We claim:

1. A valve subassembly comprising:

a body plug including a tubular side wall defining a central cavity and one or more lateral flow apertures in the side wall;

a poppet including axially extending upper and lower stem portions and a radially extending poppet sealing portion between the upper and lower stem portions, with the lower stem portion and the poppet sealing portion being received in the central cavity of the body plug; and

a seat carrier assembled with the body plug and including a central bore receiving the upper stem portion of the poppet therethrough, the seat carrier retaining a seat seal in radial alignment with the poppet sealing portion.

2. The valve subassembly of claim 1, wherein the seat carrier is threadably assembled with the body plug.

3. The valve subassembly of any of claims 1 and 2, wherein the seat carrier includes one or more lateral flow apertures.

4. The valve subassembly of any of claims 1-3, wherein the seat seal is staked into a lower end portion of the seat carrier.

5. The valve subassembly of any of claims 1-4, further comprising a poppet spring disposed in the central cavity of the body plug, the poppet spring applying an upward biasing force to the poppet, toward sealing engagement with the seat seal.

6. The valve subassembly of any of claims 1-5, further comprising a piston assembled with the central bore of the seat carrier and including a lower end portion engaging the upper stem portion of the poppet and an upper end portion extending above the seat carrier.

7. The valve subassembly of claim 6, wherein the piston includes a shoulder portion that engages a counterbore in the central bore of the seat carrier to retain the piston with the seat carrier.

8. A valve comprising:

a valve body housing including a central bore disposed between first and second end ports;

the valve subassembly of any of claims 1-7, wherein the body plug is installed in the central bore of the valve body, such that at least one of the one or more lateral flow apertures is in fluid communication with the first end port.

9. The valve of claim 8, wherein the body plug is threadably assembled with the central bore of the valve body housing.

10. The valve of any of claims 8 and 9, wherein the body plug includes an end flange fastened to the valve body housing.

11. A pressure regulator comprising:

a valve body housing including a central bore disposed between first and second end ports; a valve subassembly comprising:

a body plug including a tubular side wall defining a central cavity and one or more lateral flow apertures in the side wall, wherein the body plug is installed in the central bore of the valve body, such that at least one of the one or more lateral flow apertures is in fluid communication with the first end port;

a poppet including axially extending upper and lower stem portions and a radially extending poppet sealing portion between the upper and lower stem portions, with the lower stem portion and the poppet sealing portion being received in the central cavity of the body plug; and

a seat carrier assembled with the body plug and including a central bore receiving the upper stem portion of the poppet therethrough, the seat carrier retaining a seat seal in radial alignment with the poppet sealing portion;

a loading mechanism assembled with the valve body housing and operable to apply a set load force against the poppet for downward movement of the poppet; and

a sensing element disposed between the loading mechanism and the poppet to transmit the load force from the loading mechanism to the poppet, wherein when fluid pressure within one of the first and second end ports exceeds a pressure setting corresponding to the set load force, the sensing element is movable against the set load force to permit upward movement of the poppet.

12. The pressure regulator of claim 11, wherein the seat carrier is threadably assembled with the body plug.

13. The pressure regulator of any of claims 11 and 12, wherein the seat carrier includes one or more lateral flow apertures.

14. The pressure regulator of any of claims 11-13, wherein the seat seal is staked into a lower end portion of the seat carrier.

15. The pressure regulator of any of claims 11-14, further comprising a poppet spring disposed in the central cavity of the body plug, the poppet spring applying an upward biasing force to the poppet, toward sealing engagement with the seat seal.

16. The pressure regulator of any of claims 11-15, wherein the sensing element comprises a piston assembled with the central bore of the seat carrier and including a lower end portion engaging the upper stem portion of the poppet and an upper end portion extending above the seat carrier.

17. The pressure regulator of claim 16, wherein the piston includes a shoulder portion that engages a counterbore in the central bore of the seat carrier to retain the piston with the seat carrier.

18. The pressure regulator of any of claims 11-17, wherein the body plug is threadably assembled with the central bore of the valve body housing.

19. The pressure regulator of any of claims 11-18, wherein the body plug includes an end flange fastened to the valve body housing.

