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(54) **PRESSURE ACTUATED PORTED SUB FOR SUBTERRANEAN CEMENT COMPLETIONS**

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See application file for complete search history.

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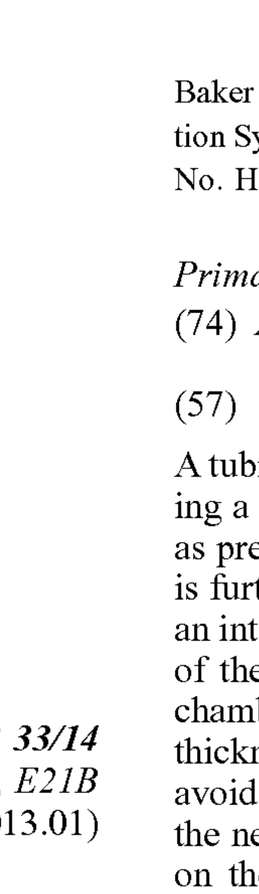
(57) **ABSTRACT**

A tubing pressure operated sliding sleeve is used in cementing a tubular string. The sleeve is configured to hold closed as pressure builds to a predetermined value. When pressure is further raised a rupture disc blows and provides access to an integral piston disposed outside the sleeve. The back side of the piston is exposed to a low pressure or atmospheric chamber located between upper and lower seals. The sleeve thickness near the chamber can be made relatively thick to avoid flexing or bending under differential pressure because the net force to shift the sleeve is from differential pressure on the piston rather than the piston areas created by the upper and lower seals.

44 Claims, 2 Drawing Sheets



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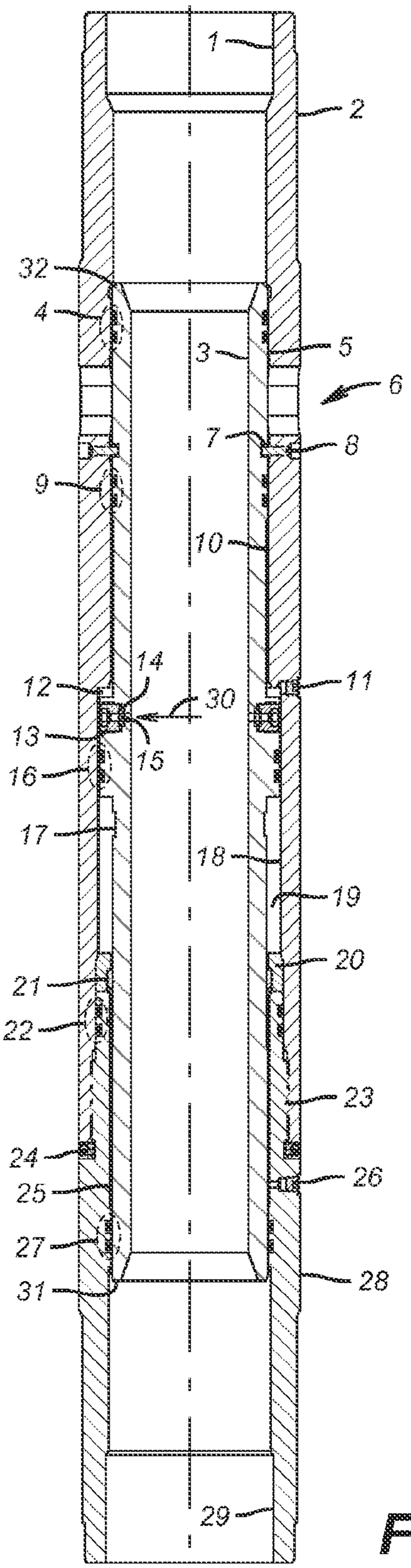
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FIG. 1

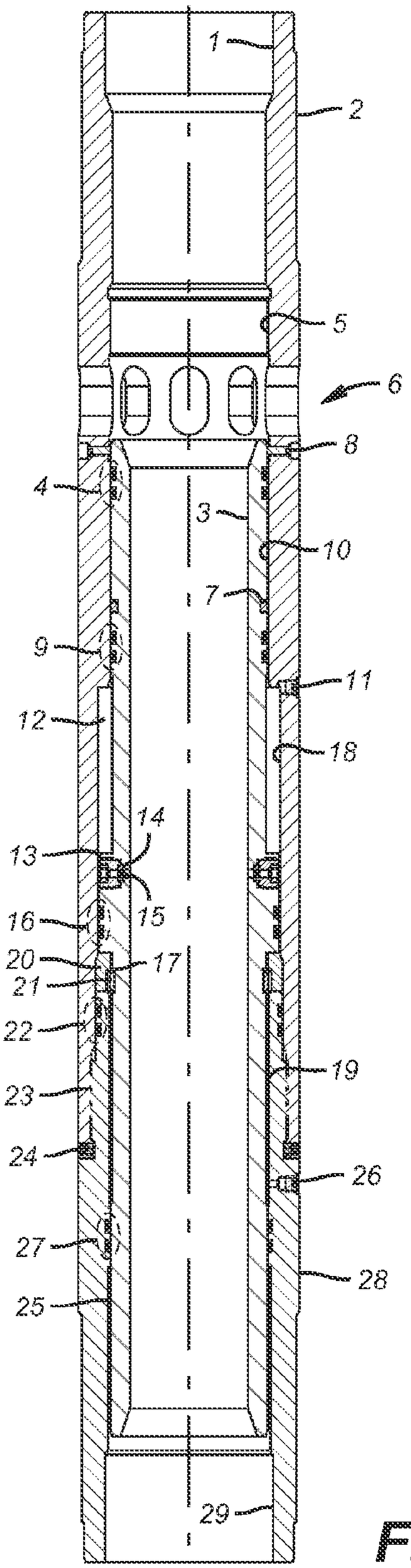
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FIG. 2

