CLAIMS

1. Valve apparatus, comprising:

a valve body that has a flow channel with a closure member positioned between an inlet end and an outlet end of the flow channel in the valve body;

a nozzle insert in the flow channel that forms an annular orifice in the flow channel;

an annular plenum around the nozzle insert in fluid flow communication with the annular orifice; and

an auxiliary port connected in fluid flow relation to the annular plenum.

2. The valve apparatus of claim 1, wherein the annular plenum comprises an annular channel extending into the inlet end of the valve body, and wherein the annular channel is enclosed by the nozzle insert to form the annular plenum.

3. The valve apparatus of claim 2, wherein the nozzle insert has a flared inlet end section that converges to a cylindrical extension which is smaller in diameter than the inside wall of the valve body that forms the flow channel.

4. The valve apparatus of claim 3, wherein the cylindrical extension extends into the flow channel farther than the annular channel to form an annular nozzle between the inside wall surface and the cylindrical extension such that said annular nozzle extends from the annular plenum to the annular orifice.

5. The valve apparatus of claim 4, including a rim flange around the periphery of the flared inlet end section that abuts the valve body adjacent to the annular channel.

6. The valve apparatus of statement 5, including a circular seal mounted on the rim flange.

7. The valve apparatus of claim 1, wherein the annular plenum comprises an annular channel extending into the outlet end of the valve body, and wherein the annular channel is enclosed by the nozzle insert to form the annular plenum.

8. Throttle valve apparatus for throttling a flow of effluent gas in a vacuum pumping line of a CVD system that produces powder particles in the effluent gas, comprising:

a valve body with a flow channel that is defined by an inside wall surface of the valve body and that extends along a longitudinal axis from an inlet port to an outlet port;

a throttling closure member positioned in the flow channel between the inlet port and the outlet port;

an annular orifice adjacent to the inside wall surface facing toward the throttling closure member;

an annular plenum in the valve body connected in fluid flow relation to the annular orifice by an annular nozzle which is oriented to inject an annular flow of cleaning gas through the annular orifice and into the flow channel along the inside wall surface of the valve body parallel to and concentric with longitudinal axis and toward the throttling closure member;

an auxiliary duct in the valve body in fluid flow relation to the annular plenum and adapted for connection to a source of cleaning gas.

9. The throttle valve apparatus of claim 8, including a cleaning gas supply valve connected in fluid flow relation to the auxiliary port for controlling a flow of cleaning gas into the auxiliary port.

10. A method of controlling powder and solid deposition in a throttle valve that has a valve body with a flow channel defined by an inside wall surface of the valve body and that extends along a longitudinal axis between an inlet port and an outlet port of the valve body, and a closure member in the flow channel, comprising:

directing two annular flows of cleaning gas toward each other in opposite directions from opposite sides of the closure member along the inside wall surface parallel to and concentric with the longitudinal axis.

11. A method of controlling powder and solid deposition in a throttle valve that has a valve body with a flow channel defined by an inside wall surface of the valve body between an inlet port and an outlet port of the valve body, and a closure member in the flow channel, comprising:

flowing a first portion of a cleaning gas through an upstream annular nozzle positioned adjacent to the inside wall surface upstream from the closure member and directed along the inside wall surface toward the closure member; and

flowing a second portion of the cleaning gas through a downstream annular nozzle positioned adjacent to the inside wall surface downstream from the closure member and directed along the inside wall surface toward the closure member.

12. The method of claim 11, including:

flowing the first portion of the cleaning gas into an upstream annular plenum for distribution to the upstream annular nozzle; and

flowing the second portion of the cleaning gas into a downstream annular plenum for distribution to the downstream annular nozzle.

13. The method of claim 12, including:

flowing the first portion of the cleaning gas from the upstream annular plenum through an upstream annular nozzle to the upstream annular orifice; and

flowing the second portion of the cleaning gas from the downstream annular plenum through a downstream annular nozzle to the downstream annular orifice.

14. The method of claim 13, including:

producing a choked flow condition in the upstream annular nozzle; and

producing a choked flow condition in the downstream annular nozzle.

15. The method of claim 11, including directing the two annular flows of cleaning gas intermittently in opposite directions from opposite sides of the closure member toward each other along the inside wall surface.

