Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3101430 C 2023/10/03

(11)(21) **3 101 430**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

(22) Date de dépôt/Filing Date: 2020/12/02
(41) Mise à la disp. pub./Open to Public Insp.: 2022/06/02
(45) Date de délivrance/Issue Date: 2023/10/03

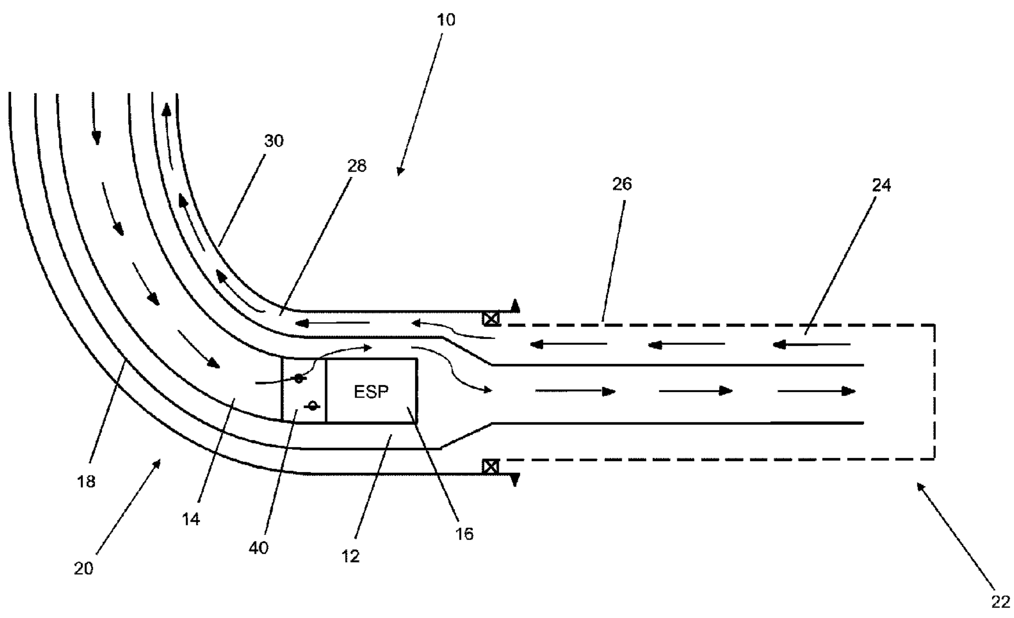
(51) Cl.Int./Int.Cl. *E21B 43/12* (2006.01), *E21B 43/24* (2006.01)

(72) Inventeur/Inventor:
WATT, ALAN FRASER, CA

(73) Propriétaire/Owner:
SUNCOR ENERGY INC., CA

(74) Agent: CPST INTELLECTUAL PROPERTY INC.

(54) Titre : SYSTEME ET METHODE POUR CONTOURNER UN MATERIEL DE FOND DE TROU ET MECANISMES DE DERIVATION CONNEXES
(54) Title: SYSTEM AND METHOD FOR BYPASSING DOWNHOLE EQUIPMENT AND BYPASS MECHANISMS THEREFOR



(57) Abrégé/Abstract:
A system is provided for injecting and producing fluids in a production well. The system includes production tubing extending into a wellbore, a bypass mechanism coupled at a first side thereof to a distal end of the production tubing, and a pump coupled at an outlet thereof to a second side of the bypass mechanism. The bypass mechanism is configured to divert fluids injected via the production tubing around the pump in an injection configuration and to permit fluids to be produced via the pump and production tubing in a production configuration. The bypass mechanism can include a housing, a sliding sleeve positioned within the housing, and a sliding actuation feature. The sliding sleeve aligns with the injection port in the injection configuration and aligns with the production port in the production configuration. The sliding actuation feature permits the sliding sleeve to move between the injection and production configurations.

ABSTRACT

A system is provided for injecting and producing fluids in a production well. The system includes production tubing extending into a wellbore, a bypass mechanism coupled at a first side thereof to a distal end of the production tubing, and a pump coupled at an outlet thereof to a second side of the bypass mechanism. The bypass mechanism is configured to divert fluids injected via the production tubing around the pump in an injection configuration and to permit fluids to be produced via the pump and production tubing in a production configuration. The bypass mechanism can include a housing, a sliding sleeve positioned within the housing, and a sliding actuation feature. The sliding sleeve aligns with the injection port in the injection configuration and aligns with the production port in the production configuration. The sliding actuation feature permits the sliding sleeve to move between the injection and production configurations.

