WE CLAIM:

1. A rolling diaphragm for receiving a medical fluid therein, the rolling diaphragm comprising:

a proximal end comprising an end wall for engagement with a plunger, a distal end received within a throughbore of a pressure jacket, the distal end having a nozzle, and a sidewall extending between the proximal end and the distal end along a longitudinal axis, at least a portion of at least one of the sidewall and the end wall having non-uniform thickness,

wherein at least a portion of the sidewall is flexible such that the sidewall rolls upon itself when acted upon by the plunger such that an outer surface of the sidewall at a folding region is folded in a radially inward direction as the plunger is advanced from the proximal end to the distal end and wherein the outer surface of the sidewall unrolls as the folding region is unfolded in a radially outward direction as the plunger is retracted from the proximal end to the distal end,

wherein the end wall has a radiused folding edge that transitions into a distally extending ramp having continuously increasing thickness, and

wherein the end wall has a plunger engagement portion protruding proximally from a central region of the ramp.

2. The rolling diaphragm of claim 1, wherein the end wall has one or more ribs protruding radially outward from the plunger engagement portion toward the radiused folding edge.

3. The rolling diaphragm of claim 1, wherein a first portion of the sidewall distal of an approximate midpoint of the rolling diaphragm has a first thickness, wherein a second portion of the sidewall proximal of the approximate midpoint of the rolling diaphragm has a second thickness, and wherein the first thickness is larger than the second thickness.

4. The rolling diaphragm of claim 1, wherein the proximal end has a rigid plunger monolithically formed with the proximal end.

5. The rolling diaphragm of claim 1, wherein the plunger engagement portion is received within an opening on the plunger.

6. The rolling diaphragm of claim 5, wherein the plunger engagement portion is non-removably secured with at least a portion of the plunger.

7. The rolling diaphragm of claim 5, wherein at least a portion of the plunger engagement portion is expanded radially outward after it is inserted into the opening on the plunger to retain the plunger engagement portion within the opening of the plunger.

8. The rolling diaphragm of claim 1, wherein an interior of the rolling diaphragm is pre-filled with a medical fluid.

9. The rolling diaphragm of claim 1, wherein the nozzle has a connector for connecting to a fluid path set.

10. The rolling diaphragm of claim 9, wherein the connector is a luer connector.

11. The rolling diaphragm of claim 1, wherein the nozzle has a piercable seal for sealing an interior of the rolling diaphragm.

12. The fluid delivery system of claim 1, wherein the nozzle has a first seal between the nozzle and the sidewall of the rolling diaphragm and a second seal at an interface for connecting the nozzle to a fluid path set.

13. A syringe for a fluid delivery system, the syringe comprising:

a pressure jacket having a distal end, a proximal end, and a throughbore extending between the distal end and the proximal end; and

a rolling diaphragm disposed within the throughbore of the pressure jacket, the rolling diaphragm having a proximal end having an end wall in engagement with a plunger, a

distal end received at the distal end of the pressure jacket, the distal end of the rolling diaphragm having a nozzle, and a sidewall extending between the proximal end and the distal end of the rolling diaphragm along a longitudinal axis, at least one of the end wall and at least a portion of the sidewall having a non-uniform thickness,

wherein at least a portion of the sidewall of the rolling diaphragm is flexible and rolls upon itself such that an outer surface of the sidewall at a folding region is folded in a radially inward direction as the plunger is advanced from the proximal end to the distal end of the rolling diaphragm and such that the outer surface of the sidewall unrolls as the folding region is unfolded in a radially outward direction as the plunger is retracted from the proximal end to the distal end of the rolling diaphragm,

wherein the end wall has a radiused folding edge that transitions into a distally extending ramp having continuously increasing thickness, and

wherein the end wall has a plunger engagement portion protruding proximally from a central region of the ramp.

14. The syringe of claim 13, wherein the pressure jacket has a removable closure for enclosing at least a portion of the rolling diaphragm.

15. The syringe of claim 14, wherein the removable closure has a threaded end for engaging corresponding threads on the distal end of the pressure jacket or wherein the removable closure has one or more radially extending tabs for insertion into corresponding slots for engaging a bayonet locking mechanism on the distal end of the pressure jacket.

16. The syringe of claim 14, wherein the proximal end of the pressure jacket has a connection interface for releasably connecting to a fluid injector.

17. A fluid delivery system, comprising:

a fluid injector comprising at least one reciprocally operable piston;

a plunger operably connectable to the piston;

a pressure jacket having a distal end, a proximal end, and a throughbore extending between the distal end and the proximal end, the pressure jacket operably connectable to the fluid injector; and

a rolling diaphragm disposed within a throughbore of the pressure jacket, the rolling diaphragm having a proximal end comprising an end wall in engagement with the plunger, a distal end received at the distal end of the pressure jacket, the distal end of the rolling diaphragm having a nozzle, and a sidewall extending between the proximal end and the distal end of the rolling diaphragm along a longitudinal axis, at least a portion of at least one of the sidewall and the end wall having non-uniform thickness,

wherein at least a portion of the sidewall of the rolling diaphragm is flexible and rolls upon itself such that an outer surface of the sidewall at a folding region is folded in a radially inward direction as the plunger is advanced by the piston from the proximal end to the distal end of the rolling diaphragm and such that the outer surface of the sidewall unrolls as the folding region is unfolded in a radially outward direction as the plunger is retracted by the piston from the proximal end to the distal end of the rolling diaphragm,

wherein the end wall has a radiused folding edge that transitions into a distally extending ramp having continuously increasing thickness, and

wherein the end wall has a plunger engagement portion protruding proximally from a central region of the ramp.