of actuation chamber 26 is at a minimum, the corresponding pump chamber 28 is at a maximum (fill stroke, see Fig. 1A, 2A). When the volume of actuation chamber 26 is at a maximum, the volume of corresponding pump chamber 28 is at a minimum (deliver stroke, see Fig. 1B, 2B). Once the excursion depth E of the diaphragms on the cassette have been chosen, the cassette thickness T can be reduced by avoiding locating actuation ports directly over the diaphragms being actuated (as in prior art designs). This is accomplished by placing the actuation ports on the thin or narrow side of the cassette and running actuation channels to their respective diaphragms in the first inter-plate space 20 in the cassette 10. This space is delimited by midplate 12 onto which the diaphragm 18 is seated and first outer plate 14 that provides a cover or roof for the actuation chamber 26 for each diaphragm 18. Surrounding the perimeter of each diaphragm is a wall 30 spanning the inter-plate space 20 that, together with the outer plate 14, completes each actuation chamber 26, except for an actuation port or window 32 connecting the actuation chamber 26 to its corresponding actuation channel (represented by the arrow in the first inter-plate space 20). The actuation channel then runs in the inter-plate space 20 to a peripheral edge or narrow side of the cassette, terminating there as a cassette actuation port (see, e.g. Fig. 9). Note that the actuation channel can be smaller than the depth provided by the inter-plate space 20, depending on what excursion depth E has been specified for the diaphragm 18. To minimize the overall thickness T of the cassette 10 for a given specified diaphragm excursion depth E, one can minimize the nominal thickness P of each plate 12, 14, 16 (within structural rigidity constraints, and any constraints placed on achieving a proper welding or cementing of the outer plate to the channel walls of the midplate). Depending on fluid flow rate requirements, one can also minimize the thickness of the cassette by reducing the depths of the liquid flow channels (i.e. the height of the channel walls) within the second inter-plate space 22.

The overall thickness T of the cassette can depend on the amount of depth required by the liquid flowpaths or channels on an opposing side of the midplate 12 of the cassette 10 within the second inter-plate space 22. In the pump shown in Figs. 1A-1B and the valve shown in Figs. 3A, 3B, the required depth of the liquid channel determines the depth of the second inter-plate space 22. Depending on the liquid flow rates specified for the cassette, the second inter-plate space 22 may have a depth L substantially smaller than the depth E of the first inter-plate space 20.

What is claimed is:

1. A fluid-handling cassette assembly comprising:

a middle cassette interposed between a first outer cassette and a second outer cassette; each said cassette comprising:

a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

a plurality of diaphragm valves or pumps comprising valve or pump actuation chambers connected to actuation channels running parallel to the face of the cassette within the first or second inter-plate space, and terminating in respective cassette valve or pump actuation ports at a first edge of the cassette between the first or second inter-plate space; and

a fluid-handling pod positioned in an inter-cassette space between the middle cassette and the first or second cassette; said pod having a fluid connection to fluid channels in the middle, first or second cassette via a fluid conduit penetrating the face of the middle, first or second cassette;

wherein the first edge of the middle, first and second cassettes are located on a first side of the cassette assembly, so that the cassette valve or pump actuation ports are configured to plug into or unplug from an actuation port receptacle assembly opposite the first side of the cassette assembly.

2. The cassette assembly of claim 1, wherein the fluid-handling pod comprises a diaphragm pump pod having an actuation and a fluid connection to actuation and fluid

channels in the middle, first or second cassette via an actuation conduit and a fluid conduit, each penetrating the face of the middle, first or second cassette.

3. The cassette assembly of claim 2, wherein the actuation conduit of the diaphragm pump pod connects to an actuation channel in a first or second inter-plate space of said middle, first or second cassette, and has an uninterrupted connection to a cassette actuation port for the diaphragm pump pod on the first edge of said middle, first or second cassette.

4. The cassette assembly of claim 2, wherein the fluid conduit of the diaphragm pump pod connects to a fluid channel in a first or second inter-plate space of said middle, first or second cassette, and connects with a diaphragm valve in said cassette, and wherein an actuation channel of said diaphragm valve connects to a cassette actuation port for said diaphragm valve in the first edge of said middle, first or second cassette.

5. The cassette assembly of claim 1, wherein the fluid conduit is rigid.

6. The cassette assembly of claim 5, comprising a plurality of fluid-handling pods between the middle cassette and the first cassette, and between the middle cassette and the second cassette, and wherein associated fluid conduits of this plurality of fluid-handling pods are rigid and provide structural support for the cassette assembly.