Date Reçue/Date Received 2020-12-02

SYSTEM AND METHOD FOR BYPASSING DOWNHOLE EQUIPMENT AND BYPASS MECHANISMS THEREFOR

TECHNICAL FIELD

[0001] The following relates to systems and methods for bypassing downhole equipment, particularly downhole pumps, and relates to bypass mechanisms therefor.

BACKGROUND

[0002] Oil sands are a natural mix of sand, water, and bitumen. Bitumen is considerably viscous and does not flow like conventional crude oil. As such, bitumen is recovered from oil sands using either surface mining techniques or in situ techniques. In surface mining, overburden is removed to access the underlying bitumen reservoir, and the oil sands are transported to an extraction facility to separate the bitumen from the other components of the oil sands (e.g., tailings). For in situ techniques, the bitumen reservoir is heated and the bitumen within flows into one or more horizontal producer wells, leaving the formation rock in the bitumen reservoir in place. Both surface mining and in situ processes produce a bitumen product that is subsequently sent to an upgrading and refining facility, to be refined into one or more petroleum products.

[0003] Bitumen reservoirs that are too deep to feasibly permit bitumen recovery by mining techniques are typically accessed by drilling wellbores into the bitumen reservoir and implementing an in situ technology. There are various in situ technologies available that use steam, heated hydrocarbon solvent, or steam and solvent in combination, to liberate the bitumen from the bitumen reservoir.

[0004] One common in situ technique is Steam Assisted Gravity Drainage (SAGD). A common equipment configuration for a SAGD process includes horizontally oriented wells extending into the bitumen reservoir, such that a pair of horizontal wells are vertically aligned with respect to each other and separated by a relatively small distance, typically in the order of several meters. The well installed closer to the surface and above the other well is generally referred to as an injection well, and the well positioned below the injection well is referred to as a production well. The injection and production wells are then connected to injection and/or production equipment installed at a surface site. In one example, the injection well facilitates steam injection into the reservoir. The injected steam propagates vertically and laterally into the reservoir to develop what is referred to as a steam chamber. Latent heat released by the

Date Reçue/Date Received 2020-12-02

injected steam mobilizes the bitumen by lowering its viscosity. The bitumen, in turn, drains due to gravity and is produced, along with condensed water, by the production well.

[0005] Prior to producing bitumen in the above manner, the SAGD process typically begins with a startup phase including steam circulation and/or bullheading, both of which involve steam injection via the production well. After conducting steam circulation and/or bullheading, the production well can be recompleted, e.g., for mechanical lift. This can involve the installation of a pump to provide the hydraulic force for lifting production fluid to the surface. Such recompletion can be time consuming and can cause considerable downtime. To address this issue, so-called “Direct-to-SAGD” or “D-SAGD” processes have been implemented. In contrast to conventional systems, the D-SAGD process can enable the downhole pump and the instrumentation to be installed in the production well before the SAGD startup phase, thus avoiding down time of mechanical lift conversion and reducing associated recompletion costs. When the reservoir is ready for production, the downhole pump is already in place and no rig mobilization or recompletion is necessary.

[0006] During steam circulation in a standard D-SAGD production well 10, injected steam flows down an annulus 12 between the production tubing 14 (coupled to a downhole pump such as an electrical submersible pump (ESP) 16) and a slave string 18, and then from the heel 20 to the toe 22 of the well 10 as illustrated in FIG. 1. The steam circulates back through an annulus 24 between the slave string 18 and the slotted liner 26 from the toe 22 toward the heel 20. The circulation returns flow uphole through an annulus 28 between the slave string 18 and the casing 30. Since the injected steam moving downhole is separated from the circulation returns by a single wall (i.e., via slave string 18), a considerable amount of heat loss can occur in the build section. Such heat loss can cause issues such as increasing the volume of steam vapor returns to production facilities during circulation.

SUMMARY

[0007] The following provides a method and system to reduce heat loss from injection steam in a production well, e.g., during a circulation phase. The method can include injecting the steam through production tubing and diverting the steam out of the production tubing into the annulus between the production tubing and a slave string before the steam reaches a pump (e.g., an ESP). The steam can be diverted using a bypass mechanism such as a steam bypass valve. The circulation returns can flow uphole through an annulus between the slave string and wellbore casing. The method can further include providing a gas blanket in the annulus

Date Reçue/Date Received 2020-12-02

between tubing and slave string to insulate the injection steam flowing downhole through the production/injection tubing.