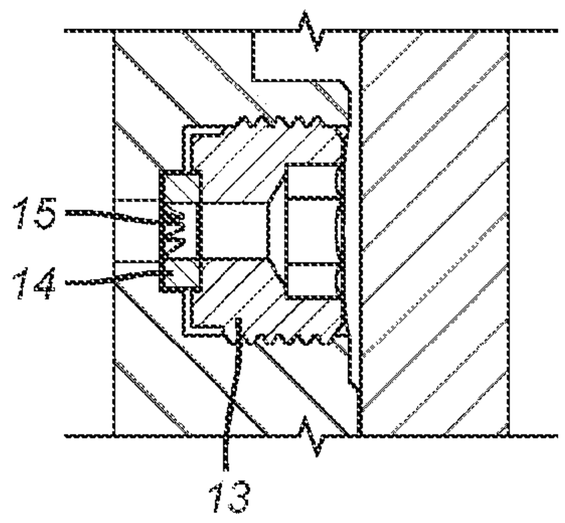
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FIG. 3

PRESSURE ACTUATED PORTED SUB FOR SUBTERRANEAN CEMENT COMPLETIONS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

FIELD OF THE INVENTION

The field of the invention is a pressure actuated sleeve used in a cementing assembly that is responsive to tubing pressure to open a port and more particularly a sleeve that is associated with a piston where the piston is not referenced to annulus pressure when actuated by selective communication of tubing pressure to one side with the opposed side referenced to a low pressure chamber within the housing.

BACKGROUND OF THE INVENTION

Prior sleeves that have been deployed in cementing service have been based on the concept of providing opposed piston areas exposed to tubing pressure that are of different dimensions so that raising the tubing pressure will create a sufficient net force to in theory overcome seal friction and move the sleeve to the open position. One such design is Halliburton Initiator Sliding Sleeve that has a larger upper seal diameter than a lower seal. Raising tubing pressure creates a net differential force and the piston is allowed to move because there is an atmospheric chamber between the upper and lower seals. The problem is that to get the lower seal to be smaller than the upper seal to create the desired net force in the needed direction, the wall of the sleeve adjacent the lower seal and the atmospheric chamber has to be reduced so that the sleeve can shift while the volume of the atmospheric chamber is reduced.

The wall of the sleeve in the area of the atmospheric chamber sees substantial differential pressure and can flex or bend. When that happens the sleeve gets stuck and the desired port opening in the housing fails to occur.

Apart from these designs there are sleeves that respond to tubing pressure with an associated piston that is open on one side to tubing pressure and on the other side to annulus pressure. Such a design is illustrated in US Publication 2011/0100643. This design cannot be used in cementing applications as the filling up of the annulus with cement can block access to annulus pressure. Furthermore, there is a leak path potential from the tubing to the annulus through a piston seal leak.

Various pressure operated sleeves for downhole use are shown in U.S. Pat. Nos. and Publications: 7,703,510; 3,662,834; 4,330,039; 6,659,186; 6,550,541; 5,355,959; 4,718,494; 7,640,988; 6,386,289; US 2010/0236781 A1; U.S. Pat. Nos. 5,649,597; 5,044,444; 5,810,087; 5,950,733; 5,954,135; 6,286,594; 4,434,854 and 3,189,044.

What is needed and provided by the present invention is an actuation technique for a sliding sleeve to open a port that responds to tubing pressure but addresses the flexing or bending problem associated with prior designs so that reliable movement of the sleeve is obtained. In the preferred embodiment the application of pressure to a predetermined level actually holds the sleeve closed because the piston area on the sleeve bottom at **31** is greater than the piston area at the top of the sleeve at **32**. Doing this allows the sleeve wall

near the atmospheric or low pressure chamber to be strong enough to resist bending or buckling under a predetermined differential pressure. When the pressure is built up access is provided to a piston on the sleeve that is referenced to a low pressure or atmospheric chamber. This can be done with breaking a rupture disc. The sleeve can then move to open the port or ports for annulus access so that tools can be pumped down with flow without having to perforate the casing which can save a run in the hole with a perforating gun. Those skilled in the art will better appreciate more aspects of the invention from a review of the description of the preferred embodiment and the associated drawings while recognizing that the full scope of the invention is to be determined by the appended claims.

