

CLAIMS

1. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device disposed on the basepipe and defining at least one flow port, the at least one flow port communicating fluid from outside the basepipe to the at least one opening defined in the basepipe; and
at least one internal valve disposed inside the flow device at the at least one flow port, at least a portion of the at least one internal valve being externally accessible on an exterior of the flow device, the at least one internal valve being externally configurable between an open state and a closed state relative to the at least one flow port and selectively controlling flow of the fluid from outside the basepipe to the at least one opening defined in the basepipe.
2. The apparatus of claim 1, further comprising a screen disposed on the basepipe, the screen screening the fluid from outside the basepipe and communicating the fluid with the flow device.
3. The apparatus of claim 1, wherein the at least one internal valve in the open state permits fluid communication through the at least one flow port to the at least one opening, and wherein the at least one internal valve in the closed state prevents fluid communication through the at least one flow port to the at least one opening.
4. The apparatus of claim 1, wherein the flow device comprises a nozzle disposed in the at least one flow port, the nozzle restricting the flow of the fluid.
5. The apparatus of claim 1, wherein the at least one internal valve comprises means for producing a pressure drop in the flow of the fluid through the internal valve in the opened state.
6. The apparatus of claim 1, wherein the flow device comprises:

a first end in fluid communication with the fluid from outside the basepipe; and
a second end in fluid communication with the at least one opening.

7. The apparatus of claim 6, wherein the first end comprises a first end-ring defining a fluid passage in fluid communication with the fluid from outside the basepipe, and wherein the second end comprises a second end-ring.

8. The apparatus of claim 7, wherein the second end-ring defines the at least one flow port communicating with the at least one opening, and wherein the second end-ring has the at least one valve disposed internally therein.

9. The apparatus of claim 7, wherein the at least one flow port comprises a nozzle restricting the flow of the fluid.

10. The apparatus of claim 7, wherein the flow device comprises a sleeve affixed to the first and second end-rings and defining a chamber with the first and second end-rings.

11. The apparatus of claim 1, wherein the at least one internal valve comprises a ball valve having an orifice defined therein, the ball valve disposed inside the flow device and being rotatable therein relative to the at least one flow port, the rotation of the ball valve being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

12. The apparatus of claim 11, wherein the ball valve comprises a rotatable body disposed in an external opening in the flow device, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the rotatable body.

13. The apparatus of claim 12, wherein the ball valve comprise seal elements disposed inside the external opening against the rotatable body.

14. The apparatus of claim 12, wherein the orifice of the ball valve in the opened state produces a pressure drop in the flow of the fluid therethrough.

15. The apparatus of claim 1, wherein the at least one internal valve comprises a gate valve disposed inside the flow device and having a gate, the gate being movable relative to the at least one flow port, the movement of the gate being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

16. The apparatus of claim 15, wherein the gate valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the gate disposed in the body and being movable relative to the orifice, the gate having a screw extending therefrom, the screw being accessible externally in the external opening in the flow device for moving the gate.

17. The apparatus of claim 1, wherein the at least one internal valve comprises a butterfly valve disposed inside the flow device and having a flapper, the flapper being rotatable relative to the at least one flow port, the rotation of the flapper being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

18. The apparatus of claim 17, wherein the butterfly valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the flapper disposed in the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the flapper.

19. The apparatus of claim 1, wherein the flow device comprises a plurality of the at least one internal valves disposed inside the flow device.

20. The apparatus of claim 1, wherein the flow device defines a tortuous path for the flow of fluid therethrough to the opening in the basepipe.

21. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device having means for receiving fluid from outside the basepipe;
at least one internal valve disposed inside the flow device and selectively configurable between opened and closed conditions to control flow of the received fluid from the receiving means to the at least one opening in the basepipe; and
means for externally accessing, on an exterior of the flow device, the internal valve.
22. The apparatus of claim 21, wherein the means for receiving the fluid from outside the basepipe comprises means for screening the fluid from outside the basepipe.
23. The apparatus of claim 21, comprising means for restricting the flow of the received fluid.
24. The apparatus of claim 21, wherein the internal valve comprises means for producing a pressure drop in the flow of the received fluid.
25. The apparatus of claim 21, wherein the internal valve comprises means for selectively permitting or preventing fluid communication of the received fluid to the at least one opening.
26. The apparatus of claim 21, wherein the means for externally accessing, on the exterior of the flow device, the internal valve comprises means for adjusting the internal valve through an external opening on the flow device.
27. The apparatus of claim 21, wherein the at least one internal valve comprises a ball valve having an orifice defined therein, the ball valve disposed inside the flow device and being rotatable therein relative to the at least one flow port, the rotation of the ball valve being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