[0008] In one aspect, there is provided a system for injecting and producing fluids in a production well, comprising: production tubing extending into a wellbore; a bypass mechanism coupled at a first side thereof to a distal end of the production tubing; and a pump coupled at an outlet thereof to a second side of the bypass mechanism; wherein the bypass mechanism is configured to divert fluids injected via the production tubing around the pump in an injection configuration and to permit fluids to be produced via the pump and production tubing in a production configuration.

[0009] In an implementation the production tubing can be positioned within a slave string that is positioned within the wellbore. A blanket gas can also be provided in an annulus between the production tubing and the slave string.

[0010] In an implementation the bypass mechanism can include an actuation feature for converting the bypass mechanism from the injection configuration to the production configuration. The actuation feature can include a sliding actuation of the bypass mechanism and can include a ball drop mechanism to activate the actuation feature. A ball used in the ball drop mechanism can be dissolvable or meltable in the produced fluids.

[0011] In an implementation the system can include a shifting tool to convert the bypass mechanism between the injection and production configurations.

[0012] In an implementation the pump is an electric submersible pump.

[0013] In an implementation the bypass mechanism includes a housing, the housing comprising: a pump interface to couple the bypass mechanism to the outlet of the pump; a tubing interface to couple the bypass mechanism to a distal end of the production tubing; an injection port positioned between the tubing interface and the pump interface, the injection port providing fluid communication between the production tubing and an exterior of the housing; and a production port positioned between the injection port and the pump interface, the production port providing fluid communication between the production tubing and the pump interface. The bypass mechanism can also include a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in the injection configuration and to be aligned with the production port in the production

Date Reçue/Date Received 2020-12-02

configuration; and a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

[0014] In an implementation the sliding sleeve can include a plurality of bypass ports aligned circumferentially about the sliding sleeve. The sliding actuation feature can include an edge of the sliding sleeve and the edge can be beveled.

[0015] In an implementation the housing can include a sleeve ball profile.

[0016] In an implementation the sliding actuation feature can include at least one shifting profile to engage a shifting tool insertable within the sliding sleeve.

[0017] In an implementation the housing can include an inner chamber to inhibit fluids from entering the pump outlet when the bypass mechanism is in the injection configuration. The bypass mechanism can include at least one seal between the inner chamber and the sliding sleeve.

[0018] In an implementation system can also include one or more collets to position the sliding sleeve within the inner chamber, the one or more collets interfacing with corresponding collet pockets in the inner chamber.

[0019] In an implementation the housing and the sliding sleeve are keyed to inhibit rotational movement relative to each other. The housing and sliding sleeve can be keyed using at least one complementary notch and ridge.

[0020] In an implementation the housing can include a slot to permit passage of cabling for the pump.

[0021] In an implementation the housing can include a slot to permit passage of instrumentation cabling.

[0022] In another aspect, there is provided a method of bypassing a pump in a production well, comprising: coupling a bypass mechanism to an outlet of the pump; coupling the bypass mechanism to production tubing to position the bypass mechanism between the production tubing and the pump, wherein the bypass mechanism is in an injection configuration which diverts fluids injected via the production tubing around the pump; deploying the pump, bypass mechanism and production tubing into a wellbore; and injecting fluids into the wellbore via the production tubing, wherein the injected fluids are diverted around the pump by the bypass mechanism.

Date Reçue/Date Received 2020-12-02

[0023] In yet another aspect, there is provided a bypass mechanism for diverting injected fluids around a downhole pump, comprising: a housing, the housing comprising: a pump interface to couple the bypass mechanism to an outlet side of the pump; a tubing interface to couple the bypass mechanism to a distal end of production tubing extending into a wellbore; an injection port positioned between the tubing interface and the pump interface, the injection port providing fluid communication between the production tubing and an exterior of the housing; and a production port positioned between the injection port and the pump interface, the production port providing fluid communication between the production tubing and the pump interface; a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in an injection configuration and to be aligned with the production port in a production configuration; and a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

[0024] In yet another aspect, there is provided a system for injecting and producing fluids in a well, comprising: tubing extending into a wellbore; a bypass mechanism coupled at a first side thereof to a distal end of the tubing; and equipment coupled at an outlet thereof to a second side of the bypass mechanism; wherein the bypass mechanism is configured to divert fluids injected via the tubing around the equipment in an injection configuration and to permit fluids to be produced via the equipment and tubing in a production configuration.