SUMMARY OF THE INVENTION

A tubing pressure operated sliding sleeve is used in cementing a tubular string. The sleeve is configured to hold closed as pressure builds to a predetermined value. When pressure is further raised a rupture disc blows and provides access to an integral piston disposed outside the sleeve. The back side of the piston is exposed to a low pressure or atmospheric chamber located between upper and lower seals. The sleeve thickness near the chamber can be made relatively thick to avoid flexing or bending under differential pressure because the net force to shift the sleeve is from differential pressure on the piston rather than the piston areas created by the upper and lower seals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a section view of the sleeve in the ports closed position;

FIG. **2** is the view of FIG. **1** with the sleeve in the ports open position; and

FIG. **3** is an enlarged view of the rupture disc assembly shown in FIG. **2**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, the apparatus has the following components:

upper body tubular connection **1**;
upper ported housing **2**;
inner shifting sleeve **3**;
port isolation seals **4**;
upper internal polished bore **5**;
fluid communication ports **6**;
sleeve shear screw shoulder **7**;
shear screws **8**;
upper internal bore piston seals **9**;
intermediate internal polished bore **10**;
upper pressure testing port **11**;
upper atmospheric chamber **12**;
burst disk load nut **13**;
burst disk load ring **14**;
burst disk or chemically responsive barrier **15**;
intermediate internal bore piston seals and piston **16**;
sleeve lock ring retention groove **17**;
lower internal polished bore **18**;
lower atmospheric chamber **19**;
sleeve lock ring retainer **20**;
sleeve lock ring **21**;
body seals **22**;
body connection **23**;

body set screws **24**;
lower sleeve polished bore **25**;
lower pressure testing port **26**;
lower external rod piston seals **27**;
lower body **28**; and
lower body tubular connection **29**.

The valve is run in open-hole cementable completions just above the float equipment. The valve is connected to the casing; through the upper body tubular connection (**1**) at the top and the lower body tubular connection (**29**) at the bottom. The structural valve body is made-up of an upper ported housing (**2**) and lower body (**28**). Pressure integrity of the valve is maintained with the body seals (**22**). The body set screws (**24**) keep the body connection threads (**23**) from backing out during installation. Between the upper ported housing (**2**) and the lower body (**28**) is captured an inner shifting sleeve (**3**). The inner shifting sleeve (**3**) has several diameters that create piston areas that generate shifting forces to open the valve. The port isolation seals (**4**) located on the upper end of the inner shifting sleeve (**3**) and the upper internal bore piston seals (**9**) below the fluid communication ports (**6**) both act to isolate the inside of the valve during and after cementation. The larger intermediate internal bore piston seals (**16**) are used to drive down the inner shifting sleeve (**3**) along the lower internal polished bore (**18**) within the upper ported housing (**2**), once the burst disk (**15**) is ruptured. Both sets of seals operate within their respective polished bores (**5**, **10**) within the upper ported housing (**2**). The lower external rod piston seals (**27**) located within the lower body (**28**) act to prevent cement from entering the lower atmospheric chamber (**19**) and wipe the outside diameter of the lower sleeve polished bore (**25**) during the opening of the valve. The inner shifting sleeve (**3**) also has a shoulder (**7**) that shears the shear screws (**8**) during the opening shift of the inner sleeve (**3**). An external sleeve lock ring retention groove (**17**) is located between the internal bore piston seals (**16**) and the lower sleeve polished bore (**25**) diameter. This recess will accept the sleeve lock ring (**21**) that is retained by the lock ring retainer (**20**) once the valve had fully opened. The sleeve lock ring (**21**) will prevent the inner shifting sleeve (**3**) from closing once the valve has fully opened.

Between the upper internal bore piston seals (**9**) and the intermediate internal bore piston seals (**16**) is created the upper atmospheric chamber (**12**) which contains air that can be independently tested through the upper pressure test port (**11**). Between the intermediate internal bore pistons seals (**16**) and the lower external rod piston seals (**27**) is created a lower atmospheric chamber (**19**) which also contains air that can be independently tested through a lower pressure testing port (**26**). A burst disk (**15**) is held into place within a port located on the outside of the inner shifting sleeve (**3**) by a load ring (**14**) and a load nut (**13**). The burst disk load nut (**13**) is sized to allow significant torque and load to be transferred into the burst disk (**15**) prior to installation of the inner shifting sleeve (**3**) within the valve.

The valve is run on casing and cemented into place within the well. After cementation the valve is scraped with wiper dart prior to actuation. Once the cement has set on the outside of the valve, it is ready to be opened with a combination of high hydrostatic and applied pressure. Once the burst pressure is reached, the burst disk (**15**) opens the upper atmospheric chamber (**12**) to the applied pressure. This pressure acts on the piston area created by the upper internal bore piston seals (**9**) and the larger intermediate internal bore piston seals (**16**) and drives the inner shifting sleeve (**3**) down compressing the air within the lower

atmospheric chamber (**19**) and opening the fluid communication ports (**6**) on the upper ported housing (**2**). Once the inner shifting sleeve (**3**) is completely shifted and in contact with the upward facing shoulder on the lock ring retainer (**20**), the sleeve lock ring (**21**) falls into the sleeve lock retention groove (**17**) on the inner shifting sleeve (**3**) preventing the valve from subsequently closing.

