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(54) **Title:** TWO-POSITION FRAC-PACK OR GRAVEL-PACK SYSTEM WITH TELEMETRY

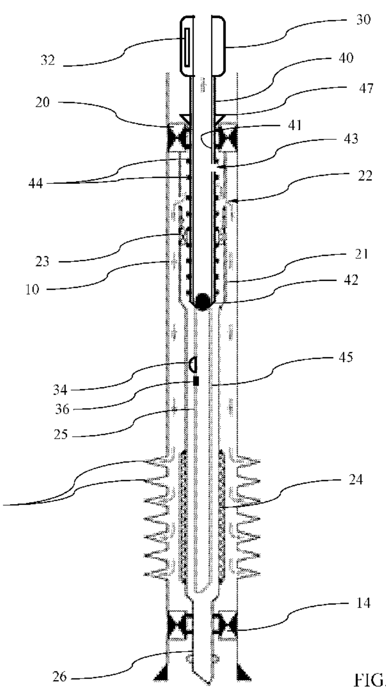

FIG. 1

(57) **Abstract:** A completion apparatus for use with a frac-pack or gravel-pack assembly is operated in any of two positions: a set down or squeeze position and a reverse circulating position. The completion apparatus includes a telemetry network, which is used to broadcast downhole data during fracking or packing operation, such as tension-compression measurements, pressure measurements, temperature measurements. The data can be used to adjust the fracking or packing operation or to determine properties of the formation being completed.

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TWO-POSITION FRAC-PACK OR GRAVEL-PACK SYSTEM WITH TELEMETRY

BACKGROUND

[0001] This disclosure relates generally to methods and apparatus for performing a completion, such as fracking or packing a perforated portion of a wellbore drilled through hydrocarbon-bearing formations. The completion may also be carried out or in wells, such as injector wells, which may not be drilled through hydrocarbon bearing formations.

[0002] In a typical completion operation, a frac-pack or gravel-pack assembly may be affixed to a completion apparatus. The completion apparatus and the frac-pack or gravel-pack assembly may be suspended from a drill string and then lowered in a wellbore, usually above a sump packer or bridge plug previously set in the wellbore below perforations. The frac-pack or gravel-pack assembly may be set in the wellbore, and a perforated portion of the wellbore may be sealed between the sump packer or bridge plug and a packer provided with the frac-pack or gravel-pack assembly. A slurry may then be pumped through the drill string, through the completion apparatus, and into the perforated portion of the wellbore, for fracking or packing the perforated portion of the wellbore. Before, during or after pumping of the slurry, the completion apparatus can be moved between three positions relative to the frac-pack or gravel-pack assembly to either seal the perforated portion of the wellbore and squeeze the slurry into the perforated portion (sometimes referred to as the set down or squeeze position), provide pressure communication between the perforated portion of the wellbore and an annulus around the drill string (sometimes referred to as the live annulus or circulating position), or to provide a fluid flow path from the annulus around the drill string into the drill string (sometimes referred to as the reverse circulating position). The live annulus or circulating position may be particularly useful because it permits monitoring the pressure in the perforated portion of the wellbore, which is transmitted to surface by the fluid filling the annulus around the drill pipe. The monitored pressure may be used to optimize the rate or pressure at which the slurry is pumped into the perforated portion of the wellbore. Pressure monitoring may also be useful to avoid the formation to kick-in and cause a well control situation, where hydrocarbons may go to the annulus, thus forcing the removal of such hydrocarbons from the wellbore, via reverse circulating position, delaying the completion operation. At the end of the completion operation, the completion apparatus and the drill string may be removed from the wellbore, leaving the frac-pack or gravel-pack assembly, and the pumped slurry in the wellbore.

[0003] Such a three-position completion apparatus may sometimes exhibit limitations. For example, the pressure communication between the perforated portion of the wellbore and the annulus around the drill string may plug, or partially plug, during use of the completion apparatus, thus preventing suitable pressure monitoring. It may not be possible to enlarge the pressure communication to avoid plugging, because such enlargement may, in turn, restrict the flow of the slurry through the completion apparatus. Further, in depleted formations, the column of fluid in the annulus may flow through the pressure communication, and be lost to the formation, thus preventing suitable pressure monitoring, or not allowing the pressure monitoring altogether. In some completion apparatus, the pressure communication created during the circulation position is maintained in the reverse circulating position, exposing the frac-packed or gravel-packed formation to pressure from the annulus that could result in washing away the frac or gravel pack into the reservoir, causing issues with formation productivity or injectivity or sand control and may force to repeat the completion operation, thus causing delays and additional costs. Further, when it is desired to apply a weight from the drill string to the frac-pack or gravel-pack assembly, during circulating position, this weight may be transmitted via a portion of the completion apparatus, usually a washpipe, that is prone to buckling, causing a failure and delaying the completion operation. Still further, this weight may be transmitted via collet provided on the washpipe and fully or partially supported by an outer shoulder in the frac-pack or gravel-pack assembly. The collet is prone to retaining debris from the slurry or the wellbore, which in turn, may prevent removing the completion apparatus and the drill string from the wellbore. Again, this type of failure may delay the completion operation.

