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CLAIM AMENDMENTS

What is claimed is:

1. (Currently Amended) A method of determining whether a wellbore sealing operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore, said tubing having at least one pressure sensor positioned in a wall of the tubing and exposed to an annular region defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located;

performing a wellbore sealing operation in ~~an~~ the annular region ~~defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located, to seal~~ and thereby sealing said tubing in the wellbore;

monitoring ~~the~~ a pressure of a fluid in the annular region during the wellbore sealing operation using the at least one pressure sensor and thereby obtaining pressure data; and

recovering the pressure data ~~concerning the pressure of the fluid monitored by the sensor~~ to surface and determining whether the wellbore sealing operation was performed correctly based on an observed pressure drop in the annular space over a period of time~~, the pressure data indicating whether the wellbore sealing operation has been performed correctly~~.

2. (Currently Amended) A method as claimed in claim 1, ~~in which the method is a method of determining whether a wellbore cementation operation has been performed correctly, the step of~~ wherein the fluid is a cement slurry and performing the ~~downhole~~ wellbore sealing operation ~~comprising~~ comprises:

supplying [[a]] the cement slurry into the annular region to seal said tubing in the wellbore; and

~~the step of recovering data concerning the pressure of the fluid comprising~~ recovering data concerning the pressure of the cement slurry to surface~~, the~~

~~pressure data indicating the extent to which the cement slurry has travelled along the annular region towards the surface, so that a determination can be made as to whether the cementation operation has been performed correctly~~.

3. (Currently Amended) A method as claimed in claim 1, ~~in which the method is a method of determining whether a packer has been correctly set in the annular region, the step of~~ wherein performing the downhole sealing operation ~~comprising~~ comprises:

setting ~~the~~ a packer in the annular region by exerting a force on a sealing element of the packer to urge it into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore; ~~and~~

~~the step of recovering data concerning the pressure of the fluid comprising~~ recovering data concerning the pressure of [[a]] the fluid in the annular region downhole of the ~~packer~~ sealing element ~~to determine~~, wherein the observed pressure drop in the annular region downhole of the sealing element over the period of time is indicative of whether a leak path past the packer exists.

4. (Currently Amended) A method as claimed in claim 1, ~~in which the method is a method of determining whether a packer has been correctly set in the annular region, the step of~~ wherein performing the downhole sealing operation ~~comprising~~ comprises:

exposing a swellable sealing element of ~~the~~ a packer to a fluid in the wellbore such that the sealing element swells and expands into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore; ~~and~~

~~the step of recovering data concerning the pressure of the fluid comprising~~ recovering data concerning the pressure of [[a]] the fluid in the annular region downhole of the ~~packer~~ sealing element ~~to determine~~, wherein the observed pressure drop in the annular region downhole of the sealing element over the period of time is indicative of whether a leak path past the packer exists.

5. (Canceled) ~~A method as claimed in either of claims 3 or 4, comprising supplying a cement slurry into the annular region to perform a primary sealing of the liner in the wellbore, positioning the packer uphole of the cement so that a space is defined between an uphole surface of the cement and the sealing element of the packer, and monitoring the pressure of the fluid in the space.~~

6. (Currently Amended) A method as claimed in claim 2, ~~in which the step of monitoring the pressure of the cement slurry comprises~~ further comprising monitoring ~~the~~ a hydrostatic pressure of the cement slurry following completion of ~~the~~ a supply of the cement slurry from the wellbore-lining tubing into the annular region.

7. (Currently Amended) A method as claimed in ~~either of claims 2 or~~ claim 6, comprising monitoring the pressure of the cement slurry during pumping of the cement slurry from the wellbore-lining tubing into the annular region, wherein an observed pressure drop in the annular region is ~~a reduction in that monitored pressure being~~ indicative of an undesired loss of cement slurry.

8. (Currently Amended) A method as claimed in ~~any preceding~~ claim 1, further comprising coupling a primary transmitter to the at least one sensor and transmitting the pressure data to surface acoustically utilising the primary transmitter, and positioning at least one repeater uphole of the primary transmitter and arranging the repeater to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the pressure data to surface.

9. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, comprising coupling a primary transmitter to the at least one sensor and transmitting the pressure data to surface electrically utilising the primary transmitter, and locating at least one inductively coupled connector uphole of the primary transmitter which provides an electrical pathway to transmit the pressure data to surface.

10. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, comprising coupling a transmitter to the at least one sensor, and transmitting the pressure data to surface using a wire coupled to the transmitter and incorporated into said tubing.

11. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, comprising running a tool on a separate string of tubing or on a wireline into the wellbore and arranging the tool to cooperate with an interface coupled to the at least one sensor, for downloading the pressure data.

12. (Currently Amended) A method as claimed in claim 11, comprising transmitting the pressure data through the wellbore-lining tubing to the interface, which is located at a position uphole of the at least one sensor, and transferring the pressure data to the tool via the interface.

13. (Currently Amended) A method as claimed in ~~either of claims 11 or~~ claim 12, in which the tool contacts the interface to download the pressure data or the pressure data is transmitted from the interface to the tool inductively.

14. (Canceled) ~~A method as claimed in either of claims 11 or 12, in which the data is transmitted from the interface to the tool inductively.~~

15. (Currently Amended) A method as claimed in claim 13 ~~any one of claims 11 to 14~~, in which the pressure data is stored in a memory in the tool, and the tool is recovered to surface for data download.

16. (Currently Amended) A method as claimed in claim 13 ~~any one of claims 11 to 14~~, in which the data is transmitted to surface through the separate string of tubing ~~string~~ or wireline, or via a fluid pressure pulse generating device coupled to the tool.

17. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, comprising storing the pressure data in a memory device coupled to the at least one sensor, and subsequently recovering the memory device to surface and downloading the pressure data.

18. (Original) A method as claimed in claim 17, comprising providing the memory device in a housing which is releasably coupled to the wellbore-lining tubing, and then releasing the housing from the tubing and recovering the housing to surface.

19. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, wherein the fluid is a cement slurry, the method further comprising:

sealing said tubing by supplying [[a]] the cement slurry into the annular region~~,~~;

positioning a fluid pressure pulse generating device in the wellbore uphole of the cement slurry~~,~~; and

activating the fluid pressure pulse generating device to generate signals for transmitting the pressure data to surface following passage of the cement slurry along said tubing and into the annular region.

20. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 7~~, comprising:

coupling a running string to said tubing and using the running string to deploy the tubing into the wellbore;

locating a fluid pressure pulse generating device in the running string for generating signals to transmit the pressure data to surface;

supplying cement through the ~~workstring~~ running string and said tubing into the annular region to seal the tubing, the fluid pressure pulse generating device being deactivated during supply of the cement through the running string; and

following completion of cementing, activating the fluid pressure pulse generating device to transmit the pressure data to surface.

21. (Currently Amended) A method as claimed in ~~any preceding~~ claim 1, comprising positioning the at least one sensor downhole of a float collar of a casing shoe of the wellbore-lining tubing and having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, so that the at least one sensor communicates with the annular region through an open end of the casing shoe to measure the pressure of the fluid in the annular region.

22. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 20~~, comprising positioning the at least one sensor uphole of a float collar of a casing shoe of the wellbore-lining tubing and having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, and arranging the at least one sensor to communicate with the annular region through [[a]] the wall of the tubing so that the at least one sensor can measure the pressure of the fluid in the annular region.

23. (Currently Amended) A method as claimed in ~~any preceding~~ claim 1, comprising locating the at least one pressure sensor on or in an internal surface of the tubing and exposing the at least one sensor to the pressure of fluid in the annular region.

24. (Currently Amended) A method as claimed in claim 1 ~~any one of claims 1 to 22~~, comprising locating the at least one pressure sensor on or in an external surface of the tubing, and inductively coupling the at least one pressure sensor to a receiver located internally of said tubing, for relaying pressure data across [[a]] the wall of the tubing.

25. (Currently Amended) A method as claimed in claim 24, comprising deploying a tool carrying the receiver into the wellbore on a separate tubing string or wireline, and storing the pressure data in a memory of the tool for recovery to surface, or transmitting the pressure data to surface.

26. (Currently Amended) A method as claimed in ~~either of claims~~ claim 2 ~~or 5~~, comprising monitoring the cement slurry ~~using a~~ with the at least one pressure sensor which is arranged so that a column of the cement slurry in the annular region acts directly on ~~it~~ the at least one pressure sensor in an axial relationship, so that when the cement slurry sets it will no longer apply pressure to the at least one pressure sensor, giving an indication at surface that the cement slurry has set.

27. (Canceled) ~~A method as claimed in any preceding claim, comprising positioning a plurality of sensors spaced apart along a length of said wellbore lining tubing, so that data can be recovered from the wellbore at a plurality of points spaced apart along the length of the wellbore.~~

28. (Canceled) ~~A method as claimed in any preceding claim, comprising monitoring at least one further parameter of the fluid in the annular region using at least one corresponding sensor, the parameter selected from the group comprising:~~

~~the temperature of the fluid; the density of the fluid; and the resistivity of the fluid; and~~

~~correlating said further parameter with the measured pressure data.~~

29. (Currently Amended) A wellbore-lining tubing comprising:

at least one pressure sensor positioned in a wall of the tubing and exposed to an annular region defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located,

wherein the at least one pressure sensor monitors ~~for monitoring the~~ a pressure of a fluid in ~~an~~ the annular region during a wellbore sealing operation to obtain pressure data, and ~~defined between an external surface of the tubing and an internal surface of a wall of a wellbore, or between an external surface of said tubing and an internal surface of another wellbore lining tubing in which said tubing is located, the at least one pressure sensor located on or in said tubing and communicating with the annular region for monitoring the pressure;~~

wherein the pressure data ~~concerning the pressure of the fluid monitored by the at least one pressure sensor can be~~ is recovered to surface~~, the pressure data indicating~~ and an observed pressure drop in the pressure data over a period of time is indicative of whether [[a]] the wellbore sealing operation was ~~has been~~ performed correctly.

30. (Original) A tubing as claimed in claim 29, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface acoustically, and at least one repeater positioned, in use, uphole of the primary transmitter and arranged to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the data to surface.

31. (Original) A tubing as claimed in claim 29, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface electrically, and at least one inductively coupled connector located, in use, uphole of the primary transmitter and which provides an electrical pathway to transmit the data to surface.

32. (Original) A tubing as claimed in claim 29, comprising a transmitter coupled to the at least one sensor and a wire coupled to the transmitter and incorporated into said tubing, for transmitting the data to surface.

33. (Currently Amended) A tubing as claimed in claim 29, comprising an interface coupled to the at least one pressure sensor, the interface ~~adapted to cooperate~~ communicating with a tool on a separate string of tubing or wireline run into the wellbore, for downloading the data.

34. (Currently Amended) A tubing as claimed in claim 33, comprising a transmitter ~~for transmitting~~ that transmits the data through the wellbore-lining tubing to the interface, ~~which is located at a position that is, in use,~~ wherein the interface is located uphole of the at least one pressure sensor, so that the data can be transferred to the tool via the interface.

35. (Original) A tubing as claimed in either of claims 33 or 34, in which the interface ~~is adapted for contact with~~ directly contacts the tool to download the data.

