupled to a bottle reservoir and after the pump assembly may be coupled to a bottle reservoir before the pump and reservoir as a sub assembly may be coupled to a dispenser. Storage can also include a condition of being coupled to a dispenser ready for use.

[0094] While not necessary, it is preferred in accordance with the present invention that the piston disc when in a larger diameter portion of a chamber continues to provide some seal and engagement between the outer disc and the inner wall of the chamber. In this regard, it is preferred that the difference in diameter, for example, in the context of FIG. 1, between the inner chamber portion 44 and the outer chamber portion 48 is selected to be not greater than a difference required to accommodate for expected set and/or shrinkage. Minimizing this difference in diameter can be advantageous at least in reducing the extent to which the transitional chamber portion 46 may be required and providing for smooth sliding of the piston when subjected to relatively constant axial forces. Preferably, this difference in diameter is not greater than an amount selected from the group consisting of: 5% of the diameter of the inner chamber portion; 2% of the diameter of the inner chamber portion; 1% of the diameter of the inner chamber portion and 0.5% of the diameter of the inner chamber portion 0.2% of the diameter of the inner chamber portion.

[0095] The inner and outer discs 33 and 34 illustrated in the preferred embodiments preferably have resiliently deformable edge portions with elastic properties biasing the edge portion radially outwardly into engagement with the chamber wall. Such deformable edge portion may be formed from plastic material which is subject to reduction of its elastic properties biasing the edge portion radially outwardly when the edge portion is held in a set position for a period of time or when the edge portion is held in the set position for a period of time at temperatures above 35° C. or 40° C. or 50° C. or 60° C. In accordance with the present invention, the piston element is made from a plastic material preferably injection moulded as an unitary element from plastic material and, thus, the deformable edge portion is preferably formed from a plastic material.

[0096] In accordance with the present invention, the deformable edge portion may be formed from relatively inexpensive plastics including polyethylene, low density polyethylene and polypropylene so as to advantageously reduce the costs of materials.

[0097] Having regard to typical such plastics which may be used for construction of the piston, when the disc on the piston may have a diameter in the range of 5 to 40 mm, it is preferred that the difference in diameter between the inner chamber portion and the outer chamber portion be in the range of about 0.25% and 2%, more preferably, about 0.5% to about 1% with the disc having an inherent unbiased diameter of about 0.5% to 4% greater than the diameter of the inner chamber portion, more preferably, about 1% to 2% greater than the diameter of the inner chamber portion. In the embodiment of FIG. 1, each of the inner disc 33 and outer disc 34 most preferably has an inherent diameter when unbiased or compressed of about 1.5% greater than the diameter of the inner chamber portion 44; and the outer chamber portion 48 preferably has a diameter of about one half the sum of the inherent diameter of the disc 34 and the diameter of the inner chamber portion 44. In one preferred embodiment utilizing a low density polyethylene plastic material, the diameter of the inner chamber portion 44 is about 12.15 mm, the diameter of the outer chamber portion 46 is about 12.25 mm and the inherent diameter of the outer disc 34 is about 12.33 mm.

[0098] Embodiments as illustrated in FIGS. 7, 8 and 10 have at least one chamber portion of a smaller diameter inward of a chamber portion of larger diameter. However, preferably, the piston-chamber forming member 16 is formed by injection moulding as a unitary element. Due to the inherent resiliency of the plastic of the piston-chamber forming member 16 during injection moulding, a centrally extending core may be provided with an enlarged portion to form the undercut, smaller diameter inward chamber portion. The relative difference between the diameter of the inner chamber portion and outer chamber portion is preferably limited to be no more than about 2%, more preferably, 1% or 0.5% to assist in permitting manufacture with such a removable core.

[0099] While the invention has been described with reference to the preferred embodiments many variations and modifications will now occur to persons skilled in the art. For a definition of the invention reference is made to the following claims.