Those skilled in the art will appreciate that the use of the rupture disc for piston access is simply the preferred way and generally more accurate than relying exclusively on shearing a shear pin. A pressure regulation valve can also be used for such selective access as well as a chemically responsive barrier that goes away in the presence of a predetermined substance or energy field, temperature downhole or other well condition for example, schematically illustrated by arrow **30**, to move the sleeve. Chamber (**12**), once the rupture disc burst is under tubing pressure so wall flexure at that location is minimized. Even before the rupture disc breaks the size of chamber (**12**) is sufficiently small to avoid sleeve wall flexing in that region. The use of a large boss to support the seal (**16**) also strengthens the sleeve (**3**) immediately above the chamber (**19**), thus at least reducing flexing or bending that could put sleeve (**3**) in a bind before it fully shifted. The slightly larger dimension of seal (**27**) than seal (**4**) that holds the sleeve (**3**) closed initially also allows a greater wall thickness for sleeve (**3**) near the chamber (**19**) to further at least reducing flexing or bending to allow the sleeve (**3**) to fully shift without getting into a bind.

The piston (**16**) can be integral to the sleeve (**3**) or a separate structure. Chamber (**19**) has an initial pressure of atmospheric or a predetermined value less than the anticipated hydrostatic pressure within sleeve (**3**). The volume of chamber (**19**) decreases and its internal pressure rises as sleeve (**3**) moves to open port (**6**).

The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

We claim:

1. A valve for subterranean use, comprising:
a housing having a passage therethrough and a port in a wall thereof;
a sleeve having a flow path therethrough movably mounted in said passage of said housing between a first position where said port is closed and a second position where said port is at least in part open;
a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure until a predetermined pressure is reached.

2. The valve of claim **1**, wherein:
said piston is integral to said sleeve.

3. The valve of claim **1**, wherein:
said piston is a discrete structure from said sleeve.

4. The valve of claim **1**, wherein:
said piston is selectively isolated from passage pressure by a pressure responsive barrier that opens.

5. The valve of claim **4**, wherein:
said pressure responsive barrier comprises at least one rupture disc.

6. The valve of claim **5**, wherein:
said piston has a first side that is selectively exposed to passage pressure and a second side opposite said first side exposed to a closed chamber in said housing.

7. The valve of claim **6**, wherein:
said sleeve at least in part defines said closed chamber.

8. The valve of claim 7, wherein:
said sleeve is configured to respond to passage pressure below said predetermined level by being urged toward said first position.
9. The valve of claim 8, wherein:
said closed chamber has an initial pressure of atmospheric or a predetermined value lower than an anticipated hydrostatic pressure in said passage.
10. The valve of claim 9, wherein:
movement of said sleeve toward said second position reduces the volume of said closed chamber.
11. The valve of claim 10, wherein:
said sleeve is retained with at least one shear pin until such time as said piston is no longer isolated from passage pressure.
12. The valve of claim 1, wherein:
said piston has a first side that is selectively exposed to passage pressure and a second side opposite said first side exposed to a closed chamber in said housing.
13. The valve of claim 12, wherein:
said sleeve at least in part defines said closed chamber.
14. The valve of claim 13, wherein:
said closed chamber has an initial pressure of atmospheric or a predetermined value lower than an anticipated hydrostatic pressure in said passage.
15. The valve of claim 14, wherein:
movement of said sleeve toward said second position reduces the volume of said closed chamber.
16. The valve of claim 1, wherein:
said sleeve is configured to respond to passage pressure below said predetermined level by being urged toward said first position.
17. The valve of claim 16, wherein:
said sleeve has piston areas adjacent opposed ends defined by seals against said housing wall that are of unequal diameters.
18. The valve of claim 1, wherein:
said selective isolation is accomplished by a barrier that is undermined in response to a predetermined substance, energy field, temperature or other subterranean condition.
19. A valve for subterranean use, comprising:
a housing having a passage therethrough and a port in a wall thereof;
a sleeve having a flow path therethrough movably mounted in said housing between a first position where said port is closed and a second position where said port is at least in part open;
a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure until a predetermined pressure is reached;
said piston has a first side that is selectively exposed to passage pressure and a second side opposite said first side exposed to a closed chamber in said housing;
said first side of said piston is exposed to a second chamber in said housing.
20. The valve of claim 19, wherein:
said second chamber is defined in part by said sleeve and decreases in volume with movement of said sleeve toward said second position.
21. A valve for subterranean use, comprising:
a housing having a passage therethrough and a port in a wall thereof;
a sleeve having a flow path therethrough movably mounted in said housing between a first position where said port is closed and a second position where said port is at least in part open;
a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure until a predetermined pressure is reached;
said sleeve is retained with a selectively defeated retainer until such time as said piston is no longer isolated from passage pressure.
22. The valve of claim 21, wherein:
said retainer fails in shear.
23. A valve for use in a cementable open-hole well comprising:
a housing having a passage therethrough and a port in a wall thereof for providing access from an interior of said housing to an exterior of the housing;
a sleeve having a longitudinal flow path therethrough movably mounted in said passage of said housing, the sleeve being movable from an initial closed position to an open position;
wherein when said sleeve is in said closed position the interior of said housing is isolated from the exterior of said housing and wherein when said sleeve is in said open position the port provides access from the interior of the housing to the exterior of the housing; and
a piston associated with said sleeve for moving said sleeve from the initial closed position to the open position, said piston selectively isolated from pressure within the passage until a predetermined pressure within the passage is reached.
24. The valve of claim 23, wherein said piston is integral to said sleeve.
25. The valve of claim 23, wherein said piston is selectively isolated from passage pressure by a pressure responsive barrier that responds to the predetermined pressure by allowing passage pressure to access said piston.
26. The valve of claim 25, wherein said pressure responsive barrier comprises at least one rupture disc.
27. The valve of claim 26, where the predetermined pressure within the passage bursts the rupture disc.
28. The valve of claim 27, wherein said piston has a first side that is selectively exposed to passage pressure and a second side opposite said first side exposed to a closed chamber in said housing.
29. The valve of claim 28, wherein said chamber has an initial pressure of atmospheric or a predetermined value lower than an anticipated hydrostatic pressure in said passage.
30. The valve of claim 28, wherein movement of the sleeve to said open position reduces a volume of the closed chamber.
31. The valve of claim 23, wherein pressure within the passage below the predetermined pressure urges the sleeve toward the closed position.
32. The valve of claim 23, wherein the piston is isolated from a pressure exterior of the housing.
33. The valve of claim 23, wherein cement may be pumped from the passage of the housing when the sleeve is in said closed position.
34. A method of temporarily isolating the inside of a valve from an open-hole well comprising:
running a valve connected to casing into an open-hole well, the valve including a housing having a passage therethrough and a port in a wall of the housing, and a sleeve positioned within the passage and movable upon exposure to a predetermined passage pressure from an initial closed position that covers the port to an open position that uncovers at least a portion of the port;