[0025] Advantages of the methods, systems, and bypass mechanisms described herein can include reducing heat loss in the build section by using production tubing for injecting fluids while bypassing the downhole pump. This can also avoid subjecting the downhole pump to unnecessary heat by only permitting fluids to pass through the pump during a production phase when the pump is being operated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Embodiments will now be described with reference to the appended drawings wherein:

[0027] FIG. 1 is a schematic cross-sectional view of a prior art D-SAGD production well.

[0028] FIG. 2 is a schematic cross-sectional view of a D-SAGD production well with a bypass mechanism above a downhole pump, during an injection phase.

Date Reçue/Date Received 2020-12-02

[0029] FIG. 3 is a schematic cross-sectional view of a D-SAGD production well with a bypass mechanism above a downhole pump, during a production phase.

[0030] FIG. 4 is a cross-sectional view of a bypass mechanism in an injection configuration.

[0031] FIG. 5a is a partial cross-sectional view of the bypass mechanism being adjusted using a ball drop technique.

[0032] FIG. 5b is a partial cross-sectional view of the bypass mechanism after a ball drop technique has been applied and during a production phase.

[0033] FIG. 6 is a cross-sectional view of a sliding sleeve of the bypass mechanism illustrating profiles to engage a shifting tool.

[0034] FIG. 7 is a cross-sectional view of the bypass mechanism of FIG. 4, in a production configuration.

[0035] FIGS. 8a and 8b are partial cross-sectional views of the bypass mechanism showing both injection and production configurations side-by-side.

[0036] FIG. 9 is a plan view of the sliding sleeve showing a collet aligned with the sliding sleeve.

[0037] FIG. 10 is an enlarged cross-sectional view of an interface between the sliding sleeve and an inner fixed sleeve of the bypass mechanism.

[0038] FIG. 11 is an end view of the bypass mechanism.

[0039] FIG. 12 is a cross sectional end view of the bypass mechanism.

[0040] FIG. 13 is a flow chart illustrating operations performed in injecting and producing fluids in a production well.

DETAILED DESCRIPTION

[0041] As indicated above, during steam circulation in a standard D-SAGD production well 10, injection steam flows down an annulus 12 between the production tubing 14 (coupled to a downhole pump such as an electrical submersible pump (ESP) 16) and a slave string 18, and then from the heel 20 to the toe 22 of the well 10 as illustrated in FIG. 1. The terms “pump” and “ESP” are used interchangeably herein and either or both can be referred to using numeral “16”. The principles discussed herein can apply to any downhole equipment that can be used

Date Reçue/Date Received 2020-12-02

subsequent to using the production tubing 14 to inject a fluid downhole, e.g., other pump types such as an electric submersible progressive cavity pump. The steam circulates back through an annulus 24 between the slave string 18 and the slotted liner 26 from the toe 22 toward the heel 20. The circulation returns flow uphole through an annulus 28 between the slave string 18 and the casing 30. Since the injected steam moving downhole is separated from the circulation returns by a single wall (i.e., via the slave string 18), a considerable amount of heat loss can occur in the build section. Such heat loss can cause issues such as increasing the volume of steam vapor returns to production facilities during circulation.

[0042] Referring now to FIG. 2, to address issues such as heat loss in the build section, the production tubing 14 that is normally coupled to the ESP 16 can include a bypass mechanism 40 between the terminal end of the production tubing 14 and the ESP 16 to enable the production tubing 14 to be used to carry injected fluid(s) during the circulation or bullheading phase (or any phase prior to using the ESP 16 or other downhole equipment coupled to the bypass mechanism 40). The bypass mechanism 40 not only allows the production tubing 14 to be used to inject fluids, but also redirects such injected fluids around the ESP 16 avoiding the need to pass therethrough. When the injected fluids are at a high temperature this can avoid subjecting the ESP 16 to such high temperatures. FIG. 2 illustrates an injection configuration, in which the production tubing 14 is used to inject a fluid such as steam. The bypass mechanism 40 is in an injection position (discussed further below). Since the fluid is injected down the production tubing 14, at least some heat loss through the wall of the slave string 18 can be avoided. Moreover, the annulus 12 between the production tubing 14 and the slave string 18 can be filled with a non-condensable “blanket” gas, e.g., natural gas, to further insulate the injected fluids.