20. A method of replacing a poppet and seat seal in a regulator valve assembly, the method comprising:

providing a regulator valve assembly including a valve body having a valve body housing defining a central bore, and a valve cartridge subassembly including a body plug and a seat carrier assembled together to retain the poppet and seat seal therebetween, the body plug being installed in the central bore;

removing the valve cartridge subassembly from the valve body by disassembling the body plug from the valve body housing, thereby withdrawing the body plug, seat carrier, poppet, and seat seal from the central bore; and

assembling a replacement valve cartridge subassembly with the regulator valve body to install a new poppet and seat seal in the valve body housing bore.

21. The method of claim 20, wherein the body plug includes a male threaded outer portion and the central bore comprises a female threaded portion, wherein disassembling the body plug from the valve body housing comprises unthreading the body plug from the central bore.

22. The method of claim 20, wherein the body plug includes a mounting plate extending from an end portion of the body plug, wherein disassembling the body plug from the valve body housing comprises removing mounting bolts securing the mounting plate to the valve body housing.

23. A seat carrier subassembly for a valve, the seat carrier subassembly comprising:

an annular seat carrier body including an annular projection extending radially into a central passage; and

an annular plastic seal ring over-molded onto the annular projection, the annular plastic seal ring defining a seat seal.

24. The seat carrier subassembly of claim 23, wherein the projection is circumferentially continuous.

25. The seat carrier subassembly of any of claims 23 and 24, wherein the projection has a rail shaped cross-section, including a narrower neck portion and an enlarged head portion.

26. The seat carrier subassembly of any of claims 23-25, wherein the projection comprises stainless steel.

27. The seat carrier subassembly of any of claims 23-26, wherein the seal ring comprises polyetheretherketone (PEEK).

28. The seat carrier subassembly of any of claims 23-27, wherein the projection has a minimum hardness of approximately 80 HRB.

29. The seat carrier subassembly of any of claims 23-28, wherein the seal ring has a maximum hardness of approximately 100 HRM.

30. The seat carrier subassembly of any of claims 23-29, wherein the seat seal faces a first side of the seat carrier body.

31. The seat carrier subassembly of claim 30, further comprising a face seal O-ring disposed in an annular groove in the first side of seat carrier body.

32. The seat carrier subassembly of any of claims 30 and 31, further comprising a face seal O-ring disposed in an annular groove in a second side of the seat carrier body opposite the first side.

33. A valve assembly, comprising:

a valve body defining a flow path between an inlet port and an outlet port;

an annular seal ring surrounding an axially extending portion of the flow path between the inlet port and the outlet port, the seal ring interlocking with a projection extending radially into the flow path; and

a poppet assembled with the valve body and axially movable between a closed position in which a radially extending sealing surface of the poppet seals against a seat sealing surface of the seal ring to prevent fluid flow through the longitudinally extending portion of the flow path, and an open position in which the poppet sealing surface axially separates from the seal ring to permit fluid flow through the axially extending portion of the flow path.

34. The valve assembly of claim 33, wherein the projection is integral with the valve body.

35. The valve assembly of claim 33, further comprising a seat carrier subassembly retained in a counterbore portion of the valve body, the seat carrier subassembly including the seal ring and an annular seat carrier body defining the projection.

36. The valve assembly of claim 35, wherein the seat carrier subassembly comprises the seat carrier subassembly of any of claims 23-32.

37. A seat carrier subassembly for a valve, the seat carrier subassembly comprising:

first and second ring components assembled over an O-ring seal;

wherein a portion of the O-ring seal is exposed in an inner diameter gap between inner edge portions of the first and second ring components to define a seat seal.

38. The seat carrier subassembly of claim 37, wherein the first and second ring components are axially compressible against the O-ring seal to squeeze the seat seal portion of the O-ring seal through the inner diameter gap between the first and second ring components.

39. The seat carrier subassembly of any of claims 37 and 38, wherein the first ring component includes a radially inward extending flange defining an inner counterbore, and an

axially upward extending flange defining an outer counterbore, and the second ring component includes an outer peripheral portion that is seated in the outer counterbore of the first ring component, and an axially downward extending flange that extends toward the radially inward extending flange of the first ring component to define an annular cavity for the O-ring seal and the inner diameter gap.

40. The seat carrier subassembly of any of claims 37-39, wherein the seat seal faces a first side of the seat carrier body.

41. The seat carrier subassembly of claim 40, further comprising a face seal O-ring disposed in an annular groove in the first side of seat carrier body.

42. The seat carrier subassembly of any of claims 40 and 41, further comprising a face seal O-ring disposed in an annular groove in a second side of the seat carrier body opposite the first side.

