CLAIMS

WHAT IS CLAIMED IS:

1. A system for processing articles, the system comprising:

a fluid supply configured to supply a process fluid;

an apparatus for controlling flow, the apparatus having an inlet, an outlet, and a valve assembly, the inlet of the apparatus fluidly coupled to the fluid supply and the valve assembly fluidly coupled between the inlet and the outlet, the valve assembly comprising:

a body, the body comprising an inlet and an outlet, a flow path extending between the inlet and the outlet;

a seat located in the flow path;

a closure member configured to engage the seat and obstruct the flow path;

an actuator assembly coupled to the closure member to move the closure member from a closed state which obstructs the flow path to an open state which permits fluid flow;

a radial flow guide located in the flow path; and

a longitudinal axis extending through the seat, the closure member, and the radial flow guide;

an outlet manifold fluidly coupled to the outlet of the apparatus; and

a processing chamber fluidly coupled to the outlet manifold; and

wherein the radial flow guide extends from an upper surface to a lower surface along the longitudinal axis of the valve assembly, the radial flow guide comprising a plurality of castellations formed in the lower surface.

2. The system of claim 1 wherein the closure member comprises a diaphragm and a needle.

3. The system of claim 1 wherein the closure member comprises a fixed portion and a movable portion, the fixed portion engaging the radial flow guide and the movable portion engaging the seat.

4. The system of claim 1 wherein the flow path comprises a first volume extending from the inlet of the body to the seat, the first volume defined by the body, the seat, and the closure member.

5. The system of claim 4 wherein the flow path further comprises a second volume extending from the seat to the outlet of the body, the second volume defined by the body, the seat, and the closure member.

6. The system of claim 4 wherein the radial flow guide divides the first volume into an outer chamber and an inner chamber, a plurality of flow passages extending from the outer chamber to the inner chamber; and wherein the plurality of flow passages are defined by the seat and a plurality of castellations formed into the radial flow guide.

7. The system of claim 1 wherein the closure member comprises a diaphragm and a needle, the needle comprising a top end, a bottom end, a cylindrical portion and a grooved portion, the longitudinal axis of the valve assembly extending from the top end to the bottom end, the grooved portion extending from the bottom end to the cylindrical portion, and the grooved portion comprising a plurality of grooves.

8. The system of claim 7 wherein the cylindrical portion comprises a first diameter and the grooved portion comprises a second diameter, the first and second diameters being equal.

9. The system of claim 7 wherein the plurality of grooves are equally spaced about the longitudinal axis.

10. The system of claim 7 wherein each of the plurality of grooves comprise a bottom surface, the bottom surface having a radial distance from the longitudinal axis that increases with increasing distance from the bottom end of the needle.

11. An apparatus for controlling flow, the apparatus comprising:

an inlet;

an outlet; and

a valve assembly, the valve assembly fluidly coupled between the inlet and the outlet, the valve assembly comprising:

a body, the body comprising an inlet and an outlet, a flow path extending between the inlet and the outlet;

a seat located in the flow path;

a closure member configured to engage the seat and obstruct the flow path;

an actuator assembly coupled to the closure member to move the closure member from a closed state which obstructs the flow path to an open state which permits fluid flow;

a radial flow guide located in the flow path; and

a longitudinal axis extending through the seat, the closure member, and the radial flow guide;

wherein the flow path comprises a first volume extending from the inlet of the body to the seat, the first volume defined by the body, the seat, and the closure member; and wherein the flow path further comprises a second volume extending from the seat to the outlet of the body, the second volume defined by the body, the seat, and the closure member; and

wherein the radial flow guide divides the first volume into an outer chamber and an inner chamber, a plurality of flow passages extending from the outer chamber to the inner chamber, and wherein the plurality of flow passages are defined by the seat and a plurality of castellations formed into the radial flow guide.

12. The apparatus of claim 11 wherein the closure member comprises a diaphragm and a needle, the needle comprising a top end, a bottom end, a cylindrical portion and a grooved portion, the longitudinal axis of the valve assembly extending from the top end to the bottom end, the grooved portion extending from the bottom end to the cylindrical portion, and the grooved portion comprising a plurality of grooves; and wherein the plurality of grooves of the grooved portion are circumferentially spaced about the longitudinal axis.

13. The apparatus of claim 11 wherein the closure member comprises a plurality of grooves and the radial flow guide defines at least a portion of a plurality of flow passages, the plurality of flow passages being greater in number than the plurality of grooves.

14. The apparatus of claim 11 wherein the closure member comprises a plurality of grooves and the radial flow guide defines at least a portion of a plurality of flow passages, the plurality of flow passages being rotationally aligned with the plurality of grooves.

15. A system for processing articles, the system comprising:

a fluid supply configured to supply a process fluid;

an apparatus for controlling flow, the apparatus having an inlet, an outlet, and a valve assembly, the inlet of the apparatus fluidly coupled to the fluid supply and the valve assembly fluidly coupled between the inlet and the outlet, the valve assembly comprising:

a body, the body comprising an inlet and an outlet, a flow path extending between the inlet and the outlet;

a seat located in the flow path;

a closure member configured to engage the seat and obstruct the flow path;

an actuator assembly coupled to the closure member to move the closure member from a closed state which obstructs the flow path to an open state which permits fluid flow;

a radial flow guide located in the flow path; and

a longitudinal axis extending through the seat, the closure member, and the radial flow guide;

an outlet manifold fluidly coupled to the outlet of the apparatus; and

a processing chamber fluidly coupled to the outlet manifold;

wherein the closure member comprises a diaphragm and a needle, the needle comprising a top end, a bottom end, a cylindrical portion and a grooved portion, the longitudinal axis of the valve assembly extending from the top end to the bottom end, the grooved portion extending from the bottom end to the cylindrical portion, and the grooved portion comprising a plurality of grooves; and

wherein the cylindrical portion comprises a first diameter and the grooved portion comprises a second diameter, the first and second diameters being equal.

16. The system of claim 15 wherein each of the plurality of grooves comprise a bottom surface, the bottom surface having a radial distance from the longitudinal axis that increases with increasing distance from the bottom end of the needle.