36. (Currently Amended) A tubing as claimed in either of claims 33 or 34, in which the interface ~~is adapted to transmit~~ transmits the data to the tool inductively.

37. (Currently Amended) A tubing as claimed in claim 29, comprising a memory device coupled to the at least one pressure sensor for storing the data, the memory device being recoverable to surface for download of the data.

38. (Currently Amended) A tubing as claimed in claim 37, in which the memory device is provided in a housing ~~which is~~ releasably coupled to the wellbore-lining tubing~~, so that the housing can be released from the tubing and recovered to surface~~.

39. (Currently Amended) A tubing as claimed in claim 29, comprising a fluid pressure pulse generating device which is positioned, in use, uphole of cement slurry supplied into the annular region to seal said tubing in the wellbore, the fluid pressure pulse generating device serving for generating signals to transmit the data to surface following passage of the cement slurry along said tubing and into the annular region.

40. (Currently Amended) A tubing as claimed in claim 29, comprising:

a running string coupled to said tubing, for deploying the tubing into the wellbore;

a fluid pressure pulse generating device located in the running string, for generating signals to transmit the data to surface;

in which the fluid pressure pulse generating device is ~~adapted to be~~ activated following supply of a cement slurry through the ~~workstring~~ running string and said tubing into the annular region to seal the tubing, to transmit the data to surface.

41. (Currently Amended) A tubing as claimed in claim 29 ~~any one of claims 29 to 40~~, in which the tubing is a casing comprising a casing shoe having a float collar with a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one pressure sensor is positioned, in use, downhole of the float collar so that the at least one pressure sensor can communicate with the annular region through an open end of the casing shoe, to measure the pressure of the fluid in the annular region.

42. (Currently Amended) A tubing as claimed in claim 29 ~~any one of claims 29 to 40~~, in which the tubing is a casing comprising a casing shoe having a float collar with a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one pressure sensor is positioned, in use, uphole of the float collar and arranged to communicate with the annular region through a wall of the tubing so that the at least one pressure sensor can measure the pressure of the fluid in the annular region.

43. (Currently Amended) A tubing as claimed in claim 29 ~~any one of claims 29 to 42~~, in which the at least one pressure sensor is located on or in an internal surface of the tubing and ~~adapted to be~~ exposed to the pressure of fluid in the annular region.

44. (Currently Amended) A tubing as claimed in claim 29 ~~any one of claims 29 to 42~~, in which the at least one pressure sensor is located on or in an external surface of the tubing, and ~~adapted to be~~ inductively coupled to a receiver located internally of said tubing~~, for~~ when relaying data across a wall of the tubing.

45. (Currently Amended) A tubing as claimed in claim 29 ~~any one of claims 29 to 42~~, in which the at least one pressure sensor ~~is adapted to monitor~~ monitors the pressure of a cement slurry supplied into the annular region, and in which said at least one pressure sensor is arranged so that a column of the cement slurry in the annular region acts directly on ~~it~~ the at least one pressure sensor in an axial relationship, so that when the cement slurry sets it will no longer apply pressure to

the at least one pressure sensor, giving an indication at surface that the cement slurry has set.

46. (Canceled) ~~A tubing as claimed in any one of claims 29 to 45, comprising a plurality of sensors spaced apart along a length of said wellbore-lining tubing, so that data can be recovered from the wellbore at a plurality of points spaced apart along the length of the wellbore.~~

47. (Canceled) ~~A tubing as claimed in any one of claims 29 to 46, comprising at least one further sensor for monitoring at least one further parameter of the fluid in the annular region, the parameter selected from the group comprising: the temperature of the fluid; the density of the fluid; and the resistivity of the fluid.~~

48. (Currently Amended) A method of determining whether a wellbore cementation operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore;

supplying a cement slurry into an annular region defined between an external surface of the tubing and an internal surface of a wall of the wellbore, to seal the tubing in the wellbore;

locating at least one marker in a stream of the cement slurry supplied into the annular region;

monitoring for the presence of the marker in the annular region utilising a sensor positioned in a wall of the tubing and exposed to the annular region; and

recovering data concerning the presence of the marker monitored by the sensor to surface, the presence of the marker indicating that the cement slurry has travelled along the annular region towards the surface to at least as far as a detectable range of the sensor, so that a determination can be made as to whether the cementation operation has been performed correctly.

49. (Original) A method as claimed in claim 48, in which the at least one marker is an active marker which emits a signal that can be detected by the sensor.

50. (Original) A method as claimed in claim 49, in which the at least one marker emits a radio-frequency signal which can be detected by the sensor.

51. (Original) A method as claimed in claim 48, in which the at least one marker is radioactive and emits radiation which can be detected by the sensor.

52. (Original) A method as claimed in claim 48, in which the at least one marker is a passive marker, and in which the method comprises interrogating the cement slurry to detect for the presence of the marker.

53. (Original) A method as claimed in claim 48, in which the at least one marker is selectively activatable, the marker being arranged so that it only emits a signal in the presence of the sensor.

54. (Original) A method as claimed in claim 53, in which the marker is arranged to emit a signal on detecting a radio-frequency field emitted by the sensor, which signal is subsequently detected by the sensor.

55. (Currently Amended) A method as claimed in claim 48 ~~any one of claims 48 to 54~~, comprising positioning a plurality of the sensors in the wellbore, which are spaced apart along a length of the wellbore-lining tubing, to facilitate recovery of data at points spaced apart along the length of the wellbore so that sequential indications of the presence of the markers, and thus cement, can be obtained as the cement travels uphole along the annular region.