28. The apparatus of claim 27, wherein the ball valve comprises a rotatable body disposed in an external opening in the flow device, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the rotatable body.

29. The apparatus of claim 28, wherein the ball valve comprises seal elements disposed inside the external opening against the rotatable body.

30. The apparatus of claim 28, wherein the orifice of the ball valve in the opened state produces a pressure drop in the flow of the fluid therethrough.

31. The apparatus of claim 21, wherein the at least one internal valve comprises a gate valve disposed inside the flow device and having a gate, the gate being movable relative to the at least one flow port, the movement of the gate being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

32. The apparatus of claim 31, wherein the gate valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the gate disposed in the body and being movable relative to the orifice, the gate having a screw extending therefrom, the screw being accessible externally in the external opening in the flow device for moving the gate.

33. The apparatus of claim 21, wherein the at least one internal valve comprises a butterfly valve disposed inside the flow device and having a flapper, the flapper being rotatable relative to the at least one flow port, the rotation of the flapper being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

34. The apparatus of claim 33, wherein the butterfly valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the flapper disposed in

the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the flapper.

35. A flow control method for a borehole, comprising:
selectively configuring one or more internal valves disposed in a housing on a basepipe by externally accessing the one or more internal valves from an exterior of the housing and selectively opening or closing fluid communication through the one or more internal valves;
deploying the basepipe in the borehole;
receiving fluid in the housing from outside the basepipe; and
controlling flow of the received fluid to one or more internal openings in the basepipe using the one or more internal valves.

36. The method of claim 35, wherein controlling the flow of the received fluid to the one or more internal openings comprises restricting the flow of the received fluid through the one or more internal valves in an open condition.

37. The method of claim 36, wherein restricting the flow of the received fluid through the one or more internal valves in the opened condition comprises producing a pressure drop in the flow of the received fluid through the one or more internal valves in the open condition.

38. The method of claim 35, wherein selectively opening or closing fluid communication through the one or more internal valves comprises selectively permitting or preventing fluid communication to the one or more internal openings through the one or more internal valves.

39. The method of claim 35, wherein selectively opening or closing fluid communication through the one or more internal valves comprises rotating a ball valve having an orifice defined therein, the ball valve disposed inside the housing and being rotatable therein relative to at least one flow port, the rotation of the ball valve being externally accessible on the exterior of the housing and changing fluid communication through the at least one flow port.

40. The method of claim 35, wherein the ball valve comprises a rotatable body disposed in an external opening in the housing, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body having a spindle extending therefrom, the spindle being accessible externally in the external opening in the housing for rotating the rotatable body.

41. The method of claim 40, wherein the ball valve comprises seal elements disposed inside the external opening against the rotatable body.

42. The method of claim 40, comprising producing a pressure drop in the flow of the fluid through the orifice of the ball valve in the opened state.

43. The method of claim 35, wherein selectively opening or closing fluid communication through the one or more internal valves comprises moving a gate valve disposed inside the housing relative to at least one flow port, the movement of the gate being externally accessible on the exterior of the housing and changing fluid communication through the at least one flow port.

44. The method of claim 43, wherein the gate valve comprises a body disposed in an external opening in the housing, the body having an orifice therethrough in communication with the at least one flow port, the gate valve having a gate disposed in the body and being movable relative to the orifice, the gate having a screw extending therefrom, the screw being accessible externally in the external opening in the housing for moving the gate.

45. The method of claim 35, wherein selectively opening or closing fluid communication through the one or more internal valves comprises rotating a butterfly valve disposed inside the housing relative to at least one flow port, the rotation of the butterfly valve being externally accessible on the exterior of the housing and changing fluid communication through the at least one flow port.