We claim:

1. A pump for dispensing fluid from a reservoir comprising:

   a piston-chamber forming member having an inner cylindrical chamber and an outer cylindrical chamber, the inner chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end,
the diameter of the inner chamber being different than the diameter of the outer chamber,
the inner chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the outer chamber,
the inner chamber in fluid communication with the reservoir,
a piston forming element received in the piston-chamber forming member axially slidable inwardly and outwardly therein,
a disc on the piston forming element extending radially outwardly,
the piston forming element slidably received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a pump outlet,
intermediate positions between the extended position and the retracted position,
one of the extended position and the retracted position being a set position,
in the set position and between the set position and the intermediate positions the disc is in the one of the inner chamber and outer chamber having the larger diameter,
in the intermediate positions, the disc is in the one of the inner chamber and outer chamber having the smaller diameter,
when the disc is in the one of the inner chamber and outer chamber having the smaller diameter, the disc engaging the chamber wall thereof circumferentially thereof to substantially prevent fluid flow in that chamber past the disc in at least one of an inward direction and an outward direction,
the pump, after assembly of the piston-chamber forming member and the piston forming element, being in the set position or between the set position and the intermediate positions: (a) when the pump is stored prior to initial use, (b) when the pump is, after initial use, between cycles of operation, or, (c) when the pump is stored prior to initial use and when the pump is, after initial use, between cycles of operation.
2. A pump as claimed in claim 1 wherein the set position is the extended position.
3. A pump as claimed in claim 1 wherein the set position is the retracted position.
4. A pump as claimed in claim 1 wherein

the diameter of the inner chamber being lesser than the diameter of the outer chamber.
5. A pump as claimed in claim 1 wherein

the diameter of the inner chamber being greater than the diameter of the outer chamber.
6. A pump as claimed in claim 1 wherein the outer disc has an inherent diameter when unbiased in a range of 0.1% to 2% greater than the diameter of the inner chamber and the outer chamber having the lesser diameter;
7. A pump as claimed in claim 6 wherein the difference in diameters between the inner chamber and the outer chamber is in the range of about 0.5% to 1%.

8. A pump as claimed in claim 1 wherein the difference in diameters between the inner chamber and the outer chamber is not greater than an amount selected from the group consisting of: 5% of the diameter of the inner chamber, 2% of the diameter of the inner chamber, 1% of the diameter of the inner chamber, 0.5% of the diameter of the inner chamber, 1 mm, 0.1 mm, and 0.05 mm.
9. A pump as claimed in claim 8 wherein

when the disc is in the one of the inner chamber and outer chamber having the larger diameter, the disc engages the chamber wall thereof circumferentially thereof to substantially prevent fluid flow in that chamber past the disc in at least one of an inward direction and an outward direction.
10. A pump as claimed in claim 1 wherein the disc having resiliently deformable edge portion with elastic properties biasing the edge portion radially outwardly into engagement with the chamber wall of the one of the inner chamber and outer chamber having the smaller diameter.
11. A pump as claimed in claim 10 wherein the deformable edge portion is formed from material which is subject to a reduction of its elastic properties biasing the edge portion radially outwardly when: (a) the edge portion is held in the set position for a period of time or (b) the edge portion is held in the set position for a period of time at temperatures above 30 degrees Celsius.
12. A pump as claimed in claim 11 wherein

the deformable edge portion is formed from plastic material.
13. A pump as claimed in claim 12 wherein

the deformable edge portion is formed from plastic material selected from polyethylene and polypropylene.
14. A pump as claimed in claim 1 wherein said piston forming element having an axially extending hollow stem having a central passageway having an outlet proximate an outer end and an inlet located on the stem between the inner disc and the outer disc,

the disc comprising an outer disc on the stem substantially preventing fluid flow in the inner chamber past the outer disc in an outward direction,
an inner disc on the stem spaced axially inwardly from the outer disc extending radially outwardly from the stem to proximate the chamber wall of the inner chamber circumferentially thereof,
the inner disc substantially preventing fluid flow in the inner chamber past the inner disc in an inward direction,
the inner disc elastically deforming away from the chamber wall of the inner chamber to permit fluid flow in the inner chamber past the inner disc in an outward direction.
15. A pump as claimed in claim 14 wherein the outer disc substantially preventing fluid flow in the inner chamber past the outer disc in an inward direction.
16. A pump as claimed in claim 1 wherein said piston forming element having an axially extending hollow stem having a central passageway having an outlet proximate an outer end and an inlet located on the stem between the inner disc and the outer disc,
the disc comprising an inner disc on the stem, an outer disc on the stem spaced axially outwardly from the inner disc extending radially outwardly from the stem to proximate the chamber wall of the outer chamber circumferentially thereabout, the outer disc substantially preventing fluid flow in the outer chamber past the inner disc in an inward direction, the outer disc elastically deforming away from the chamber wall of the outer chamber to permit fluid flow in the outer chamber past the outer disc in an outward direction.