56. (Currently Amended) A method as claimed in ~~any one of claims 48 to~~ claim 55, comprising positioning at least one of the plurality of the sensors ~~sensor~~ adjacent an uphole end of the wellbore-lining tubing, detection of a marker by said

sensor providing an indication that the cement slurry has passed up the annular region along at least a majority of a length of the wellbore-lining tubing.

57. (Currently Amended) A method as claimed in claim 48 ~~any one of claims 48 to 56~~, comprising:

locating a first wellbore-lining tubing of a first diameter in the wellbore and cementing the first tubing in place; and

locating a second wellbore-lining tubing of a second diameter which is smaller than the first diameter in said first tubing, and cementing the second tubing in place;

in which the second tubing carries a sensor adjacent an interface between the first and second tubings, detection of a marker by said sensor providing an indication that the cement slurry has passed up the annular region between the external surface of the second tubing and the internal wall of the wellbore to at least a level of the intersection between the first and second tubings.

CLAIMS

1. A method of determining whether a wellbore sealing operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore, said tubing having at least one pressure sensor;

performing a wellbore sealing operation in an annular region defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located, to seal said tubing in the wellbore;

monitoring the pressure of fluid in the annular region using the at least one pressure sensor; and

recovering data concerning the pressure of the fluid monitored by the sensor to surface, the pressure data indicating whether the wellbore sealing operation has been performed correctly.

2. A method as claimed in claim 1, in which the method is a method of determining whether a wellbore cementation operation has been performed correctly, the step of performing the downhole sealing operation comprising supplying a cement slurry into the annular region to seal said tubing in the wellbore; and the step of recovering data concerning the pressure of the fluid comprising recovering data concerning the pressure of the cement slurry to surface, the pressure data indicating the extent to which the cement slurry has travelled along the annular region towards the surface, so that a determination can be made as to whether the cementation operation has been performed correctly.

3. A method as claimed in claim 1, in which the method is a method of determining whether a packer has been correctly set in the annular region, the step of performing the downhole sealing operation comprising setting the packer by exerting a force on a sealing element of the packer to urge it into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore; and the step of recovering data concerning the pressure of the fluid comprising recovering data concerning the pressure of

a fluid in the annular region downhole of the packer sealing element to determine whether a leak path past the packer exists.

4. A method as claimed in claim 1, in which the method is a method of determining whether a packer has been correctly set in the annular region, the step of performing the downhole sealing operation comprising exposing a swellable sealing element of the packer to a fluid in the wellbore such that the sealing element swells and expands into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore; and the step of recovering data concerning the pressure of the fluid comprising recovering data concerning the pressure of a fluid in the annular region downhole of the packer sealing element to determine whether a leak path past the packer exists.

5. A method as claimed in either of claims 3 or 4, comprising supplying a cement slurry into the annular region to perform a primary sealing of the liner in the wellbore, positioning the packer uphole of the cement so that a space is defined between an uphole surface of the cement and the sealing element of the packer, and monitoring the pressure of the fluid in the space.

6. A method as claimed in claim 2, in which the step of monitoring the pressure of the cement slurry comprises monitoring the hydrostatic pressure of the slurry following completion of the supply of the cement slurry from the wellbore-lining tubing into the annular region.

7. A method as claimed in either of claims 2 or 6, comprising monitoring the pressure of the cement slurry during pumping of the slurry from the wellbore-lining tubing into the annular region, a reduction in that monitored pressure being indicative of an undesired loss of cement slurry.

8. A method as claimed in any preceding claim, comprising coupling a primary transmitter to the at least one sensor and transmitting the data to surface acoustically utilising the primary transmitter, and positioning at least one repeater uphole of the primary

transmitter and arranging the repeater to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the data to surface.

9. A method as claimed in any one of claims 1 to 7, comprising coupling a primary transmitter to the at least one sensor and transmitting the data to surface electrically utilising the primary transmitter, and locating at least one inductively coupled connector uphole of the primary transmitter which provides an electrical pathway to transmit the data to surface.

10. A method as claimed in any one of claims 1 to 7, comprising coupling a transmitter to the at least one sensor, and transmitting the data to surface using a wire coupled to the transmitter and incorporated into said tubing.

11. A method as claimed in any one of claims 1 to 7, comprising running a tool on a separate string of tubing or on a wireline into the wellbore and arranging the tool to cooperate with an interface coupled to the at least one sensor, for downloading the data.

12. A method as claimed in claim 11, comprising transmitting the data through the wellbore-lining tubing to the interface, which is located at a position uphole of the sensor, and transferring the data to the tool via the interface.

13. A method as claimed in either of claims 11 or 12, in which the tool contacts the interface to download the data.

14. A method as claimed in either of claims 11 or 12, in which the data is transmitted from the interface to the tool inductively.

15. A method as claimed in any one of claims 11 to 14, in which the data is stored in a memory in the tool, and the tool recovered to surface for data download.

16. A method as claimed in any one of claims 11 to 14, in which the data is transmitted to surface through the separate tubing string or wireline, or via a fluid pressure pulse generating device coupled to the tool.

17. A method as claimed in any one of claims 1 to 7, comprising storing the data in a memory device coupled to the at least one sensor, and subsequently recovering the memory device to surface and downloading the data.

18. A method as claimed in claim 17, comprising providing the memory device in a housing which is releasably coupled to the wellbore-lining tubing, and then releasing the housing from the tubing and recovering the housing to surface.

19. A method as claimed in any one of claims 1 to 7, comprising sealing said tubing by supplying a cement slurry into the annular region, positioning a fluid pressure pulse generating device in the wellbore uphole of the cement, and activating the device to generate signals for transmitting the data to surface following passage of the cement along said tubing and into the annular region.