7. The cassette assembly of claim 1, comprising a cassette assembly frame configured to enhance the structural stiffness of the cassette assembly, the cassette assembly frame comprising a rigid support plate on a second side of the cassette assembly opposite the first side of the cassette assembly, said support plate configured to engage a cassette loading apparatus opposite the actuation port receptacle.

8. A fluid-handling cassette assembly comprising:

a middle cassette interposed between a first outer cassette and a second outer cassette;

each said cassette comprising:

a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

a plurality of diaphragm valves or pumps comprising valve or pump actuation chambers connected to actuation channels running parallel to the face of the cassette within the first or second inter-plate space, and terminating in respective cassette valve or pump actuation ports at a first edge of the cassette between the first or second inter-plate space;

a first fluid-handling pod positioned in an inter-cassette space between the middle cassette and the first or second cassette; said pod having a fluid connection to fluid channels in the middle, first or second cassette via a fluid conduit penetrating the face of the middle, first or second cassette; and

a second fluid-handling pod comprising a diaphragm pump pod having an actuation and a fluid connection to actuation and fluid channels in the middle, first or second cassette via an actuation conduit and a fluid conduit, each penetrating the face of the middle, first or second cassette;

wherein the first edge of the middle, first and second cassettes are located on a first side of the cassette assembly, so that the cassette valve or pump actuation ports are configured to plug into or unplug from an actuation port receptacle assembly opposite the first side of the cassette assembly.

9. The cassette assembly of claim 8, wherein the actuation conduit of the diaphragm pump pod connects to an actuation channel in a first or second inter-plate space of said middle, first or second cassette, and has an uninterrupted connection to a cassette actuation port for the diaphragm pump pod on the first edge of said middle, first or second cassette.

10. The cassette assembly of claim 8, wherein the fluid conduit of the diaphragm pump pod connects to a fluid channel in a first or second inter-plate space of said middle, first or second cassette, and connects with a diaphragm valve in said cassette, and wherein an actuation channel of said diaphragm valve connects to a cassette actuation port for said diaphragm valve in the first edge of said middle, first or second cassette.

11. The cassette assembly of claim 8, wherein the fluid conduit is rigid.

12. The cassette assembly of claim 11, comprising a plurality of fluid-handling pods between the middle cassette and the first cassette, and between the middle cassette and the second cassette, and wherein associated fluid conduits of this plurality of fluid-handling pods are rigid, providing structural support for the cassette assembly.

13. The cassette assembly of claim 8, comprising a cassette assembly frame configured to enhance the structural stiffness of the cassette assembly, the cassette assembly frame comprising a rigid support plate on a second side of the cassette assembly opposite the first side of the cassette assembly, said support plate configured to engage a cassette loading apparatus opposite the actuation port receptacle.

14. A fluid handling cassette comprising a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

the mid-plate comprising a pump station defined by a pump diaphragm and the first side of the mid-plate, said pump diaphragm seated against the first side of the midplate and having an excursion range defined by the width of the first inter-plate space; and

a pump actuation channel running parallel to the face of the cassette in the first inter-plate space connecting a pump actuation chamber bounded by the first plate and the pump diaphragm with a cassette pump actuation port located within the first inter-plate space at a first edge of the cassette.

15. The cassette of claim 14, comprising a first and a second pump fluid port in the pump station fluidly connecting a respective first and second fluid channel in the second inter-plate space to a pumping chamber defined by the pump diaphragm and the first side of the mid-plate.

16. The cassette of claim 14, comprising a pump fluid port in the pump station fluidly connecting a fluid channel in the second inter-plate space with a pumping chamber defined by the pump diaphragm and the first side of the mid-plate.

17. The cassette of claim 14, comprising an aperture in the mid-plate at the pump station, said aperture allowing the pump diaphragm to move from the first plate to the second plate when actuated by positive or negative pressure delivered through the pump actuation channel.

18. The cassette of claim 14, wherein the plates are insufficiently thick to allow fluid or actuation channels to travel within the plates in a direction parallel to the face of the cassette.

19. The cassette of claim 14, comprising a fluid channel running in the second inter-plate space, and fluidly connected to a pumping chamber defined by the pump diaphragm and the first side of the mid-plate, said connection being made through one or more pump fluid ports in the mid-plate, wherein the fluid channel runs parallel to the face of the cassette in the second inter-plate space connecting the pumping chamber with a cassette fluid port located within the second inter-plate space at the first edge or at a second edge of the cassette.