43. A valve assembly, comprising:

a valve body including:

a body housing defining a first end port, a second end port, and a central cavity extending from a bottom end of the body housing to a top end of the body housing; and

a body plug assembled with the central cavity of the body housing and defining a flow path between the inlet port and the outlet port;

the seat carrier subassembly of any of claims 1-10 and 15-20, wherein the seat carrier subassembly is disposed in the body housing and secured between an end face of the body plug and a counterbore in the central cavity; and

a poppet assembled with the valve body and axially movable in the central cavity of the body housing between a closed position in which a radially extending sealing surface of the poppet seals against the seat seal to prevent fluid flow through the longitudinally extending portion of the flow path, and an open position in which the poppet sealing surface axially separates from the seat seal to permit fluid flow between the first and second end ports.

44. The valve assembly of claim 43, further comprising an actuator assembled with the valve body for movement of the poppet between the open and closed positions.

45. The valve assembly of claim 44, wherein the actuator includes a loading mechanism configured to bias the poppet toward one of the open and closed positions and a sensing mechanism in fluid communication with the first end port and configured to move against the loading mechanism when a fluid pressure in the first end port exceeds a set pressure, to permit movement of the poppet to the other of the open and closed positions.

46. A poppet subassembly comprising:

a poppet including a central portion disposed between axially extending upper and lower stem portions, the central portion defining an upward facing radially extending sealing portion and a downward facing radially extending shoulder portion;

a retaining clip secured above an enlarged foot portion of the lower stem portion; and

a poppet spring disposed around the lower stem portion and captured between the shoulder portion and the retaining clip.

47. A valve comprising:

a valve body housing including a central bore disposed between first and second end ports;

a body plug installed in the central bore of the valve body, such that at least one of the one or more lateral flow apertures is in fluid communication with the first end port;

a poppet including a central portion disposed between axially extending upper and lower stem portions, the central portion defining an upward facing radially extending sealing portion and a downward facing radially extending shoulder portion;

a retaining clip secured above an enlarged foot portion of the lower stem portion; and

a poppet spring disposed around the lower stem portion and captured between the shoulder portion and the retaining clip;

wherein a counterbore in the central bore of the valve body housing engages the retaining clip to compress the poppet spring.

48. A pressure regulator comprising:

a valve body housing including a central bore disposed between first and second end ports; a body plug installed in the central bore of the valve body;

a poppet including axially extending upper and lower stem portions and a radially extending poppet sealing portion between the upper and lower stem portions, with the lower stem portion being received in a central cavity of the body plug; and

a seat carrier assembled with the body plug and including a central bore receiving the upper stem portion of the poppet therethrough, the seat carrier retaining a seat seal in radial alignment with the poppet sealing portion;

a loading mechanism assembled with the valve body housing and operable to apply a set load force against the poppet for downward movement of the poppet; and

a sensing element disposed between the loading mechanism and the poppet to transmit the load force from the loading mechanism to the poppet;

wherein a lower end of the sensing element includes a socket receiving an enlarged head portion of the upper stem portion of the poppet, wherein the socket is sized to permit axial movement of the poppet with respect to the sensing element; and

wherein the pressure regulator further comprises an overtravel spring disposed around the upper stem portion of the poppet and compressed between a shoulder portion of the poppet and an end face of the socket.

49. A pressure regulator comprising:

a valve body housing including a central bore disposed between first and second end ports; a body plug installed in the central bore of the valve body;

a poppet including axially extending upper and lower stem portions and a radially extending poppet sealing portion between the upper and lower stem portions, with the lower stem portion being received in a central cavity of the body plug; and

a seat carrier assembled with the body plug and including a central bore receiving the upper stem portion of the poppet therethrough, the seat carrier retaining a seat seal in radial alignment with the poppet sealing portion;

a loading mechanism assembled with the valve body housing and operable to apply a set load force against the poppet for downward movement of the poppet; and

a sensing element disposed between the loading mechanism and the poppet to transmit the load force from the loading mechanism to the poppet;

wherein a lower end of the sensing element includes a socket receiving an enlarged head portion of the upper stem portion of the poppet, wherein the socket is sized to permit axial movement of the poppet with respect to the sensing element; and

wherein the pressure regulator further comprises an overtravel spring disposed around the upper stem portion of the poppet and compressed between a shoulder portion of the poppet and an end face of the socket.