[0004] Thus, there is a continuing need in the art for methods and apparatus for performing a completion, such as fracking or packing a perforated portion of a wellbore. Preferably, these methods and apparatus alleviate the limitations that may be encountered with a three-position completion apparatus and may arise with the use of the live annulus or circulating position. However, these methods and apparatus should still provide some of the advantages that arise with the use of the live annulus or circulating position. Accordingly, these methods and apparatus preferably permit the monitoring of pressure or other parameter in the perforated portion of the wellbore that is sealed below the packer provided with the frac-pack or gravel-pack assembly.

SUMMARY

[0005] The disclosure describes an apparatus, which may be used for performing a completion, such as fracking or packing a perforated portion of a wellbore drilled through hydrocarbon-bearing formations. The apparatus may alternatively be used for performing a completion in wells, such as injector wells, which may not be drilled through hydrocarbon bearing formations.

[0006] The apparatus may comprise a crossover tool. The crossover tool may include an elongated cylindrical body. The elongated cylindrical body may have an outer surface, a central bore along a length of the elongated cylindrical body, and a wall spanning between the central bore and the outer surface. The crossover tool may include a ball seat extending from the wall into the central bore. The crossover tool may include a lateral port located above the ball seat. The lateral port may provide a flow path through the wall. The crossover tool may include a plurality of seals located on the outer surface. Preferably, the crossover tool does not include a fluid bypass extending through the wall, from the central bore below the ball seat, to the outer surface above the lateral port.

[0007] The apparatus may comprise a setting tool connected above the crossover tool. The setting tool may be capable of transmitting, via a threaded connection, a downward force to a frac-pack or gravel-pack assembly set in a wellbore.

[0008] The apparatus may comprise a washpipe connected below the crossover tool. Preferably, the washpipe does not include an outer shoulder or collet capable of transmitting the downward force to the frac-pack or gravel-pack assembly.

[0009] The apparatus may comprise a sensor located below the plurality of seals. The sensor may be a pressure sensor configured to be in pressure communication with fluid around the crossover tool or around the washpipe. Alternatively or additionally, the sensor may be a pressure sensor configured to be in pressure communication with fluid inside the crossover tool or inside the washpipe. The sensor may be a temperature sensor coupled to the acoustic telemetry system. The sensor may be a tension-compression sensor coupled to the acoustic telemetry system. The apparatus may further comprise a plurality of sensors located along the washpipe underneath the crossover tool.

[0010] The apparatus may comprise an acoustic telemetry system connected to the sensor. The acoustic telemetry system may be capable of emitting waves that propagate along the length of the elongated cylindrical body. The acoustic telemetry system may be coupled to the washpipe.

[0011] The apparatus may comprise a drill string connected above the crossover tool. The drill string may comprise one or more inline acoustic repeaters.

[0012] The disclosure describes a method of using the apparatus.

[0013] The method may comprise the step of setting, in a wellbore, a frac-pack or gravel-pack assembly including a packer, a pack extension having a circulating port and a seal bore, and a screen. The method may comprise the step of sealing a first annulus between the frac-pack or gravel-pack assembly and the wellbore with the packer.

[0014] The method may comprise the step of providing, in the wellbore, the apparatus described above. The method may comprise the step of sealing a second annulus between the crossover tool and the frac-pack or gravel-pack assembly with the seal bore.

[0015] The method may comprise the step of moving the crossover tool between a first position and a second position. In the first position, the lateral port of the crossover tool may be in fluid communication with the circulating port of the frac-pack or gravel-pack. In the second position, the lateral port of the crossover tool may be in fluid communication with a third annulus located above the first annulus between a drill string connected on top of the crossover tool and the wellbore. Between the first position and the second position, a fourth annulus located below the second annulus between a washpipe connected below the crossover tool and the frac-pack or gravel-pack may remain isolated from the third annulus.

[0016] The method may comprise the steps of providing, in the wellbore, a first telemetry system connected to a sensor, and providing, in a drill string connected above the crossover tool, a second telemetry system connected to a surface receiver.

[0017] The method may comprise the step of measuring data with the sensor. The step of measuring the data with the sensor may be performed while performing a fracking or packing operation.

[0018] The method may comprise the step of broadcasting the data with the acoustic telemetry system. The step of broadcasting the data may include broadcasting the data from the sensor to the second telemetry system along the crossover tool with the first telemetry system. The step of broadcasting the data may be performed by emitting waves that propagate along the length of the elongated cylindrical body. The step of broadcasting the data may further include broadcasting the data from the second telemetry system to the surface receiver with the second telemetry system. The step of broadcasting the data may be performed while the fourth annulus is isolated from the third annulus.