20. A method as claimed in any one of claims 1 to 7, comprising:

coupling a running string to said tubing and using the running string to deploy the tubing into the wellbore;

locating a fluid pressure pulse generating device in the running string for generating signals to transmit the data to surface;

supplying cement through the workstring and said tubing into the annular region to seal the tubing, the device being deactivated during supply of the cement through the running string; and

following completion of cementing, activating the device to transmit the data to surface.

21. A method as claimed in any preceding claim, comprising positioning the at least one sensor downhole of a float collar of a shoe of the wellbore-lining tubing having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid

return, so that the sensor communicates with the annular region through an open end of the casing shoe to measure the pressure of the fluid in the annular region.

22. A method as claimed in any one of claims 1 to 20, comprising positioning the at least one sensor uphole of a float collar of a shoe of the wellbore-lining tubing having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, and arranging the at least one sensor to communicate with the annular region through a wall of the tubing so that the sensor can measure the pressure of the fluid in the annular region.

23. A method as claimed in any preceding claim, comprising locating at least one pressure sensor on or in an internal surface of the tubing and exposing the at least one sensor to the pressure of fluid in the annular region.

24. A method as claimed in claim any one of claims 1 to 22, comprising locating at least one pressure sensor on or in an external surface of the tubing, and inductively coupling the sensor to a receiver located internally of said tubing, for relaying data across a wall of the tubing.

25. A method as claimed in claim 24, comprising deploying a tool carrying the receiver into the wellbore on a separate tubing string or wireline, and storing the data in a memory of the tool for recovery to surface, or transmitting the data to surface.

26. A method as claimed in either of claims 2 or 5, comprising monitoring the cement using a pressure sensor which is arranged so that a column of cement slurry in the annular region acts directly on it in an axial relationship, so that when the cement sets it will no longer apply pressure to the sensor, giving an indication at surface that the cement has set.

27. A method as claimed in any preceding claim, comprising positioning a plurality of sensors spaced apart along a length of said wellbore-lining tubing, so that data can be recovered from the wellbore at a plurality of points spaced apart along the length of the wellbore.

28. A method as claimed in any preceding claim, comprising monitoring at least one further parameter of the fluid in the annular region using at least one corresponding sensor, the parameter selected from the group comprising:

the temperature of the fluid; the density of the fluid; and the resistivity of the fluid; and

correlating said further parameter with the measured pressure data.

29. A wellbore-lining tubing comprising:

at least one pressure sensor for monitoring the pressure of a fluid in an annular region defined between an external surface of the tubing and an internal surface of a wall of a wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located, the at least one pressure sensor located on or in said tubing and communicating with the annular region for monitoring the pressure;

wherein data concerning the pressure of the fluid monitored by the at least one pressure sensor can be recovered to surface, the pressure data indicating whether a wellbore sealing operation has been performed correctly.

30. A tubing as claimed in claim 29, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface acoustically, and at least one repeater positioned, in use, uphole of the primary transmitter and arranged to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the data to surface.

31. A tubing as claimed in claim 29, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface electrically, and at least one inductively coupled connector located, in use, uphole of the primary transmitter and which provides an electrical pathway to transmit the data to surface.

32. A tubing as claimed in claim 29, comprising a transmitter coupled to the at least one sensor and a wire coupled to the transmitter and incorporated into said tubing, for transmitting the data to surface.

33. A tubing as claimed in claim 29, comprising an interface coupled to the at least one sensor, the interface adapted to cooperate with a tool on a separate string of tubing or wireline run into the wellbore, for downloading the data.

34. A tubing as claimed in claim 33, comprising a transmitter for transmitting the data through the wellbore-lining tubing to the interface, which is located at a position that is, in use, uphole of the sensor, so that the data can be transferred to the tool via the interface.

35. A tubing as claimed in either of claims 33 or 34, in which the interface is adapted for contact with the tool to download the data.

36. A tubing as claimed in either of claims 33 or 34, in which the interface is adapted to transmit the data to the tool inductively.

37. A tubing as claimed in claim 29, comprising a memory device coupled to the at least one sensor for storing the data, the memory device being recoverable to surface for download of the data.

38. A tubing as claimed in claim 37, in which the memory device is provided in a housing which is releasably coupled to the wellbore-lining tubing, so that the housing can be released from the tubing and recovered to surface.

39. A tubing as claimed in claim 29, comprising a fluid pressure pulse generating device which is positioned, in use, uphole of cement slurry supplied into the annular region to seal said tubing in the wellbore, the device serving for generating signals to transmit the data to surface following passage of the cement along said tubing and into the annular region.

40. A tubing as claimed in claim 29, comprising:

a running string coupled to said tubing, for deploying the tubing into the wellbore;

a fluid pressure pulse generating device located in the running string, for generating signals to transmit the data to surface;

in which the device is adapted to be activated following supply of cement through the workstring and said tubing into the annular region to seal the tubing, to transmit the data to surface.

41. A tubing as claimed in any one of claims 29 to 40, in which the tubing is a casing comprising a shoe having a float collar with a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one sensor is positioned, in use, downhole of the float collar so that the sensor can communicate with the annular region through an open end of the casing shoe, to measure the pressure of the fluid in the annular region.

42. A tubing as claimed in any one of claims 29 to 40, in which the tubing is a casing comprising a shoe having a float collar with a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one sensor is positioned, in use, uphole of the float collar and arranged to communicate with the annular region through a wall of the tubing so that the sensor can measure the pressure of the fluid in the annular region.

43. A tubing as claimed in any one of claims 29 to 42, in which the at least one pressure sensor is located on or in an internal surface of the tubing and adapted to be exposed to the pressure of fluid in the annular region.