20. A fluid handling cassette comprising a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the

mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

the mid-plate comprising a valve station defined by a valve diaphragm and the first side of the mid-plate, said valve diaphragm seated against the first side of the midplate and having an excursion range defined by the width of the first inter-plate space; and

a valve actuation channel running parallel to the face of the cassette in the first inter-plate space connecting a valve actuation chamber bounded by the first plate and the valve diaphragm with a cassette valve actuation port located within the first inter-plate space at a first edge of the cassette.

21. The cassette of claim 20, comprising a first and second valve fluid port in the valve station fluidly connecting a respective first and second fluid channel in the second inter-plate space to a valve fluid chamber defined by the valve diaphragm and the first side of the mid-plate.

22. The cassette of claim 21, wherein one or both valve fluid ports comprise a raised valve seat to seal the valve diaphragm over the first or second valve fluid port when positive pressure is applied to the valve diaphragm via the valve actuation channel.

23. The cassette of claim 21, wherein the first fluid channel is fluidically isolated from the second fluid channel other than through the first and second valve fluid ports.

24. The cassette of claim 20, comprising a fluid channel running in the second inter-plate space, and fluidly connected to a valve fluid chamber defined by the valve diaphragm and the first side of the mid-plate, said connection being made through two valve fluid ports in the mid-plate, wherein the fluid channel runs parallel to the face of the cassette in the second inter-plate space connecting the valve fluid chamber with a cassette fluid port

located within the second inter-plate space at the first edge or at a second edge of the cassette.

25. A fluid handling cassette comprising a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

the mid-plate comprising a pump station defined by a pump diaphragm and the first side of the mid-plate, said pump diaphragm seated against the first side of the mid-plate and having an excursion ranged defined by the width of the first inter-plate space;

the mid-plate also comprising first and second valve stations, each defined by a valve diaphragm and the first side of the mid-plate, said valve diaphragm seated against the first side of the midplate and having an excursion range defined by the width of the first inter-plate space; and

a pump actuation channel for the pump station, and a valve actuation channel for each of the first and second valve stations;

said pump actuation channel running parallel to the face of the cassette in the first inter-plate space connecting a pump actuation chamber bounded by the first plate and the pump diaphragm with a cassette pump actuation port located within the first inter-plate space at a first edge of the cassette; and

each said valve actuation channel running parallel to the face of the cassette in the first inter-plate space connecting a valve actuation chamber bounded by the first plate and the valve diaphragm with a cassette valve actuation port located within the first inter-plate space at the first edge of the cassette.

26. The cassette of claim 25, comprising an inlet and outlet valve fluid port in each of said two valve stations, and one or more pump fluid ports in the pump station, each of said valve and pump fluid ports fluidly connecting a fluid channel in the second inter-plate space with:

a pumping chamber defined by the pump diaphragm and the first side of the mid-plate;

and a valve fluid chamber in each of said valve stations defined by the corresponding valve diaphragm and the first side of the mid-plate;

the fluid channel having a flowpath that passes through said inlet and outlet valve fluid ports and said one or more pump fluid ports;

wherein selective actuation of the pump actuation chamber and said valve actuation chambers allows for uni-directional flow of a fluid through the fluid channel.

27. The cassette of claim 25, comprising a fluid channel running in the second inter-plate space, and fluidly connected to:

a pumping chamber defined by the pump diaphragm and the first side of the mid-plate, said connection being made through a pump fluid port in the mid-plate; and

a valve fluid chamber of each valve station, each said valve fluid chamber being defined by the corresponding valve diaphragm and the first side of the mid-plate, each said connection being made through two valve fluid ports in the mid-plate;

wherein the fluid channel runs parallel to the face of the cassette in the second inter-plate space connecting the pumping chamber and each of the valve fluid chambers with a cassette fluid inlet port and a cassette fluid outlet port located within the second inter-plate space at the first edge or at a second edge of the cassette.

28. The cassette of claim 27, wherein the cassette fluid inlet port and cassette fluid outlet port are located at a second edge of the cassette, so that the cassette pump actuation port and the cassette valve actuation port are configured to be plugged directly into a mating actuation receptacle external to the cassette, and so that the fluid inlet port and fluid outlet port are arranged to be connected via flexible or malleable tubing to a fluid source or destination external to the cassette.