[0019] The data may comprise fluid pressure around the crossover tool or around the washpipe. Alternatively or additionally, the data may comprise fluid pressure inside the crossover tool or inside the washpipe. In embodiments where a plurality of sensors are provided, for example, on a washpipe connected below the crossover tool, the data may comprise fluid pressure, fluid temperature, or washpipe tension-compression.

[0020] The method may further include the step of adjusting the fracking or packing operation based on the data broadcasted to the surface receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] For a more detailed description of the embodiments of the disclosure, reference will now be made to the accompanying drawings, wherein:

[0022] Figure 1 is a schematic view of a frac-pack or gravel-pack assembly and a completion apparatus comprising a crossover tool, wherein the crossover tool is in a squeeze position;

[0023] Figure 2 is a schematic view of the frac-pack or gravel-pack assembly and the completion apparatus shown in Figure 1, wherein the crossover tool is in a reverse circulating position; and

[0024] Figure 3 is a flowchart of a method of performing a completion operation that may be performed with the completion apparatus shown in Figure 1.

DETAILED DESCRIPTION

[0025] The disclosure describes embodiments of a completion apparatus for use with a frac-pack or gravel-pack assembly. The completion apparatus may be operated in any of two positions relative to the frac-pack or gravel-pack assembly, a set down or squeeze position and a reverse circulating position. In contrast with other completion apparatus, the completion apparatus does not have a live annulus or circulating position that provides, during fracking or packing operation, pressure communication between the perforated portion of the wellbore and an annulus around the drill string. Accordingly, the complexity of the design of the completion apparatus may be reduced, and thus the risk of operational failure may also be reduced. In addition, the completion apparatus comprises an acoustic telemetry network or other telemetry network, including electrical communication through conductive bodies of the apparatus and/or the casing. The disclosure also describes embodiments of a method of using the completion apparatus and the telemetry network. The telemetry network may be used to broadcast downhole data during fracking or packing operation, such as tension-compression measurements, pressure measurements, temperature measurements, and/or other measurements. Accordingly, the data may be used to adjust in real-time, or near real-time, the fracking or packing operation, as well as to determine properties of the formation being completed.

[0026] Referring to Figure 1, a wellbore 10 drilled through a hydrocarbon-bearing formation is illustrated. The wellbore 10 as shown has been cased and perforated. A sump packer 14 (or a bridge plug) has been previously set in the wellbore 10 below perforations 12. A frac-pack or gravel-pack assembly has been set on top of the sump packer 14. Typically, the frac-pack or gravel-pack assembly includes a packer 20, a pack extension 21 having a circulating port 22 and a seal bore 23, a screen 24, a spacer pipe 25, and a stinger 26 that engages the sump packer 14 (or a bull plug that engages the bridge plug).

[0027] A completion apparatus is shown suspended from a drill string 30. Accordingly, the completion apparatus can be moved relative to the frac-pack or gravel-pack assembly by raising or lowering the drill string 30 in the wellbore 10. The completion apparatus typically includes a crossover tool, a service or setting tool connected above the crossover tool (not shown), and a washpipe 45 connected below the crossover tool. Optionally, the setting tool is capable of transmitting a downward force to the frac-pack or gravel-pack assembly already set in the wellbore 10. The transmission of the force is performed via a threaded connection 47 including a box end that is implemented in the frac-pack or gravel-pack assembly and a pin end that is implemented in the setting tool. In the prior art, after the frac-pack or gravel-pack assembly is set, the completion apparatus is detached from the frac-pack or gravel-pack assembly to displace the crossover tool. As such, the box and the pin are no longer in contact, preventing the transmission of weight. In the completion apparatus shown in Figure 1, it is not required to detach the completion apparatus from the frac-pack or gravel-pack assembly. As such, the threaded connection 47 can be utilized to apply the downward force to the frac-pack or gravel-pack assembly already set, therefore avoiding transmitting the weight applied by the drill string 30 down to the packer 20 via the washpipe 45, and thus, may avoid buckling the washpipe 45. Preferably, the washpipe 45 does not include any outer shoulder or collet capable of transmitting the downward force to the frac-pack or gravel-pack assembly. As such, the risk of trapping debris from the slurry between the washpipe 45 and the frac-pack or gravel-pack assembly may be reduced. Thus, the completion apparatus may be more easily pulled out of the frac-pack or gravel-pack assembly at the end of the completion operation.

[0028] The crossover tool as shown includes an elongated cylindrical body. The elongated cylindrical body has an outer surface 40, a central bore 41 along a length of the elongated cylindrical body, and a wall spanning between the central bore 41 and the outer surface 40. The crossover tool further includes a ball seat 42 extending from the wall into the central bore 41. The crossover tool further includes a lateral port 43 located above the ball seat 42 and providing a flow path through the wall. The crossover tool further includes a plurality of seals 44 located on the outer surface 40. In contrast with other crossover tools, the crossover tool as shown does not include a fluid bypass extending through the wall, from the central bore 41 below the ball seat 42, to the outer surface 40 above the lateral port 43. Not providing such a fluid bypass eliminates the risk of plugging the fluid bypass, and may permit reducing the thickness of the wall spanning between the central bore 41 and the outer surface 40 of the crossover tool. In turn, the central bore 41 may be enlarged, therefore facilitating the flow of the slurry through the completion apparatus.