exposing the sleeve to the predetermined passage pressure; and

moving the sleeve from the initial closed position to the open position.

35. The method of claim 34, wherein the step of exposing the sleeve to the predetermined pressure further comprises actuating a pressure responsive barrier in the passage by exposing the pressure responsive barrier to the predetermined pressure.

36. The method of claim 35, wherein actuating the pressure responsive barrier comprises bursting the pressure responsive barrier to expose the sleeve to the predetermined pressure.

37. The method of claim 36, wherein bursting the pressure responsive barrier exposes a first side of a piston to the predetermined pressure and a second side of the piston being exposed to a closed chamber in the housing, the piston being operatively connected to the sleeve.

38. The method of claim 37, moving the piston to reduce a volume of the closed chamber.

39. The method of claim 38, wherein the closed chamber has an initial pressure that is less than the predetermined pressure.

40. The method of claim 39, wherein the piston is integral to the sleeve.

41. The method of claim 34, wherein the pressure within the passage urges the sleeve to the initial position until the pressure reaches the predetermined pressure.

42. The method of claim 41, further comprising shearing a shearable device prior to moving the sleeve from the initial position to the open position.

43. The method of claim 34, wherein the step of exposing the sleeve to the predetermined pressure further comprises actuating a chemically responsive barrier in the passage by exposing the chemically responsive barrier to a predetermined substance, energy field, or temperature.

44. The method of claim 34, wherein the sleeve is exposed to the predetermined pressure after a cementation process.

* * * * *

Disclaimer

RE46,137 E - Mailand C. Jason, The Woodlands, TX (US); Justin C. Kellner, Pearland, TX (US); Charles C. Johnson, League City, TX (US); Charles T. Kirkpatrick, New Caney, TX (US); Marcus A. Avant, Kingwood, TX (US). PRESSURE ACTUATED PORTED SUB FOR SUBTERRANEAN CEMENT COMPLETIONS. Patent dated September 6, 2016. Disclaimer filed March 6, 2020, by the assignee, Baker Hughes Oilfield Operations, LLC.

I hereby disclaim the following complete claims 2-7, 12-15, 18-30, 32, 33, 35-40, 43 and 44 of said patent.

(Official Gazette, September 27, 2022)

US00RE46137C1

(12) EX PARTE REEXAMINATION CERTIFICATE (11885th)

United States Patent

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(54) **PRESSURE ACTUATED PORTED SUB FOR SUBTERRANEAN CEMENT COMPLETIONS**

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CPC ***E21B 33/14*** (2013.01); ***E21B 34/063*** (2013.01); ***E21B 34/10*** (2013.01); *E21B 2200/06* (2020.05)

(58) **Field of Classification Search**
None
See application file for complete search history.

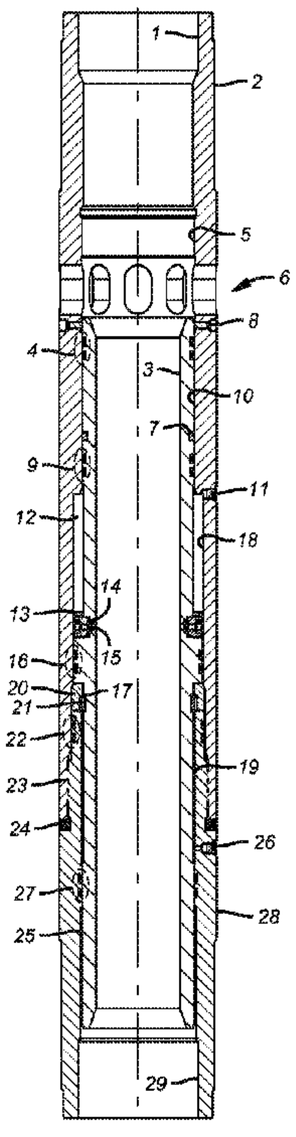
(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/014,418, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner — William C Doerrler

(57) **ABSTRACT**

A tubing pressure operated sliding sleeve is used in cementing a tubular string. The sleeve is configured to hold closed as pressure builds to a predetermined value. When pressure is further raised a rupture disc blows and provides access to an integral piston disposed outside the sleeve. The back side of the piston is exposed to a low pressure or atmospheric chamber located between upper and lower seals. The sleeve thickness near the chamber can be made relatively thick to avoid flexing or bending under differential pressure because the net force to shift the sleeve is from differential pressure on the piston rather than the piston areas created by the upper and lower seals.