46. The method of claim 45, wherein the butterfly valve comprises a body disposed in an external opening in the housing, the body having an orifice

therethrough in communication with the at least one flow port, the butterfly valve having a flapper disposed in the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the housing for rotating the flapper.

CLAIMS

1. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device disposed on the basepipe and defining at least one flow port, the at least one flow port communicating fluid from outside the basepipe to the at least one opening defined in the basepipe; and
at least one internal valve disposed inside the flow device at the at least one flow port, the at least one internal valve having a member being externally exposed and accessible on an exterior of the flow device, the at least one internal valve being externally configurable with the member between an open state and a closed state relative to the at least one flow port and selectively controlling flow of the fluid from outside the basepipe to the at least one opening defined in the basepipe.
2. The apparatus of claim 1, 15, or 17, further comprising a screen disposed on the basepipe, the screen screening the fluid from outside the basepipe and communicating the fluid with the flow device.
3. The apparatus of claim 1, 15, or 17, wherein the at least one internal valve in the open state permits fluid communication through the at least one flow port to the at least one opening, and wherein the at least one internal valve in the closed state prevents fluid communication through the at least one flow port to the at least one opening.
4. The apparatus of claim 1, 15, or 17, wherein the flow device comprises a nozzle disposed in the at least one flow port, the nozzle restricting the flow of the fluid.
5. The apparatus of claim 1, 15, or 17, wherein the at least one internal valve comprises means for producing a pressure drop in the flow of the fluid through the internal valve in the opened state.

6. The apparatus of claim 1, 15, or 17, wherein the flow device comprises:
a first end in fluid communication with the fluid from outside the basepipe; and
a second end in fluid communication with the at least one opening.
7. The apparatus of claim 6, wherein the first end comprises a first end-ring defining a fluid passage in fluid communication with the fluid from outside the basepipe, and
wherein the second end comprises a second end-ring.
8. The apparatus of claim 7, wherein the second end-ring defines the at least one flow port communicating with the at least one opening, and wherein the second end-ring has the at least one valve disposed internally therein.
9. The apparatus of claim 7, wherein the at least one flow port comprises a nozzle restricting the flow of the fluid.
10. The apparatus of claim 7, wherein the flow device comprises a sleeve affixed to the first and second end-rings and defining a chamber with the first and second end-rings.
11. The apparatus of claim 1, wherein the at least one internal valve comprises a ball valve having an orifice defined therein and having the member extending therefrom, the ball valve disposed inside the flow device and being rotatable therein with the member relative to the at least one flow port, the rotation of the ball valve being externally accessible with the member exposed on the exterior of the flow device and changing fluid communication through the at least one flow port.
12. The apparatus of claim 11, wherein the ball valve comprises a rotatable body disposed in an external opening in the flow device, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body

having a spindle as the member extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the rotatable body.

13. The apparatus of claim 12, wherein the ball valve comprise seal elements disposed inside the external opening against the rotatable body.

14. The apparatus of claim 12, wherein the orifice of the ball valve in the opened state produces a pressure drop in the flow of the fluid therethrough.

15. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device disposed on the basepipe and defining at least one flow port, the at least one flow port communicating fluid from outside the basepipe to the at least one opening defined in the basepipe; and
at least one internal valve disposed inside the flow device at the at least one flow port, at least a portion of the at least one internal valve being externally accessible on an exterior of the flow device, the at least one internal valve being externally configurable between an open state and a closed state relative to the at least one flow port and selectively controlling flow of the fluid from outside the basepipe to the at least one opening defined in the basepipe,
wherein the at least one internal valve comprises a gate valve disposed inside the flow device and having a gate, the gate being movable relative to the at least one flow port, the movement of the gate being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

16. The apparatus of claim 15, wherein the gate valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the gate disposed in the body and being

movable relative to the orifice, the gate having a screw extending therefrom, the screw being accessible externally in the external opening in the flow device for moving the gate.