We claim:

1. A valve subassembly comprising:

a body plug including a tubular side wall defining a central cavity and one or more lateral flow apertures in the side wall;

a poppet including axially extending upper and lower stem portions and a radially extending poppet sealing portion between the upper and lower stem portions, with the lower stem portion and the poppet sealing portion being received in the central cavity of the body plug;

a seat carrier including a central bore receiving the upper stem portion of the poppet therethrough, the seat carrier retaining a seat seal in radial alignment with the poppet sealing portion; and

a piston assembled with the central bore of the seat carrier and including a lower end portion engaging the upper stem portion of the poppet and an upper end portion extending above the seat carrier;

wherein the seat carrier is assembled with the body plug to retain the poppet, the seat seal, and the piston together with the seat carrier and the body plug as a replaceable cartridge subassembly.

2. The valve subassembly of claim 1, wherein the seat carrier is threadably assembled with the body plug.

3. The valve subassembly of claim 1, wherein the seat carrier includes one or more lateral flow apertures.

4. The valve subassembly of claim 1, wherein the seat seal is staked into a lower end portion of the seat carrier.

5. The valve subassembly of claim 1, further comprising a poppet spring disposed in the central cavity of the body plug, the poppet spring applying an upward biasing force to the poppet, toward sealing engagement with the seat seal.

6. The valve subassembly of claim 1, wherein the piston includes a shoulder portion that engages a counterbore in the central bore of the seat carrier to retain the piston with the seat carrier.

7. A valve comprising:

a valve body housing including a central bore disposed between first and second end ports; and

the valve subassembly of claim 1, wherein the body plug is installed in the central bore of the valve body, such that at least one of the one or more lateral flow apertures is in fluid communication with the first end port.

8. The valve of claim 7, wherein the body plug is threadably assembled with the central bore of the valve body housing.

9. The valve of claim 7, wherein the body plug includes an end flange fastened to the valve body housing.

10. A pressure regulator comprising:

a valve body housing including a central bore disposed between first and second end ports;

the valve subassembly of claim 1; and

a loading mechanism assembled with the valve body housing and operable to apply a set load force against the poppet for downward movement of the poppet; and

wherein the piston of the valve subassembly functions as a sensing element disposed between the loading mechanism and the poppet of the valve subassembly to transmit the load force from the loading mechanism to the poppet, wherein when fluid pressure within one of the first and second end ports exceeds a pressure setting corresponding to the set load force, the sensing element is movable against the set load force to permit upward movement of the poppet.

11. The pressure regulator of claim 10, wherein the seat carrier is threadably assembled with the body plug.

12. The pressure regulator of claim 10, wherein the seat carrier includes one or more lateral flow apertures.

13. The pressure regulator of claim 10, wherein the seat seal is staked into a lower end portion of the seat carrier.

14. The pressure regulator of claim 10, further comprising a poppet spring disposed in the central cavity of the body plug, the poppet spring applying an upward biasing force to the poppet, toward sealing engagement with the seat seal.

15. The pressure regulator of claim 10, wherein the piston includes a shoulder portion that engages a counterbore in the central bore of the seat carrier to retain the piston with the seat carrier.

16. The pressure regulator of claim 10, wherein the body plug is threadably assembled with the central bore of the valve body housing.

17. The pressure regulator of claim 10, wherein the body plug includes an end flange fastened to the valve body housing.

18. A method of replacing a poppet and seat seal in a regulator valve assembly, the method comprising:

providing a regulator valve assembly including a valve body having a valve body housing defining a central bore, and the valve subassembly of claim 1, with the body plug of the valve subassembly being installed in the central bore;

removing the valve subassembly from the valve body by disassembling the body plug from the valve body housing, thereby withdrawing the body plug, the seat carrier, the poppet, the piston, and the seat seal from the central bore; and

assembling a replacement valve subassembly with the regulator valve body to install a new poppet, piston, and seat seal in the valve body housing bore.

19. The method of claim 18, wherein the body plug includes a male threaded outer portion and the central bore comprises a female threaded portion, wherein disassembling the body plug from the valve body housing comprises unthreading the body plug from the central bore.

20. The method of claim 18, wherein the body plug includes a mounting plate extending from an end portion of the body plug, wherein disassembling the body plug from the valve body housing comprises removing mounting bolts securing the mounting plate to the valve body housing.