44. A tubing as claimed in any one of claims 29 to 42, in which the at least one pressure sensor is located on or in an external surface of the tubing, and adapted to be inductively coupled to a receiver located internally of said tubing, for relaying data across a wall of the tubing.

45. A tubing as claimed in any one claims 29 to 42, in which the at least one sensor is adapted to monitor the pressure of a cement slurry supplied into the annular region, and in which said sensor is arranged so that a column of cement slurry in the annular region acts directly on it in an axial relationship, so that when the cement sets it will no longer apply pressure to the sensor, giving an indication at surface that the cement has set.

46. A tubing as claimed in any one of claims 29 to 45, comprising a plurality of sensors spaced apart along a length of said wellbore-lining tubing, so that data can be recovered from the wellbore at a plurality of points spaced apart along the length of the wellbore.

47. A tubing as claimed in any one of claims 29 to 46, comprising at least one further sensor for monitoring at least one further parameter of the fluid in the annular region, the parameter selected from the group comprising: the temperature of the fluid; the density of the fluid; and the resistivity of the fluid.

48. A method of determining whether a wellbore cementation operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore;

supplying a cement slurry into an annular region defined between an external surface of the tubing and an internal surface of a wall of the wellbore, to seal the tubing in the wellbore;

locating at least one marker in a stream of the cement slurry supplied into the annular region;

monitoring for the presence of the marker in the annular region utilising a sensor in the tubing; and

recovering data concerning the presence of the marker monitored by the sensor to surface, the presence of the marker indicating that the cement slurry has travelled along the annular region towards the surface to at least as far as a detectable range of the sensor, so that a determination can be made as to whether the cementation operation has been performed correctly.

49. A method as claimed in claim 48, in which the at least one marker is an active marker which emits a signal that can be detected by the sensor.

50. A method as claimed in claim 49, in which the at least one marker emits a radio-frequency signal which can be detected by the sensor.

51. A method as claimed in claim 48, in which the at least one marker is radioactive and emits radiation which can be detected by the sensor.

52. A method as claimed in claim 48, in which the at least one marker is a passive marker, and in which the method comprises interrogating the cement slurry to detect for the presence of the marker.

53. A method as claimed in claim 48, in which the at least one marker is selectively activatable, the marker being arranged so that it only emits a signal in the presence of the sensor.

54. A method as claimed in claim 53, in which the marker is arranged to emit a signal on detecting a radio-frequency field emitted by the sensor, which signal is subsequently detected by the sensor.

55. A method as claimed in any one of claims 48 to 54, comprising positioning a plurality of sensors in the wellbore, which are spaced apart along a length of the wellbore-lining tubing, to facilitate recovery of data at points spaced apart along the length of the wellbore so that sequential indications of the presence of the markers, and thus cement, can be obtained as the cement travels uphole along the annular region.

56. A method as claimed in any one of claims 48 to 55, comprising positioning at least one sensor adjacent an uphole end of the wellbore-lining tubing, detection of a marker by said sensor providing an indication that the cement slurry has passed up the annular region along at least a majority of a length of the wellbore-lining tubing.

57. A method as claimed in any one of claims 48 to 56, comprising:

locating a first wellbore-lining tubing of a first diameter in the wellbore and cementing the first tubing in place; and

locating a second wellbore-lining tubing of a second diameter which is smaller than the first diameter in said first tubing, and cementing the second tubing in place;

in which the second tubing carries a sensor adjacent an interface between the first and second tubings, detection of a marker by said sensor providing an indication that the cement slurry has passed up the annular region between the external surface of the second tubing and the internal wall of the wellbore to at least a level of the intersection between the first and second tubings.

CLAIMS

What is claimed is:

1. A method of determining whether a wellbore sealing operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore, said tubing having at least one pressure sensor positioned in a wall of the tubing and exposed to an annular region defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said tubing and an internal surface of another wellbore-lining tubing in which said tubing is located;

performing a wellbore sealing operation in the annular region and thereby sealing said tubing in the wellbore;

monitoring a pressure of a fluid in the annular region during the wellbore sealing operation using the at least one pressure sensor and thereby obtaining pressure data; and

recovering the pressure data to surface and determining whether the wellbore sealing operation was performed correctly based on an observed pressure drop in the annular space over a period of time.

2. A method as claimed in claim 1, wherein the fluid is a cement slurry and performing the wellbore sealing operation comprises:

supplying the cement slurry into the annular region to seal said tubing in the wellbore; and

recovering data concerning the pressure of the cement slurry to surface.

3. A method as claimed in claim 1, wherein performing the downhole sealing operation comprises:

setting a packer in the annular region by exerting a force on a sealing element of the packer to urge it into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore;

recovering data concerning the pressure of the fluid in the annular region downhole of the sealing element, wherein the observed pressure drop in the

annular region downhole of the sealing element over the period of time is indicative of whether a leak path past the packer exists.

4. A method as claimed in claim 1, wherein performing the downhole sealing operation comprises:

exposing a swellable sealing element a packer to a fluid in the wellbore such that the sealing element swells and expands into sealing abutment with a casing in which said wellbore-lining tubing is located or the wall of the wellbore; ~~and~~

recovering data concerning the pressure of the fluid in the annular region downhole of the sealing element, wherein the observed pressure drop in the annular region downhole of the sealing element over the period of time is indicative of whether a leak path past the packer exists.

5. A method as claimed in claim 2, further comprising monitoring a hydrostatic pressure of the cement slurry following completion of a supply of the cement slurry from the wellbore-lining tubing into the annular region.