17. A flow control apparatus for a borehole, comprising:
- a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
 - a flow device disposed on the basepipe and defining at least one flow port, the at least one flow port communicating fluid from outside the basepipe to the at least one opening defined in the basepipe; and
 - at least one internal valve disposed inside the flow device at the at least one flow port, at least a portion of the at least one internal valve being externally accessible on an exterior of the flow device, the at least one internal valve being externally configurable between an open state and a closed state relative to the at least one flow port and selectively controlling flow of the fluid from outside the basepipe to the at least one opening defined in the basepipe,
- wherein the at least one internal valve comprises a butterfly valve disposed inside the flow device and having a flapper, the flapper being rotatable relative to the at least one flow port, the rotation of the flapper being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

18. The apparatus of claim 17, wherein the butterfly valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the flapper disposed in the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the flapper.

19. The apparatus of claim 1, 15, or 17, wherein the flow device comprises a plurality of the at least one internal valves disposed inside the flow device.
20. The apparatus of claim 1, 15, or 17, wherein the flow device defines a tortuous path for the flow of fluid therethrough to the opening in the basepipe.
21. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device having means for receiving fluid from outside the basepipe;
at least one internal valve disposed inside the flow device and selectively configurable between opened and closed conditions to control flow of the received fluid from the receiving means to the at least one opening in the basepipe; and

a member being exposed and accessible on an exterior of the flow device and providing means for externally configuring the at least one internal valve disposed inside the flow device.
22. The apparatus of claim 21, 31, or 33, wherein the means for receiving the fluid from outside the basepipe comprises means for screening the fluid from outside the basepipe.
23. The apparatus of claim 21, 31, or 33, comprising means for restricting the flow of the received fluid.
24. The apparatus of claim 21, 31, or 33, wherein the internal valve comprises means for producing a pressure drop in the flow of the received fluid.

25. The apparatus of claim 21, 31, or 33, wherein the internal valve comprises means for selectively permitting or preventing fluid communication of the received fluid to the at least one opening.
26. The apparatus of claim 21, 31, or 33, wherein the means for externally accessing, on the exterior of the flow device, the internal valve comprises means for adjusting the internal valve through an external opening on the flow device.
27. The apparatus of claim 21, wherein the at least one internal valve comprises a ball valve having an orifice defined therein and having the member extending therefrom, the ball valve disposed inside the flow device and being rotatable therein with the member relative to the at least one flow port, the rotation of the ball valve being externally accessible with the member exposed on the exterior of the flow device and changing fluid communication through the at least one flow port.
28. The apparatus of claim 27, wherein the ball valve comprises a rotatable body disposed in an external opening in the flow device, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body having a spindle as the member extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the rotatable body.
29. The apparatus of claim 28, wherein the ball valve comprises seal elements disposed inside the external opening against the rotatable body.
30. The apparatus of claim 28, wherein the orifice of the ball valve in the opened state produces a pressure drop in the flow of the fluid therethrough.
31. A flow control apparatus of claim 21 for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device having means for receiving fluid from outside the basepipe;

at least one internal valve disposed inside the flow device and selectively configurable between opened and closed conditions to control flow of the received fluid from the receiving means to the at least one opening in the basepipe; and
means for externally accessing, on an exterior of the flow device, the at least one internal valve,
wherein the at least one internal valve comprises a gate valve disposed inside the flow device and having a gate, the gate being movable relative to the at least one flow port, the movement of the gate being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

32. The apparatus of claim 31, wherein the gate valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the gate disposed in the body and being movable relative to the orifice, the gate having a screw extending therefrom, the screw being accessible externally in the external opening in the flow device for moving the gate.

33. A flow control apparatus for a borehole, comprising:
a basepipe having a bore for conveying fluid and defining at least one opening for communicating fluid into the bore;
a flow device having means for receiving fluid from outside the basepipe;
at least one internal valve disposed inside the flow device and selectively configurable between opened and closed conditions to control flow of the received fluid from the receiving means to the at least one opening in the basepipe; and
means for externally accessing, on an exterior of the flow device, the at least one internal valve,
wherein the at least one internal valve comprises a butterfly valve disposed inside the flow device and having a flapper, the flapper being rotatable

relative to the at least one flow port, the rotation of the flapper being externally accessible on the exterior of the flow device and changing fluid communication through the at least one flow port.