EX PARTE REEXAMINATION CERTIFICATE

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [ ] appeared in the reissue patent but has been deleted by this reexamination certificate and is no longer a part of the reissue patent; matter printed in italics indicates additions made to the reissue patent by this reexamination certificate.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

Claims **2-7**, **12-15**, **18-30**, **32**, **33**, **35-40**, **43** and **44** were previously disclaimed.

Claims **1** and **34** are cancelled.

New claims **45-148** are added and determined to be patentable.

Claims **8-11**, **16**, **17**, **31**, **41** and **42** were not reexamined.

45. A valve for subterranean use, comprising:

a housing having a passage therethrough and a port in a wall thereof;

a sleeve having a flow path therethrough movably mounted in said passage of said housing between:

a first position where said port is closed because said port is covered by said sleeve; and

a second position where said sleeve is farther from an end of said valve than is said port such that said port is at least in part open; and

a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure with a rupture disc until a predetermined pressure is reached.

46. The valve of claim 45, wherein the piston is integral to the sleeve.

47. The valve of claim 45, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

the first chamber is selectively isolated from passage pressure with the rupture disc until the predetermined pressure is reached.

48. The valve of claim 47, wherein the volume of the second chamber decreases when the sleeve moves from the first position to the second position.

49. The valve of claim 45, comprising one or more shearable members configured to be sheared when the sleeve moves from the first position to the second position.

50. The valve of claim 45, comprising a retainer configured to prevent the sleeve from moving from the second position to the first position after the sleeve moves to the second position.

51. The valve of claim 50, wherein the sleeve defines a recess configured to receive the retainer when the sleeve is in the second position.

52. The valve of claim 45, wherein the sleeve is the only sleeve movably mounted in the passage of the housing.

53. A valve for subterranean use, comprising:

a housing having a passage therethrough and a port in a wall thereof;

a sleeve having a flow path therethrough movably mounted in said passage of said housing between:

a first position where said port is closed because said sleeve is sealingly engaged with said housing on two sides of said port; and

a second position where said port is at least in part open and said sleeve is sealingly engaged with said housing on only one side of said port; and

a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure with a rupture disc until a predetermined pressure is reached.

54. The valve of claim 53, wherein the piston is integral to the sleeve.

55. The valve of claim 53, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

the first chamber is selectively isolated from passage pressure with the rupture disc until the predetermined pressure is reached.

56. The valve of claim 55, wherein the volume of the second chamber decreases when the sleeve moves from the first position to the second position.

57. The valve of claim 53, comprising one or more shearable members configured to be sheared when the sleeve moves from the first position to the second position.

58. The valve of claim 53, comprising a retainer configured to prevent the sleeve from moving from the second position to the first position after the sleeve moves to the second position.

59. The valve of claim 58, wherein the sleeve defines a recess configured to receive the retainer when the sleeve is in the second position.

60. The valve of claim 53, wherein the sleeve is the only sleeve movably mounted in the passage of the housing.

61. A valve for subterranean use, comprising:

a housing having a passage therethrough and a port in a wall thereof;

a sleeve having a flow path therethrough movably mounted in said passage of said housing between:

a first position where said port is closed because said port is covered by said sleeve; and

a second position where said sleeve is farther from an end of said valve than is said port such that said port is at least in part open;

a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure until a predetermined pressure is reached; and

a retainer configured to prevent the sleeve from moving from the second position to the first position after the sleeve moves to the first position.

62. The valve of claim 61, wherein the piston is integral to the sleeve.

63. The valve of claim 61, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

the first chamber is selectively isolated from passage pressure until the predetermined pressure is reached.

64. The valve of claim 63, wherein the volume of the second chamber decreases when the sleeve moves from the first position to the second position.

65. The valve of claim 61, comprising one or more shearable members configured to be sheared when the sleeve moves from the first position to the second position.

66. The valve of claim 61, wherein the sleeve defines a recess configured to receive the retainer when the sleeve is in the second position.

67. The valve of claim 61, wherein the sleeve is the only sleeve movably mounted in the passage of the housing.

68. A valve for subterranean use, comprising:

a housing having a passage therethrough and a port in a wall thereof;

a single sleeve having a flow path therethrough movably mounted in said passage of said housing between:

a first position where said port is closed because said port is covered by said sleeve; and

a second position where said sleeve is farther from an end of said valve than is said port such that said port is at least in part open; and

a piston associated with said sleeve for moving said sleeve, said piston selectively isolated from passage pressure until a predetermined pressure is reached.

