CLAIMS

What is Claimed is:

1. A combinatorial fluid switch for controlling fluid flow through a plurality of fluid flow-paths, comprising:

(a) a plurality of fluid inputs;

(b) a first two-position valve having individual fluid flow-paths, through which fluids from the plurality of fluid inputs are guided;

(c) a second two-position valve having individual fluid flow-paths, through which fluids from the plurality of fluid inputs are guided; and

(d) a plurality of fluid outputs,

wherein the combinatorial fluid switch is configured to allow:

fluid flow from a first fluid input to a first fluid output when the first two-position valve is in an open position and the second two-position valve is in an open position;

fluid flow from a second fluid input to a second fluid output when the first two-position valve is in a closed position and the second two-position valve is in an open position;

fluid flow from a third fluid input to a third fluid output when the first two-position valve is in an open position and the second two-position valve is in a closed position; and

fluid flow from a fourth fluid input to a fourth fluid output when the first two-position valve is in a closed position and the second two-position valve is in a closed position.

2. The combinatorial fluid switch of claim 1, wherein fluids within the fluid flow paths are not allowed to mix.

3. A combinatorial fluid switch for controlling fluid flow through at least four fluid flow-paths, comprising:

(a) a first, a second, a third and a fourth fluid inputs;

(b) a first two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided;

(c) a second two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided; and

(d) a first, a second, a third and a fourth fluid outputs,

wherein the combinatorial fluid switch is configured to allow:

fluid flow from the first fluid input to the first fluid output when the first two-position valve is in an open position and the second two-position valve is in an open position;

fluid flow from the second fluid input to the second fluid output when the first two-position valve is in a closed position and the second two-position valve is in an open position;

fluid flow from the third fluid input to the third fluid output when the first two-position valve is in an open position and the second two-position valve is in a closed position; and

fluid flow from the fourth fluid input to the fourth fluid output when the first two-position valve is in a closed position and the second two-position valve is in a closed position.

4. The combinatorial fluid switch of any one of claims 1-3, wherein the fluid inputs, the fluid flow-paths and the fluid outputs consist of four tubing lines.

5. The combinatorial fluid switch of any one of claims 1-4, wherein each of the fluid inputs are fed from a single fluid source.

6. A system for controlling fluid flow through at least sixteen fluid flow-paths, comprising:

(a) a first combinatorial fluid switch comprising:

i. a first, a second, a third and a fourth fluid inputs;

ii. a first two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided;

iii. a second two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided; and

iv. a first, a second, a third and a fourth fluid outputs,

wherein the first combinatorial fluid switch is configured to allow:

fluid flow from the first fluid input to the first fluid output when the first two-position valve is in an open position and the second two-position valve is in an open position;

fluid flow from the second fluid input to the second fluid output when the first two-position valve is in a closed position and the second two-position valve is in an open position;

fluid flow from the third fluid input to the third fluid output when the first two-position valve is in an open position and the second two-position valve is in a closed position; and

fluid flow from the fourth fluid input to the fourth fluid output when the first two-position valve is in a closed position and the second two-position valve is in a closed position; and

(b) a second combinatorial fluid switch fluidly connected to the first combinatorial fluid switch, the second combinatorial fluid switch comprising:

i. a fifth, a sixth, a seventh and an eighth fluid inputs;

ii. a third two-position valve having four fluid flow-paths, through which fluids from the fifth, sixth, seventh and eighth fluid inputs are guided;

iii. a fourth two-position valve having four fluid flow-paths, through which fluids from the fifth, sixth, seventh and eighth fluid inputs are guided; and

iv. a fifth, a sixth, a seventh and an eighth fluid outputs,

wherein the second combinatorial fluid switch configured to allow:

fluid flow from the fifth fluid input to the fifth fluid output when the third two-position valve is in an open position and the fourth two-position valve is in an open position;

fluid flow from the sixth fluid input to the sixth fluid output when the third two-position valve is in a closed position and the third two-position valve is in an open position;

fluid flow from the seventh fluid input to the seventh fluid output when the third two-position valve is in an open position and the fourth two-position valve is in a closed position; and

fluid flow from the eighth fluid input to the eighth fluid output when the third two-position valve is in a closed position and the fourth two-position valve is in a closed position.

7. A system for controlling fluid flow through at least sixteen fluid flow-paths, comprising:

(a) a plurality of combinatorial fluid switches, each combinatorial fluid switch comprising:

i. a first, a second, a third and a fourth fluid inputs;

ii. a first two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided;

iii. a second two-position valve having four fluid flow-paths, through which fluids from the first, second, third and fourth fluid inputs are guided; and

iv. a first, a second, a third and a fourth fluid outputs,

wherein the first combinatorial fluid switch is configured to allow:

fluid flow from the first fluid input to the first fluid output when the first two-position valve is in an open position and the second two-position valve is in an open position;

fluid flow from the second fluid input to the second fluid output when the first two-position valve is in a closed position and the second two-position valve is in an open position;

fluid flow from the third fluid input to the third fluid output when the first two-position valve is in an open position and the second two-position valve is in a closed position; and

fluid flow from the fourth fluid input to the fourth fluid output when the first two-position valve is in a closed position and the second two-position valve is in a closed position.