6. A method as claimed in claim 5, comprising monitoring the pressure of the cement slurry during pumping of the cement slurry from the wellbore-lining tubing into the annular region, wherein an observed pressure drop in the annular region is indicative of an undesired loss of cement slurry.

7. A method as claimed in claim 1, further comprising coupling a primary transmitter to the at least one sensor and transmitting the pressure data to surface acoustically utilising the primary transmitter, and positioning at least one repeater uphole of the primary transmitter and arranging the repeater to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the pressure data to surface.

8. A method as claimed in claim 1, comprising coupling a primary transmitter to the at least one sensor and transmitting the pressure data to surface

electrically utilising the primary transmitter, and locating at least one inductively coupled connector uphole of the primary transmitter which provides an electrical pathway to transmit the pressure data to surface.

9. A method as claimed in claim 1, comprising coupling a transmitter to the at least one sensor, and transmitting the pressure data to surface using a wire coupled to the transmitter and incorporated into said tubing.

10. A method as claimed in claim 1, comprising running a tool on a separate string of tubing or on a wireline into the wellbore and arranging the tool to cooperate with an interface coupled to the at least one sensor, for downloading the pressure data.

11. A method as claimed in claim 10, comprising transmitting the pressure data through the wellbore-lining tubing to the interface, which is located at a position uphole of the at least one sensor, and transferring the pressure data to the tool via the interface.

12. A method as claimed in claim 11, in which the tool contacts the interface to download the pressure data or the pressure data is transmitted from the interface to the tool inductively.

13. A method as claimed in claim 12, in which the pressure data is stored in a memory in the tool, and the tool is recovered to surface for data download.

14. A method as claimed in claim 12, in which the data is transmitted to surface through the separate string of tubing or wireline, or via a fluid pressure pulse generating device coupled to the tool.

15. A method as claimed in claim 1, comprising storing the pressure data in a memory device coupled to the at least one sensor, and subsequently recovering the memory device to surface and downloading the pressure data.

16. A method as claimed in claim 15, comprising providing the memory device in a housing which is releasably coupled to the wellbore-lining tubing, and then releasing the housing from the tubing and recovering the housing to surface.

17. A method as claimed in claim 1, wherein the fluid is a cement slurry, the method further comprising:

sealing said tubing by supplying the cement slurry into the annular region;

positioning a fluid pressure pulse generating device in the wellbore uphole of the cement slurry; and

activating the fluid pressure pulse generating device to generate signals for transmitting the pressure data to surface following passage of the cement slurry along said tubing and into the annular region.

18. A method as claimed in claim 1, comprising:

coupling a running string to said tubing and using the running string to deploy the tubing into the wellbore;

locating a fluid pressure pulse generating device in the running string for generating signals to transmit the pressure data to surface;

supplying cement through the running string and said tubing into the annular region to seal the tubing, the fluid pressure pulse generating device being deactivated during supply of the cement through the running string; and

following completion of cementing, activating the fluid pressure pulse generating device to transmit the pressure data to surface.

19. A method as claimed in claim 1, comprising positioning the at least one sensor downhole of a float collar of a casing shoe of the wellbore-lining tubing and having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, so that the at least one sensor communicates with the annular region through an open end of the casing shoe to measure the pressure of the fluid in the annular region.

20. A method as claimed in claim 1, comprising positioning the at least one sensor uphole of a float collar of a casing shoe of the wellbore-lining tubing and having a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, and arranging the at least one sensor to communicate with the annular region through the wall of the tubing so that the at least one sensor can measure the pressure of the fluid in the annular region.

21. A method as claimed in claim 1, comprising locating the at least one pressure sensor on or in an internal surface of the tubing and exposing the at least one sensor to the pressure of fluid in the annular region.

22. A method as claimed in claim 1, comprising locating the at least one pressure sensor on or in an external surface of the tubing, and inductively coupling the at least one pressure sensor to a receiver located internally of said tubing, for relaying pressure data across the wall of the tubing.

23. A method as claimed in claim 22, comprising deploying a tool carrying the receiver into the wellbore on a separate tubing string or wireline, and storing the pressure data in a memory of the tool for recovery to surface, or transmitting the pressure data to surface.

24. A method as claimed in claim 2, comprising monitoring the cement slurry with the at least one pressure sensor which is arranged so that a column of the cement slurry in the annular region acts directly on the at least one pressure sensor in an axial relationship, so that when the cement slurry sets it will no longer apply pressure to the at least one pressure sensor, giving an indication at surface that the cement slurry has set.

25. A wellbore-lining tubing comprising:

at least one pressure sensor positioned in a wall of the tubing and exposed to an annular region defined between an external surface of said tubing and an internal surface of a wall of the wellbore, or between an external surface of said

tubing and an internal surface of another wellbore-lining tubing in which said tubing is located,

wherein the at least one pressure sensor monitors a pressure of a fluid in the annular region during a wellbore sealing operation to obtain pressure data, and

wherein the pressure data is recovered to surface and an observed pressure drop in the pressure data over a period of time is indicative of whether the wellbore sealing operation was performed correctly.

26. A tubing as claimed in claim 25, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface acoustically, and at least one repeater positioned, in use, uphole of the primary transmitter and arranged to receive a signal transmitted by the primary transmitter and to repeat the signal to transmit the data to surface.

27. A tubing as claimed in claim 25, comprising a primary transmitter coupled to the at least one sensor for transmitting the data to surface electrically, and at least one inductively coupled connector located, in use, uphole of the primary transmitter and which provides an electrical pathway to transmit the data to surface.

28. A tubing as claimed in claim 25, comprising a transmitter coupled to the at least one sensor and a wire coupled to the transmitter and incorporated into said tubing, for transmitting the data to surface.