17. A pump for dispensing fluid from a reservoir comprising:

a piston-chamber forming member having an inner cylindrical chamber, an intermediate chamber and an outer cylindrical chamber, the inner chamber, intermediate chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end, the diameter of the inner chamber being less than the diameter of the intermediate chamber, the diameter of the intermediate chamber being less than the diameter of the outer chamber, the inner chamber, intermediate chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the intermediate chamber and with the outer end of the intermediate chamber opening into the inner end of the outer chamber, the inner chamber in fluid communication with the reservoir, a piston forming element received in the piston-chamber forming member axially slideable inwardly and outwardly therein, an inner disc on the piston forming element extending radially outwardly, an outer disc on the piston forming element extending radially outwardly, the outer disc located on the piston axially outwardly from the inner disc, the piston forming element slidably received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a pump outlet, intermediate positions between the extended position and the retracted position, in the retracted position and between the retracted position and the intermediate positions the inner disc is in the inner chamber and the outer disc is in the intermediate chamber, in the extended position and between the extended position and the intermediate positions the inner disc is in the intermediate chamber and the outer disc is in the outer chamber, when the inner disc is in the inner chamber, the inner disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the inner chamber past the inner disc in at least one of an inward direction and an outward direction, when the outer disc is in intermediate chamber, the outer disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the intermediate chamber past the outer disc in at least one of an inward direction and an outward direction, the pump, after assembly of the piston-chamber forming member and the piston forming element, being in the extended position or between the extended position and the intermediate positions: (a) when the pump is stored prior to initial use, (b) when the pump is, after initial use, between cycles of operation, or, (c) when the pump is stored prior to initial use and when the pump is, after initial use, between cycles of operation.

18. A pump as claimed in claim 17 wherein said piston forming element having an axially extending hollow stem having a central passageway having an outlet proximate an outer end and an inlet located on the stem between the inner disc and the outer disc, the inner disc provided on the stem extending radially outwardly from the stem, the outer disc on the stem spaced axially outwardly from the inner disc and extending radially outwardly from the stem, the inner disc when in the inner chamber substantially preventing fluid flow in the inner chamber past the inner disc in an inward direction, the outer disc when in the intermediate chamber substantially preventing fluid flow in the intermediate chamber past the outer disc in an outward direction.

19. A pump as claimed in claim 18 including a one-way valve between the reservoir and the inner chamber preventing fluid flow inwardly from the inner chamber to the reservoir.

20. A pump for dispensing fluid from a reservoir comprising:

a piston-chamber forming member having an inner cylindrical chamber, an intermediate chamber and an outer cylindrical chamber, the inner chamber, intermediate chamber and outer chamber each having a diameter, a chamber wall, an inner end and an outer end, the diameter of the intermediate chamber being greater than the diameter of the inner chamber, the diameter of the intermediate chamber being greater than the diameter of the outer chamber, the inner chamber, intermediate chamber and outer chamber being coaxial with the outer end of the inner chamber opening into the inner end of the intermediate chamber and with the outer end of the intermediate chamber opening into the inner end of the outer chamber, the inner chamber in fluid communication with the reservoir, a piston forming element received in the piston-chamber forming member axially slideable inwardly and outwardly therein,
a disc on the piston forming element extending radially outwardly,
the piston forming element slidably received in the piston-chamber forming member for reciprocal axial inward and outward movement therein in a cycle of operation between an extended position and a retracted position to pump fluid from the reservoir out a pump outlet,
when the disc is in the intermediate chamber, the disc engaging the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in the intermediate chamber past the disc in at least one of an inward direction and an outward direction,
in the retracted position, the disc is in the inner chamber, in the extended position, the disc is in the outer chamber,
the pump, after assembly of the piston-chamber forming member and the piston forming element, being in a position that the disc is in the inner chamber or in the outer chamber: (a) when the pump is stored prior to initial use, (b) when the pump is, after initial use, between cycles of operation, or (c) when the pump is stored prior to initial use and when the pump is, after initial use, between cycles of operation,
when the disc is in the one of the inner chamber or outer chamber, the disc engages the chamber wall thereof circumferentially thereabout to substantially prevent fluid flow in that chamber past the disc in at least one of an inward direction and an outward direction.