34. The apparatus of claim 33, wherein the butterfly valve comprises a body disposed in an external opening in the flow device, the body having an orifice therethrough in communication with the at least one flow port, the flapper disposed in the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the flow device for rotating the flapper.

35. A flow control method for a borehole, comprising:
selectively configuring one or more internal valves disposed in a housing on a basepipe by externally accessing a member extending from the one or more internal valves and being exposed on an exterior of the housing and selectively opening or closing fluid communication through the one or more internal valves;
deploying the basepipe in the borehole;
receiving fluid in the housing from outside the basepipe; and
controlling flow of the received fluid to one or more internal openings in the basepipe using the one or more internal valves.

36. The method of claim 35, 43, or 45, wherein controlling the flow of the received fluid to the one or more internal openings comprises restricting the flow of the received fluid through the one or more internal valves in an open condition.

37. The method of claim 36, wherein restricting the flow of the received fluid through the one or more internal valves in the opened condition comprises producing a pressure drop in the flow of the received fluid through the one or more internal valves in the open condition.

38. The method of claim 35, 43, or 45, wherein selectively opening or closing fluid communication through the one or more internal valves comprises selectively permitting or preventing fluid communication to the one or more internal openings through the one or more internal valves.

39. The method of claim 35, wherein selectively opening or closing fluid communication through the one or more internal valves comprises rotating a ball valve having an orifice defined therein and having the member extending therefrom, the ball valve disposed inside the housing and being rotatable therein relative to at least one flow port, the rotation of the ball valve being externally accessible with the member exposed on the exterior of the housing and changing fluid communication through the at least one flow port.

40. The method of claim 35, wherein the ball valve comprises a rotatable body disposed in an external opening in the housing, the rotatable body having the orifice therethrough and being rotatable relative to the at least one flow port, the rotatable body having a spindle as the member extending therefrom, the spindle being accessible externally in the external opening in the housing for rotating the rotatable body.

41. The method of claim 40, wherein the ball valve comprises seal elements disposed inside the external opening against the rotatable body.

42. The method of claim 40, comprising producing a pressure drop in the flow of the fluid through the orifice of the ball valve in the opened state.

43. A flow control method for a borehole, comprising:
selectively configuring one or more internal valves disposed in a housing on a basepipe by externally accessing the one or more internal valves from an exterior of the housing and selectively opening or closing fluid communication through the one or more internal valves;
deploying the basepipe in the borehole;

receiving fluid in the housing from outside the basepipe; and
controlling flow of the received fluid to one or more internal openings in the
basepipe using the one or more internal valves,
wherein selectively opening or closing fluid communication through the one or
more internal valves comprises moving a gate valve disposed inside the
housing relative to at least one flow port, the movement of the gate being
externally accessible on the exterior of the housing and changing fluid
communication through the at least one flow port.

44. The method of claim 43, wherein the gate valve comprises a body disposed in an
external opening in the housing, the body having an orifice therethrough in
communication with the at least one flow port, the gate valve having a gate disposed in
the body and being movable relative to the orifice, the gate having a screw extending
therefrom, the screw being accessible externally in the external opening in the housing
for moving the gate.

45. A flow control method for a borehole, comprising:
selectively configuring one or more internal valves disposed in a housing on a
basepipe by externally accessing the one or more internal valves from an
exterior of the housing and selectively opening or closing fluid
communication through the one or more internal valves;
deploying the basepipe in the borehole;
receiving fluid in the housing from outside the basepipe; and
controlling flow of the received fluid to one or more internal openings in the
basepipe using the one or more internal valves,
wherein selectively opening or closing fluid communication through the one or
more internal valves comprises rotating a butterfly valve disposed inside
the housing relative to at least one flow port, the rotation of the butterfly
valve being externally accessible on the exterior of the housing and
changing fluid communication through the at least one flow port.

46. The method of claim 45, wherein the butterfly valve comprises a body disposed in an external opening in the housing, the body having an orifice therethrough in communication with the at least one flow port, the butterfly valve having a flapper disposed in the body and being rotatable relative to the orifice, the flapper having a spindle extending therefrom, the spindle being accessible externally in the external opening in the housing for rotating the flapper.