29. A tubing as claimed in claim 25, comprising an interface coupled to the at least one pressure sensor, the interface communicating with a tool on a separate string of tubing or wireline run into the wellbore, for downloading the data.

30. A tubing as claimed in claim 29, comprising a transmitter that transmits the data through the wellbore-lining tubing to the interface, wherein the interface is located uphole of the at least one pressure sensor, so that the data can be transferred to the tool via the interface.

31. A tubing as claimed in either of claims 29 or 30, in which the interface directly contacts the tool to download the data.

32. A tubing as claimed in either of claims 29 or 30, in which the interface transmits the data to the tool inductively.

33. A tubing as claimed in claim 25, comprising a memory device coupled to the at least one pressure sensor for storing the data, the memory device being recoverable to surface for download of the data.

34. A tubing as claimed in claim 33, in which the memory device is provided in a housing releasably coupled to the wellbore-lining tubing.

35. A tubing as claimed in claim 25, comprising a fluid pressure pulse generating device which is positioned, in use, uphole of cement slurry supplied into the annular region to seal said tubing in the wellbore, the fluid pressure pulse generating device serving for generating signals to transmit the data to surface following passage of the cement slurry along said tubing and into the annular region.

36. A tubing as claimed in claim 25, comprising:

a running string coupled to said tubing, for deploying the tubing into the wellbore;

a fluid pressure pulse generating device located in the running string, for generating signals to transmit the data to surface;

in which the fluid pressure pulse generating device is activated following supply of a cement slurry through the running string and said tubing into the annular region to seal the tubing, to transmit the data to surface.

37. A tubing as claimed in claim 25, in which the tubing is a casing comprising a casing shoe having a float collar with a one-way valve that permits

fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one pressure sensor is positioned, in use, downhole of the float collar so that the at least one pressure sensor can communicate with the annular region through an open end of the casing shoe, to measure the pressure of the fluid in the annular region.

38. A tubing as claimed in claim 25, in which the tubing is a casing comprising a casing shoe having a float collar with a one-way valve that permits fluid to flow from the tubing into the wellbore but prevents fluid return, in which the at least one pressure sensor is positioned, in use, uphole of the float collar and arranged to communicate with the annular region through a wall of the tubing so that the at least one pressure sensor can measure the pressure of the fluid in the annular region.

39. A tubing as claimed in claim 25, in which the at least one pressure sensor is located on or in an internal surface of the tubing and exposed to the pressure of fluid in the annular region.

40. A tubing as claimed in claim 25, in which the at least one pressure sensor is located on or in an external surface of the tubing, and inductively coupled to a receiver located internally of said tubing when relaying data across a wall of the tubing.

41. A tubing as claimed in claim 25, in which the at least one pressure sensor monitors the pressure of a cement slurry supplied into the annular region, and in which said at least one pressure sensor is arranged so that a column of the cement slurry in the annular region acts directly on the at least one pressure sensor in an axial relationship, so that when the cement slurry sets it will no longer apply pressure to the at least one pressure sensor, giving an indication at surface that the cement slurry has set.

42. A method of determining whether a wellbore cementation operation has been performed correctly, the method comprising the steps of:

locating a wellbore-lining tubing in a wellbore;

supplying a cement slurry into an annular region defined between an external surface of the tubing and an internal surface of a wall of the wellbore, to seal the tubing in the wellbore;

locating at least one marker in a stream of the cement slurry supplied into the annular region;

monitoring for the presence of the marker in the annular region utilising a sensor positioned in a wall of the tubing and exposed to the annular region; and

recovering data concerning the presence of the marker monitored by the sensor to surface, the presence of the marker indicating that the cement slurry has travelled along the annular region towards the surface to at least as far as a detectable range of the sensor, so that a determination can be made as to whether the cementation operation has been performed correctly.

43. A method as claimed in claim 42, in which the at least one marker is an active marker which emits a signal that can be detected by the sensor.

44. A method as claimed in claim 43, in which the at least one marker emits a radio-frequency signal which can be detected by the sensor.

45. A method as claimed in claim 42, in which the at least one marker is radioactive and emits radiation which can be detected by the sensor.

46. A method as claimed in claim 42, in which the at least one marker is a passive marker, and in which the method comprises interrogating the cement slurry to detect for the presence of the marker.

47. A method as claimed in claim 42, in which the at least one marker is selectively activatable, the marker being arranged so that it only emits a signal in the presence of the sensor.

48. A method as claimed in claim 47, in which the marker is arranged to emit a signal on detecting a radio-frequency field emitted by the sensor, which signal is subsequently detected by the sensor.

49. A method as claimed in claim 42, comprising positioning a plurality of the sensors in the wellbore, which are spaced apart along a length of the wellbore-lining tubing, to facilitate recovery of data at points spaced apart along the length of the wellbore so that sequential indications of the presence of the markers, and thus cement, can be obtained as the cement travels uphole along the annular region.

50. A method as claimed in claim 49, comprising positioning at least one of the plurality of the sensors adjacent an uphole end of the wellbore-lining tubing, detection of a marker by said sensor providing an indication that the cement slurry has passed up the annular region along at least a majority of a length of the wellbore-lining tubing.

51. A method as claimed in claim 42, comprising:

locating a first wellbore-lining tubing of a first diameter in the wellbore and cementing the first tubing in place; and

locating a second wellbore-lining tubing of a second diameter which is smaller than the first diameter in said first tubing, and cementing the second tubing in place;

in which the second tubing carries a sensor adjacent an interface between the first and second tubings, detection of a marker by said sensor providing an indication that the cement slurry has passed up the annular region between the external surface of the second tubing and the internal wall of the wellbore to at least a level of the intersection between the first and second tubings.