69. The valve of claim 68, wherein the piston is integral to the sleeve.

70. The valve of claim 68, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

the first chamber is selectively isolated from passage pressure until the predetermined pressure is reached.

71. The valve of claim 70, wherein the volume of the second chamber decreases when the sleeve moves from the first position to the second position.

72. The valve of claim 68, comprising one or more shearable members configured to be sheared when the sleeve moves from the first position to the second position.

73. The valve of claim 68, comprising a retainer configured to prevent the sleeve from moving from the second position to the first position after the sleeve moves to the second position.

74. The valve of claim 73, wherein the sleeve defines a recess configured to receive the retainer when the sleeve is in the second position.

75. A method of temporarily isolating the inside of a valve from an open-hole well comprising:

running a valve connected to casing into an open-hole well, the valve including:

a housing having a passage therethrough and a port in a wall of the housing;

a piston selectively isolated from passage pressure until a predetermined pressure is reached; and

a single sleeve positioned within the passage and movable upon exposure of the piston to the predetermined passage pressure from an initial closed position where the sleeve covers the port to an open position where the sleeve is farther from an end of the valve than is the port such that the sleeve uncovers at least a portion of the port;

exposing the sleeve and the piston to the predetermined passage pressure; and

moving the sleeve from the initial closed position to the open position.

76. The method of claim 75, wherein the piston is integral to the sleeve.

77. The method of claim 75, wherein exposing the sleeve and the piston to the predetermined passage pressure comprises bursting a rupture disc such that the piston is exposed to passage pressure.

78. The method of claim 77, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

bursting the rupture disc exposes the first side of the piston to passage pressure.

79. The method of claim 78, wherein moving the sleeve from the initial closed position to the open position includes moving the piston such that the volume of the second chamber decreases.

80. The method of claim 75, wherein moving the sleeve from the initial closed position to the open position comprises shearing one or more shearable members.

81. The method of claim 75, wherein:

the valve comprises a retainer; and

the retainer prevents the sleeve from moving from the open position to the initial closed position after the sleeve moves to the open position.

82. The method of claim 81, wherein:

the sleeve defines a recess; and

the recess receives the retainer when the sleeve is in the open position.

83. The method of claim 78, wherein, when the sleeve is in the initial closed position, a thickness of a portion of the sleeve that overlies the second chamber is greater than a thickness of a portion of the sleeve that overlies the first chamber.

84. The method of claim 77, wherein the rupture disc is coupled to the sleeve such that the rupture disc moves with the sleeve between the initial closed and open positions.

85. The valve of claim 78, wherein, when the sleeve is in the initial closed position, the rupture disc is positioned closer to the first chamber than to the second chamber.

86. The method of claim 75, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

87. The method of claim 86, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

88. The method of claim 75, comprising cementing the valve into the well.

89. The method of claim 88, wherein, during cementing, cement passes through the passage of the housing.

90. The method of claim 88, comprising scraping the valve with a wiper dart.

91. The method of claim 88, comprising, after cementing and moving the sleeve to the open position, pumping fluid through the passage, through the port, and into an annulus without perforating.

92. The method of claim 91, wherein, during pumping, a tool flows with the fluid.

93. The method of claim 75, wherein passage pressure urges the sleeve toward the initial closed position before the predetermined passage pressure is reached.

94. The method of claim 93, wherein the valve comprises:

first and second seals that each is disposed:

at a respective one of opposing first and second ends of the sleeve; and

between the wall of the housing and the sleeve;

wherein the diameter of the first seal is larger than the diameter of the second seal such that a piston area defined by the first end of the sleeve is larger than a piston area defined by the second end of the sleeve.

95. The valve of claim 47, wherein, when the sleeve is in the first position, a thickness of a portion of the sleeve that overlies the second chamber is greater than a thickness of a portion of the sleeve that overlies the first chamber.

96. The valve of claim 45, wherein the rupture disc is coupled to the sleeve such that the rupture disc moves with the sleeve between the first and second positions.

97. The valve of claim 47, wherein, when the sleeve is in the first position, the rupture disc is positioned closer to the first chamber than to the second chamber.

98. The valve of claim 45, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

99. The valve of claim 98, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

100. The valve of claim 45, wherein the valve is cemented into a well.

101. The valve of claim 45, comprising:

one or more shearable members configured to be sheared when the sleeve moves from the first position to the second position; and

a retainer configured to prevent the sleeve from moving from the second position to the first position after the sleeve moves to the second position.

102. The valve of claim 101, wherein the rupture disc is coupled to the sleeve such that the rupture disc moves with the sleeve between the first and second positions.

103. The valve of claim 102, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

104. The valve of claim 103, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

105. The valve of claim 104, wherein the piston is integral to the sleeve.

106. The valve of claim 105, wherein the sleeve is the only sleeve movably mounted in the passage of the housing.

107. The valve of claim 106, wherein the valve is connected to casing and is cemented into a well.

108. The valve of claim 107, wherein:

the piston has a first side that is exposed to a first chamber and a second side opposite the first side that is exposed to a second chamber; and

the first chamber is selectively isolated from passage pressure with the rupture disc until the predetermined pressure is reached.

109. The valve of claim 108, wherein the volume of the second chamber decreases when the sleeve moves from the first position to the second position.