8. An automated biologic production system, comprising:

(a) an enclosable housing;

(b) a cassette contained within the enclosable housing, the cassette comprising:

i. a cell culture chamber

ii. a combinatorial fluid switch of claim 1;

iii. a pumping system fluidly connected to the cell culture chamber and the combinatorial switch;

iv. one or more of a temperature sensor, a pH sensor, a glucose sensor, a lactose sensor, an oxygen sensor, a carbon dioxide sensor, and an optical density sensor; and

v. mechanisms to automatically adjust one or more of a temperature, a pH level, a glucose level, a lactose level, an oxygen level, a carbon dioxide level, and an optical density.

9. An automated biologic production system, comprising:

(a) an enclosable housing;

(b) a cassette contained within the enclosable housing, the cassette comprising:

i. a cell culture chamber;

ii. a system of claim 2 or claim 3;

iii. a pumping system fluidly connected to the cell culture chamber and the system;

iv. one or more of a temperature sensor, a pH sensor, a glucose sensor, a lactose sensor, an oxygen sensor, a carbon dioxide sensor, and an optical density sensor; and

v. mechanisms to automatically adjust one or more of a temperature, a pH level, a glucose level, a lactose level, an oxygen level, a carbon dioxide level, and an optical density.

10. A combinatorial fluid switch, comprising:

(a) a housing having two opposing sides, each side having four openings passing therethrough; and

(b) two, two-position valves disposed within the housing, each valve having four openings passing therethrough,

wherein the openings in the sides and the openings in the two-position valves are configured to receive tubing therethrough, so as to create four flow-paths within the combinatorial fluid switch, and

wherein the two-position valves are moveable within the housing to allow fluid flow through only one flow-path at a time.

11. The combinatorial fluid switch of claim 10, wherein the two-position valves are slidable within the housing.

12. The combinatorial fluid switch of claim 10, wherein the two-position valves are rotatable within the housing.

13. The combinatorial fluid switch of any one of claims 10-12, further comprising four tubing lines passing through the four openings in the sides and the four openings in the two-position valves.

14. A combinatorial fluid switch, comprising:

(a) a support base comprising two raised portions and two recessed portions, the two raised portions comprising a plurality of partitions extending above the support base configured to allow tubing to pass therethrough so as to create four fluid flow-paths, the two recessed portions each comprising four stationary compression members extending above the support base;

(b) two, two-position valves having openings to allow the stationary compression members to pass through, the valves further comprising four movable compression members configured to compress against a complementary, stationary compression member on the support base so as to constrict a tubing between the movable compression member and the complementary, stationary compression member,

wherein the two-position valves are configured to slide along the support base and allow fluid flow through only one flow-path at a time.

15. The combinatorial fluid switch of claim 14, wherein the two, two-position valves are flat valves that slide within the two recessed portions of the support base.

16. The combinatorial fluid switch of claim 14 or claim 15, further comprising four tubing lines passing through the partitions, the stationary compression members and the movable compression members.

17. A combinatorial fluid switch, comprising:

(a) at least three, stationary compression members;

(b) a first two-position valve having two movable compression members integrated into the valve; and

(c) a second two-position valve having three movable compression members integrated into the valve,

wherein the movable compression members of the first and second two-position valves are configured to compress against a complementary, stationary compression member so as to constrict a tubing between the movable compression member and the complementary, stational compression member,

wherein the two-position valves are configured to slide and allow fluid flow through one flow-path at a time.

18. The combinatorial fluid switch of claim 17, further comprising four tubing lines passing through the stationary compression members and the movable compression members, to provide four fluid flow-paths.

19. A combinatorial fluid switch for controlling fluid flow through a plurality of fluid flow-paths, comprising:

(a) a plurality of fluid inputs;

(b) a first control valve, through which fluids from the plurality of fluid inputs are guided;

(c) a second control valve having individual fluid flow-paths, through which fluids from the plurality of fluid inputs are guided; and

(d) a plurality of fluid outputs,

wherein the combinatorial fluid switch is configured to allow fluid flow through a designated combination of fluid inputs and fluid outputs.

20. A method for controlling fluid flow within a closed, cell engineering system, comprising:

(a) providing a plurality of fluid inputs;

(b) providing a plurality of fluid outputs;

(c) providing a plurality of flow-paths connecting the fluid inputs to the fluid outputs;

(d) providing a plurality of valves controlling the flow within the flow-paths, thereby controlling the direction, speed, duration and/or interval of fluid flow within the flow-paths.