[0029] Turning briefly to Figure 2, and also applicable to Figure 1, a first annulus 50 between the frac-pack or gravel-pack assembly and the wellbore 10 with the packer 20 is sealed upon setting, in the wellbore 10, the frac-pack or gravel-pack assembly. A second annulus 52 between the crossover tool and the frac-pack or gravel-pack assembly is sealed with the seal bore 23. A third annulus 54 is located above the first annulus 50, between a drill string 30 and the wellbore 10. A fourth annulus 56 is located below the second annulus 52, between a washpipe 45 and the frac-pack or gravel-pack. Also, some of the plurality of seals 44 may engage and seal against an inner bore of the packer 20.

[0030] By lowering the drill string 30 in the wellbore 10 as shown in Figure 1, the completion apparatus, including the crossover tool, may be moved to a first position that may be referred to as the set down or squeeze position, which is the same position in which the frac-pack or gravel-pack assembly was set. In the first position, the lateral port 43 of the crossover tool is in fluid communication with the circulating port 22 of the frac-pack or gravel-pack. Also in the first position, the threaded connection 47 may optionally transmit a downward force to the frac-pack or gravel-pack assembly set in a wellbore 10 via the contact between pin and box. Conversely, by raising the drill string 30 in the wellbore 10 as shown in Figure 2, the completion apparatus, including the crossover tool, may be moved to a second position that may be referred to as the reverse circulating position. In the second position, the lateral port 43 of the crossover tool is in fluid communication with the third annulus 54. Because the crossover tool does not include a fluid bypass extending along the wall, from the central bore 41 below the ball seat 42, to the outer surface 40 above the lateral port 43, the fourth annulus 56 can remain isolated from the third annulus 54.

[0031] Referring to Figures 1 and 2, the completion apparatus comprises a pressure sensor 36 located below the plurality of seals 44. In some embodiments, the pressure sensor 36 may be configured to be in pressure communication with fluid around the setting tool or around the washpipe 45. In some embodiments, the pressure sensor 36 may be configured to be in pressure communication with fluid inside the setting tool or inside the washpipe 45. In some embodiments, a temperature sensor and/or a tension-compression sensor may also be provided on the completion apparatus. Other types of sensors may be provided on the completion apparatus. A plurality of sensors may be provided on the completion apparatus, including sensors located underneath the crossover tool. Some sensors may be collocated, and some other sensors, for example a set of sensors of the same type, may be distributed along at least a portion of the length of the completion apparatus.

[0032] The completion apparatus further comprises an acoustic telemetry system 34 connected to the pressure sensor 36 and capable of emitting waves that propagate along the length of the elongated cylindrical body, to one or more inline acoustic repeater 32 comprised in the drill string 30. In some embodiments, the acoustic telemetry system 34 may be clamped on the washpipe 45. Thus, downhole pressure data measured by the pressure sensor 36 may be broadcasted to the one or more inline acoustic repeaters 32. The downhole pressure data may, in turn, be broadcasted to a surface receiver with the one or more inline acoustic repeaters 32.

[0033] The downhole pressure may be used to monitor in real-time, or near real-time, the pressure in the perforated portion of the wellbore 10, for example, for optimizing the rate or pressure at which the slurry is pumped into the perforated portion of the wellbore 10. The downhole pressure data may be easier to interpret than surface pressure data, which would be measured near pumps used to pump the slurry in the drill string 30, because the surface pressure data that would be measured near pumps is affected by the friction of the slurry along the drill string. Also, the acoustic telemetry system 34 does not rely on a pressure communication between the fourth annulus 56 (the perforated portion of the wellbore) and the third annulus 54 (around the drill string 30). Thus, broadcasting the downhole pressure data can be performed while the fourth annulus 56 is isolated from the third annulus 54.