16. The method of claim 11, including directing the two annular flows of cleaning gas in pulsed flows in opposite directions from opposite sides of the closure member toward each other along the inside wall surface.

17. The method of claim 11, including directing the two annular flows of cleaning gas in steady-state flows in opposite directions from opposite sides of the closure member toward each other along the inside wall surface.

18. The method of claim 11, wherein the cleaning gas is a non-reactive gas.

19. The method of claim 11, wherein the cleaning gas is a reactive gas.

20. The method of claim 11, including moving the closure member back and forth between the opened and closed positions in the flow channel while directing the two annular flows of cleaning gas in opposite directions from opposite sides of the closure member toward each other along the inside wall surface.

21. A method of controlling powder and solid deposition in a valve that has a valve body and that extends along a longitudinal axis with a flow channel defined by an inside wall surface of the valve body between an inlet port and an outlet port of the valve body, and a closure member in the flow channel, comprising:

directing at least one annular flow of cleaning gas into the flow chamber along the inside wall surface toward the closure member parallel to and concentric with the longitudinal axis.

22. The method of claim 21, including directing the annular flow of cleaning gas into the flow chamber by flowing the cleaning gas through at least one annular nozzle positioned adjacent to the inside wall surface of the valve body and oriented to inject the cleaning gas

along the inside wall surface toward the closure member in an annular jet flow that is parallel to and concentric with a longitudinal axis of the flow chamber.

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23. The method of claim 22, including flowing the cleaning gas into an annular plenum for distribution to the annular nozzle.

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24. The method of claim 23, including flowing the cleaning gas through the annular nozzle and out of an annular orifice positioned upstream of the closure member.

25. The method of claim 23, including flowing the cleaning gas through the annular nozzle and out of an annular orifice positioned downstream of the closure member.

26. The method of claim 23, including producing a choked flow condition in the annular nozzle.

27. The method of claim 21, including directing two annular flows of cleaning gas in opposite directions from opposite sides of the closure member toward each other along the inside wall surface.

28. The method of claim 21, wherein the cleaning gas is a non-reactive gas.

29. The method of claim 21, wherein the cleaning gas is a reactive gas.

30. The method of claim 21, including moving the closure member back and forth between the opened and closed positions in the flow channel while directing the at least one

annular flow of cleaning gas into the flow chamber along the inside wall surface toward the closure member.

31. Valve apparatus that has a valve body with a flow channel defined by an inside wall surface of the valve body and that extends along a longitudinal axis between an inlet port and an outlet port of the valve body, and a closure member in the flow channel, characterized by means for directing two annular flows of cleaning gas toward each other in opposite directions from opposite sides of the closure member along the inside wall surface parallel to and concentric with the longitudinal axis.

32. Valve apparatus that has a valve body with a flow channel defined by an inside wall surface of the valve body between an inlet port and an outlet port of the valve body, and a closure member in the flow channel, comprising:

an upstream annular nozzle positioned adjacent to the inside wall surface upstream from the closure member and directed along the inside wall surface toward the closure member; and

a downstream annular nozzle positioned adjacent to the inside wall surface downstream from the closure member and directed along the inside wall surface toward the closure member.

33. The valve apparatus of claim 32, including:

an upstream annular plenum for distributing a first portion of the cleaning gas to the upstream annular nozzle; and

a downstream annular plenum for distributing a second portion of the cleaning gas to the downstream annular nozzle.

34. The valve apparatus of claim 33, including:

an upstream annular nozzle extending between the upstream annular plenum to the upstream annular orifice for flowing the first portion of the cleaning gas from the upstream annular plenum to the upstream annular orifice; and

a downstream annular nozzle extending between the downstream annular plenum to the downstream annular nozzle for flowing the second portion of the cleaning gas from the downstream annular plenum to the downstream annular orifice.

35. The valve apparatus of claim 34, wherein:

the upstream annular nozzle has a cross-sectional area that is sized to produce a choked flow condition in the upstream annular nozzle in vacuum parameters in which the valve is operated and pressure parameters in which the cleaning gas is supplied; and

the downstream annular nozzle has a cross-sectional area that is sized to produce a choked flow condition in the downstream annular nozzle in the vacuum parameters in which the valve is operated and the pressure parameters in which the cleaning gas is supplied.