29. The cassette of claim 25, comprising a fluid channel running in the second inter-plate space, and fluidly connected to:

a pumping chamber defined by the pump diaphragm and the first side of the mid-plate, said connection being made through a pump fluid port in the mid-plate; and

a valve fluid chamber of each valve station, each said valve fluid chamber being defined by the corresponding valve diaphragm and the first side of the mid-plate, each said connection being made through two valve fluid ports in the mid-plate;

wherein the fluid channel runs parallel to the face of the cassette in the second inter-plate space and connects the pumping chamber and each of the valve fluid chambers with a cassette fluid inlet port and a cassette fluid outlet port, said cassette fluid inlet port and fluid outlet port exiting the cassette through rigid conduits originating on the mid-plate and penetrating the face of the cassette through the first or second outer plates.

30. The cassette of any of claims14, 20, 25, comprising a plurality of walls formed on the first and second sides of the mid-plate, said walls arranged to be fused with the first and second plates to form said actuation or fluid channels within the cassette.

31. The cassette of claim 30, wherein a first type of said walls comprises parallel walls to define the actuation or fluid channels, and a second type of said walls comprises circumferential perimeter walls defining pump or valve actuation stations, and a third type of said walls comprises adjacent end walls defining a channel termination at which a valve or pump fluid port penetrates the mid-plate.

32. The cassette of claim 31, wherein the first plate comprises one or more circumferential valve or pump diaphragm retainers configured to fit within the circumferential perimeter walls of the opposing mid-plate that define pump or valve actuation stations, said retainers arranged to clamp a peripheral bead or rim of an associated diaphragm positioned in the pump or valve station of the mid-plate.

33. The cassette of claim 32, wherein the retainers include holes, fenestrations or slots to permit transmission of actuation fluid or gas between the valve or pump actuation chamber surrounded by the retainer and an associated actuation channel.

34. The cassette of claim 31, wherein the first plate comprises an elongate rib configured to be positioned within a mating actuation channel of the mid-plate, the cross-sectional size and length of the rib arranged to adjust the actuation channel volume to a pre-determined value between an actuation port of the cassette and an associated valve or pump actuation chamber.

35. A fluid handling cassette comprising a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

the mid-plate comprising first and second valve stations, the first valve station defined by a first valve diaphragm and the first side of the mid-plate, and the second valve station defined by a second valve diaphragm and the second side of the mid-plate, said first valve diaphragm seated against the first side of the midplate and having an excursion range defined by the width of the first inter-plate space, and said second valve diaphragm seated against the second side of the mid-plate and having an excursion range defined by the width of the second inter-plate space; and

a first valve actuation channel for the first valve station and running parallel to the face of the cassette in the first inter-plate space, and a second valve actuation channel for the second valve station and running parallel to the face of the cassette in the second inter-plate space;

said first valve actuation channel connecting a first valve actuation chamber bounded by the first plate and the first valve diaphragm with a first cassette valve actuation port located within the first inter-plate space at a first edge of the cassette; and

said second valve actuation channel connecting a second valve actuation chamber bounded by the second plate and the second valve diaphragm with a second cassette valve actuation port located within the second inter-plate space at the first edge of the cassette.

36. A fluid handling cassette comprising a mid-plate positioned between a first plate and a second plate, said plates having a length, a width and a plate thickness, a first side of the mid-plate opposing the first plate and a second side of the mid-pate opposing the second plate;

the first plate spaced apart from the mid-plate defining a width of a first inter-plate space, and the second plate spaced apart from the mid-plate defining a width of a second inter-plate space;

an edge of the cassette having a cassette thickness defined by the thickness of each plate plus the width of the first and second inter-plate spaces, and a face of the cassette being defined by the length and width of the first or second plate;

the mid-plate comprising first and second pump stations, the first pump station defined by a first pump diaphragm and the first side of the mid-plate, and the second pump station defined by a second pump diaphragm and the second side of the mid-plate, said first pump diaphragm seated against the first side of the midplate and having an excursion range defined by the width of the first inter-plate space, and said second pump diaphragm seated against the second side of the mid-plate and having an excursion range defined by the width of the second inter-plate space; and

a first pump actuation channel for the first pump station and running parallel to the face of the cassette in the first inter-plate space, and a second pump actuation channel for the second pump station and running parallel to the face of the cassette in the second inter-plate space;

said first pump actuation channel connecting a first pump actuation chamber bounded by the first plate and the first pump diaphragm with a first cassette pump actuation port located within the first inter-plate space at a first edge of the cassette; and

said second pump actuation channel connecting a second pump actuation chamber bounded by the second plate and the second pump diaphragm with a second cassette pump actuation port located within the second inter-plate space at the first edge of the cassette.