[0034] Turning to Figure 3, a flowchart of a method of performing a completion, such as fracking or packing a perforated portion of a cased wellbore, is illustrated. The method comprises a setting step 100. The setting step 100 may involve setting, in a wellbore 10, a frac-pack or gravel-pack assembly. The frac-pack or gravel-pack assembly may include a packer 20, a pack extension 21 having a circulating port 22 and a seal bore 23, and a screen 24, for example, as shown in Figures 1 and 2. The method comprises a step 102 of providing a crossover tool that is comprised in a completion apparatus. For example, the crossover tool may be similar to the crossover tool shown in Figures 1 and 2. In particular, the crossover tool may not include a fluid bypass extending along the wall of the crossover tool. The method comprises a step 104 of providing a downhole sensor. The downhole sensor may be similar to the pressure sensor 36 provided below a plurality of seals of the crossover tool, for example, as shown in Figures 1 and 2, or may include a temperature sensor and/or a tension-compression sensor, or other known sensor, located on the completion apparatus. The method comprises a step 106 of providing a first telemetry system connected to the sensor. The first telemetry system may be similar to the acoustic telemetry system 34, for example, as shown in Figures 1 and 2, or may comprise other known type of telemetry system, such as based on conduction of electrical system through metallic parts of the casing or the completion apparatus. The method comprises a step 108 of providing a second telemetry system connected to a surface receiver. The second telemetry system may be similar to the one or more inline acoustic repeaters 32, for example, as shown in Figures 1 and 2, or may comprise other known type of telemetry system, such electromagnetic telemetry. The first and second telemetry systems thus form a telemetry network, wherein the type of the first telemetry may be selected to provide a short-range telemetry across the crossover tool and the type of the second telemetry may be selected to provide a long-range telemetry to the surface receiver. The method comprises a measuring step 110. The measuring step 110 may involve measuring data with the sensor while performing a mini-frac analysis, fracking or packing operation. Data may include pressure and/or temperature measurements of the fluid inside the crossover tool or inside the washpipe, pressure and/or temperature measurements of the fluid around the crossover tool or around the washpipe, and/or tension-compression in the crossover tool or the washpipe. The method comprises a step 112 of broadcasting the measured data from the sensor to the second telemetry system with the first telemetry system. The method comprises a step 114 of broadcasting the data from the second telemetry system to the surface receiver with the second telemetry system. Accordingly, the telemetry network formed by the first and second telemetry systems may be capable of providing data in real-time, or near real-time, to the surface receiver during fracking or packing. In some embodiments, the surface receiver may display the data to an operator. The method may comprise an adjusting step 116. The adjusting step 116 may involve adjusting the fracking or packing operation based on the data broadcasted to the surface receiver. In some embodiments, the adjusting step 116 may be performed by the operator. In some embodiments, the surface receiver may be coupled to a controller that is configured to adjust the pumping pressure, the pumping rate, the pumping duration, and/or the pumping volume of fracking or packing slurry.

[0035] While the disclosure is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and description. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the claims to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the claims.

What is claimed is:

1. An apparatus comprising:

a crossover tool including

an elongated cylindrical body having an outer surface, a central bore along a length of the elongated cylindrical body, and a wall spanning between the central bore and the outer surface;

a ball seat extending from the wall into the central bore;

a lateral port located above the ball seat and providing a flow path through the wall;

a plurality of seals located on the outer surface;

wherein the crossover tool does not include a fluid bypass extending through the wall, from the central bore below the ball seat, to the outer surface above the lateral port;

a sensor located below the plurality of seals; and

an acoustic telemetry system connected to the sensor and capable of emitting waves that propagate along the length of the elongated cylindrical body.

2. The apparatus of claim 1 further comprising a washpipe connected below the crossover tool, wherein the acoustic telemetry system is coupled to the washpipe.

3. The apparatus of claim 2 wherein the sensor is a pressure sensor configured to be in pressure communication with fluid around the crossover tool or around the washpipe.

4. The apparatus of claim 2 wherein the sensor is a pressure sensor configured to be in pressure communication with fluid inside the crossover tool or inside the washpipe.

5. The apparatus of claim 2 further comprising a plurality of sensors located along the washpipe underneath the crossover tool.

6. The apparatus of claim 1 further comprising a drill string connected above the crossover tool, wherein the drill string comprises one or more inline acoustic repeaters.

7. The apparatus of claim 1 further comprising a setting tool connected above the crossover tool, the setting tool is capable of transmitting a downward force to a frac-pack or gravel-pack assembly set in a wellbore, via a threaded connection, and wherein a washpipe connected below the crossover tool does not include an outer shoulder or collet capable of transmitting the downward force to the frac-pack or gravel-pack assembly.

8. The apparatus of claim 1 wherein the sensor is a temperature sensor coupled to the acoustic telemetry system.

9. The apparatus of claim 1 wherein the sensor is a tension-compression sensor coupled to the acoustic telemetry system.

10. A method comprising:

providing, in a wellbore, a crossover tool including

an elongated cylindrical body having an outer surface, a central bore along a length of the elongated cylindrical body, and a wall spanning between the central bore and the outer surface;

a ball seat extending from the wall into the central bore;

a lateral port located above the ball seat and providing and providing a flow path through the wall;

a plurality of seals located on the outer surface;

wherein the crossover tool does not include a fluid bypass extending through the wall, from the central bore below the ball seat, to the outer surface above the lateral port;

providing, in the wellbore, a sensor located below the plurality of seals;

providing, in the wellbore, an acoustic telemetry system connected to the sensor;

measuring data with the sensor; and

broadcasting the data with the acoustic telemetry system by emitting waves that propagate along the length of the elongated cylindrical body.