110. The valve of claim 109, wherein, when the sleeve is in the first position, the rupture disc is positioned closer to the first chamber than to the second chamber.

111. The valve of claim 45, wherein the valve is configured such that passage pressure urges the sleeve toward the first position before the predetermined pressure is reached.

112. The valve of claim 111, comprising:

first and second seals that each is disposed:

at a respective one of opposing first and second ends of the sleeve; and

between the wall of the housing and the sleeve;

wherein the diameter of the first seal is larger than the diameter of the second seal such that a piston area defined by the first end of the sleeve is larger than a piston area defined by the second end of the sleeve.

113. The valve of claim 55, wherein, when the sleeve is in the first position, a thickness of a portion of the sleeve that overlies the second chamber is greater than a thickness of a portion of the sleeve that overlies the first chamber.

114. The valve of claim 53, wherein the rupture disc is coupled to the sleeve such that the rupture disc moves with the sleeve between the first and second positions.

115. The valve of claim 58, wherein, when the sleeve is in the first position, the rupture disc is positioned closer to the first chamber than to the second chamber.

116. The valve of claim 53, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

117. The valve of claim 116, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

118. The valve of claim 53, wherein the valve is cemented into a well.

119. The valve of claim 53, wherein the valve is configured such that passage pressure urges the sleeve toward the first position before the predetermined pressure is reached.

120. The valve of claim 119, comprising:

first and second seals that each is disposed:

at a respective one of opposing first and second ends of the sleeve; and

between the wall of the housing and the sleeve;

wherein the diameter of the first seal is lamer than the diameter of the second seal such that a piston area defined by the first end of the sleeve is larger than a piston area defined by the second end of the sleeve.

121. The valve of claim 63, wherein, when the sleeve is in the first position, a thickness of a portion of the sleeve that overlies the second chamber is greater than a thickness of a portion of the sleeve that overlies the first chamber.

122. The valve of claim 61, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

the pressure-responsive barrier is coupled to the sleeve such that the pressure-responsive barrier moves with the sleeve between the first and second positions.

123. The valve of claim 63, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

when the sleeve is in the first position, the pressure-responsive barrier is positioned closer to the first chamber than to the second chamber.

124. The valve of claim 61, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

125. The valve of claim 124, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

126. The valve of claim 61, wherein the valve is cemented into a well.

127. The valve of claim 61, wherein the valve is configured such that passage pressure urges the sleeve toward the first position before the predetermined pressure is reached.

128. The valve of claim 127, comprising:

first and second seals that each is disposed:

at a respective one of opposing first and second ends of the sleeve; and

between the wall of the housing and the sleeve;

wherein the diameter of the first seal is larger than the diameter of the second seal such that a piston area defined by the first end of the sleeve is larger than a piston area defined by the second end of the sleeve.

129. The valve of claim 70, wherein, when the sleeve is in the first position, a thickness of a portion of the sleeve that overlies the second chamber is greater than a thickness of a portion of the sleeve that overlies the first chamber.

130. The valve of claim 68, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

the pressure-responsive barrier is coupled to the sleeve such that the pressure-responsive barrier moves with the sleeve between the first and second positions.

131. The valve of claim 70, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

when the sleeve is in the first position, the pressure-responsive barrier is positioned closer to the first chamber than to the second chamber.

132. The valve of claim 68, wherein:

the port extends between first and second ends; and

a line that is parallel to a longitudinal axis of the housing extends through the first and second ends of the port.

133. The valve of claim 132, wherein the port has a perimeter that includes:

a first arcuate portion that includes the first end of the port;

a second arcuate portion that includes the second end of the port; and

two side portions, each extending between the first and second arcuate portions.

134. The valve of claim 68, wherein the valve is cemented into a well.

135. The valve of claim 68, wherein the valve is configured such that passage pressure urges the sleeve toward the first position before the predetermined pressure is reached.

136. The valve of claim 135, comprising:

first and second seals that each is disposed:

at a respective one of opposing first and second ends of the sleeve; and

between the wall of the housing and the sleeve;

wherein the diameter of the first seal is larger than the diameter of the second seal such that a piston area defined by the first end of the sleeve is larger than a piston area defined by the second end of the sleeve.

137. The valve of claim 46, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

138. The valve of claim 137, wherein the rupture disc is recessed into the boss.

139. The valve of claim 105, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

140. The valve of claim 139, wherein the rupture disc is recessed into the boss.

141. The valve of claim 54, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

142. The valve of claim 141, wherein the rupture disc is recessed into the boss.

143. The valve of claim 62, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

144. The valve of claim 143, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

the pressure-responsive barrier is recessed into the boss.

145. The valve of claim 69, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

146. The valve of claim 145, wherein:

the piston is selectively isolated from passage pressure by a pressure-responsive barrier that opens; and

the pressure-responsive barrier is recessed into the boss.

147. The method of claim 76, wherein:

the piston includes a boss into which a seal is recessed; and

the seal is engaged with the housing.

148. The method of claim 147, wherein:

exposing the sleeve and the piston to the predetermined passage pressure comprises bursting a rupture disc such that the piston is exposed to passage pressure; and

the rupture disc is recessed into the boss.

* * * * *