11. The method of claim 10 further comprising:

setting, in the wellbore, a frac-pack or gravel-pack assembly including a packer, a pack extension having a circulating port and a seal bore, and a screen;

sealing a first annulus between the frac-pack or gravel-pack assembly and the wellbore with the packer; and

sealing a second annulus between the crossover tool and the frac-pack or gravel-pack assembly with the seal bore,

moving the crossover tool between a first position and a second position,

wherein, in the first position, the lateral port of the crossover tool is in fluid communication with the circulating port of the frac-pack or gravel-pack,

wherein, in the second position, the lateral port of the crossover tool is in fluid communication with a third annulus located above the first annulus between a drill string connected on top of the crossover tool and the wellbore, and

wherein, between the first position and the second position, a fourth annulus located below the second annulus between a washpipe connected below the crossover tool and the frac-pack or gravel-pack remains isolated from the third annulus.

12. The method of claim 11 wherein broadcasting the data is performed while the fourth annulus is isolated from the third annulus.

13. The method of claim 11 wherein the sensor is a pressure sensor, and wherein the data comprise fluid pressure around the crossover tool or around the washpipe.

14. The method of claim 11 wherein the sensor is a pressure sensor , and wherein the data comprise fluid pressure inside the crossover tool or inside the washpipe.

15. A method comprising:

setting, in a wellbore, a frac-pack or gravel-pack assembly including a packer, a pack extension having a circulating port and a seal bore, and a screen;

providing, in the wellbore, a crossover tool including:

an elongated cylindrical body having an outer surface, a central bore through a length of the elongated cylindrical body, and a wall spanning between the central bore and the outer surface;

a ball seat extending from the wall into the central bore;

a lateral port located above the ball seat and providing and providing a flow path through the wall;

a plurality of seals located on the outer surface;

wherein the crossover tool does not include a fluid bypass extending along the wall, from the central bore below the ball seat, to the outer surface above the lateral port;

providing, in the wellbore, a sensor located below the plurality of seals;

providing, in the wellbore, a first telemetry system connected to the sensor;

providing, in a drill string connected above the crossover tool, a second telemetry system connected to a surface receiver;

measuring data with the sensor while performing a fracking or packing operation;

broadcasting the data from the sensor to the second telemetry system along the crossover tool with the first telemetry system;

broadcasting the data from the second telemetry system to the surface receiver with the second telemetry system; and

adjusting the fracking or packing operation based on the data broadcasted to the surface receiver.

16. The method of claim 15 further comprising providing a plurality of sensors on a washpipe connected below the crossover tool, and wherein the data comprise fluid pressure, fluid temperature, or washpipe tension-compression.

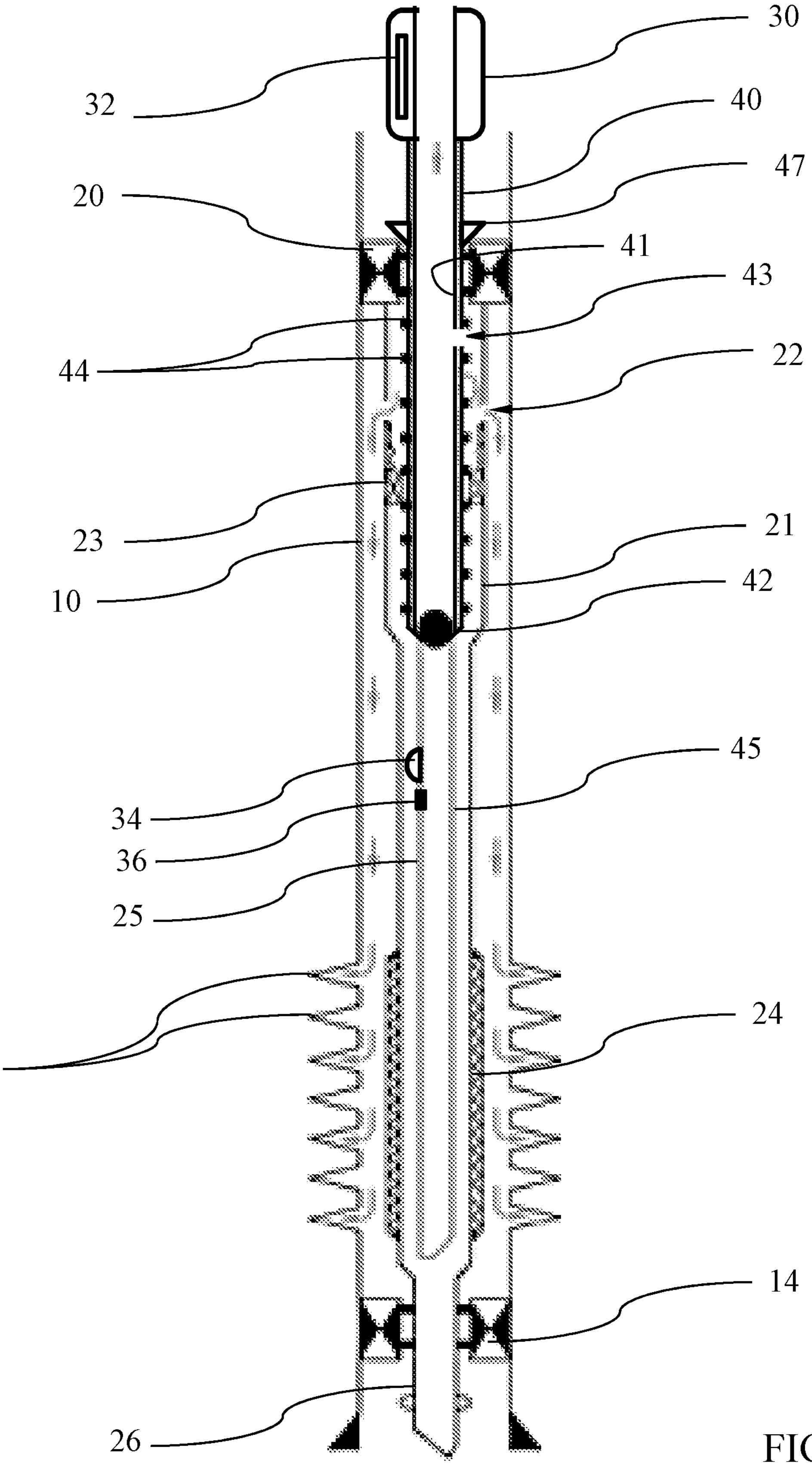

FIG. 1

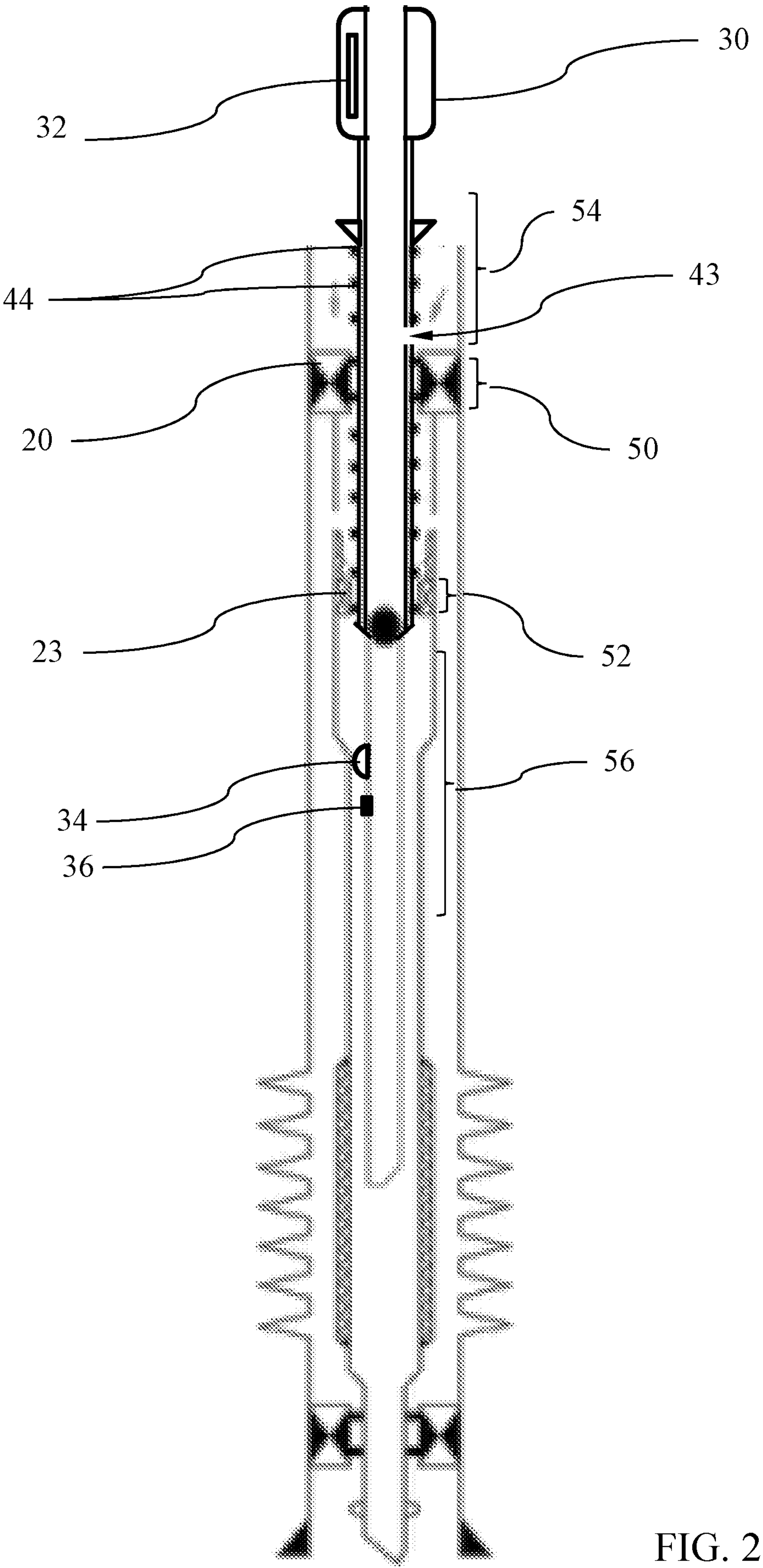

FIG. 2

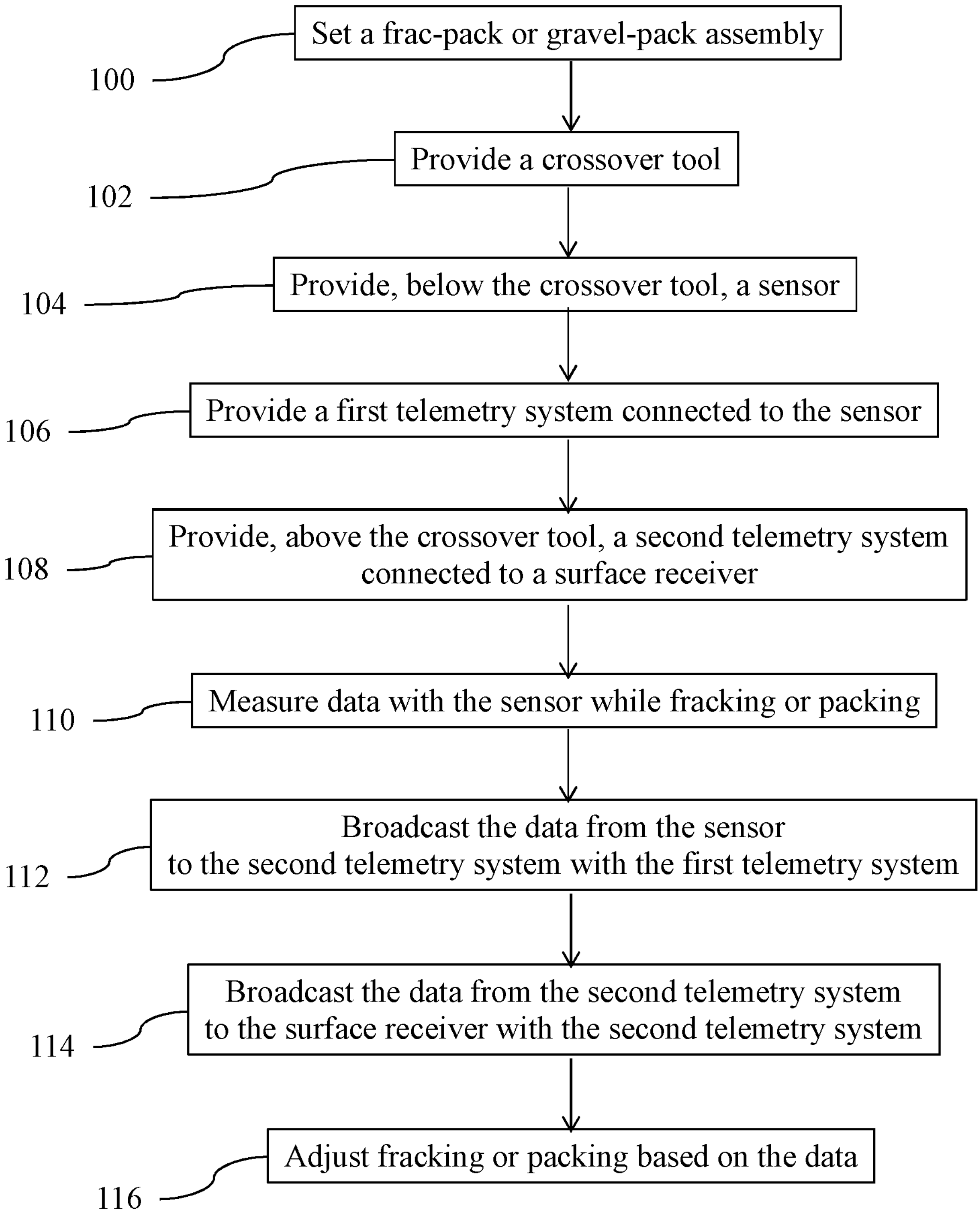
Set a frac-pack or gravel-pack assembly
100
Provide a crossover tool
102
Provide, below the crossover tool, a sensor
104
Provide a first telemetry system connected to the sensor
106
Provide, above the crossover tool, a second telemetry system connected to a surface receiver
108
Measure data with the sensor while fracking or packing
110
Broadcast the data from the sensor to the second telemetry system with the first telemetry system
112
Broadcast the data from the second telemetry system to the surface receiver with the second telemetry system
114
Adjust fracking or packing based on the data
116

FIG. 3