[0043] FIG. 3 illustrates a production configuration in which the production tubing 16 is used to produce fluids to surface, using the mechanical lift provided by the ESP 16. Fluids that flow towards the production well 10 and through the slotted liner 26 continue to flow through the annulus 24 into the long tubing at the toe 22 of the production well 10 and are pumped through the ESP 16 and into the production tubing 14. To enable this configuration, the bypass mechanism 40 is changed, converted or otherwise adapted to permit the produced fluids to flow into and through the ESP 16 and bypass mechanism 40 as illustrated schematically in FIG. 3.

[0044] A cross-sectional view of an implementation of the bypass mechanism 140 is shown in FIG. 4. It can be appreciated that the implementation shown in FIG. 4 is one illustrative

Date Reçue/Date Received 2020-12-02

example and that various other bypass mechanisms 40 can be used without departing from the principles illustrated in FIGS. 2-3. The bypass mechanism 140 includes a pump interface portion 100 that couples or connects to the outlet of the ESP 16 to allow fluids pumped through the ESP 16 to flow into the production tubing 14. The interface portion 100 transitions to a production flow chamber 102 having an inner chamber 110 to contain and position a sliding sleeve 114. The inner chamber 110 includes a production portion 112, which is blocked by the sliding sleeve 114 in the injection configuration. The inner chamber 110 also includes an injection port 104, which in FIG. 4 is aligned with one or more bypass ports 116 in the sleeve 114. The injection port 104 follows a rim 106 extending from tubing interface 108. The tubing interface 108 contains the tubing side portion of the inner chamber 110, along which the sliding sleeve 114 can move. The tubing interface 108 also couples or connects to the production tubing 14.

[0045] The sliding sleeve 114 can include one or more sliding actuation features and FIG. 4 illustrates two such features. In this example, the sleeve 114 includes a beveled edge 124 to provide a profile for a sleeve ball to engage and push the sleeve 114 into the inner chamber 110 to align the bypass port(s) 116 with the production port 112 and at the same time block the injection port 104, as detailed below. The sleeve 114 in this example also includes a first shifting profile 118a on the production tubing side and a second shifting profile 118b on the ESP side of the bypass mechanism 140. The shifting profiles 118a, 118b provide gripping points for a shifting tool, as detailed below. A pair of collet pockets 121 can be included between the inner chamber 110 and the sliding sleeve 114 to provide a seating mechanism for a collet 120 that is aligned with the bypass port(s) 116. The collet 120 includes a resilient member that can engage the pockets 121 to align the bypass port(s) 116 with the injection and production ports 104, 112. A series of seals 142 can also be placed on either side of the injection and production ports 104, 112, which are seated in seal pockets 144 in the inner chamber 110 (see also FIG. 10). The seals 142 inhibit the leakage of fluids into the injection port 104 when in the production configuration and into the production port 112 when in the injection configuration.

[0046] To transition from the injection configuration shown in FIG. 4 to a production configuration shown in FIG. 7, the sliding sleeve 114 is moved from its position shown in FIG. 4 further into the inner chamber 110 with the collet 120 sliding from one collet pocket 121 to the next collet pocket 121. As noted above, this can be done using a sliding actuation feature such as a sleeve ball in a ball drop mechanism or a shifting tool, to name two. FIGS. 5a and 5b illustrate a ball drop mechanism. In FIG. 5a a sleeve ball 130 is dropped down the production tubing 14, engages the beveled edge 124, and pushes the sleeve 114 forward, blocking the injection port 104. The ball 130 then settles into a ball profile 122 in the tubing interface 108 to permit fluids to pass around the ball 130 as shown in FIG. 5b during a production phase in which the ESP 16 is being used to pump fluids to surface. It can be appreciated that the ball 130 can be left downhole as shown in FIG. 5b during the production phase and/or can be composed of a meltable and/or dissolvable material such as high density polyethylene (HDPE) to progressively open up the passage into the production tubing 14 as the ball 130 dissolves in the produced fluid(s).

[0047] As shown in FIG. 6, the shifting profiles 118a, 118b can also be used to shift the sliding sleeve 114 within the inner chamber 110. It can be appreciated that either of the profiles 118a, 118b can be engaged by the shifting tool. An example of a suitable shifting tool is a Halliburton Otis® positioning/shifting tool. Such a shifting tool is designed to engage either of the shifting profiles 118a, 118b that provide recesses in the sliding sleeve 114. When engaged, the shifting tool generates a “jarring” action and can include an automatic releasing feature to automatically release itself when it reaches its fully open or closed position as is known in the art.

[0048] FIG. 7 illustrates the production configuration of the bypass mechanism 140 in which the sliding sleeve 114 has been shifted to close the injection port 104 and open the production port 112. In this way, fluid pumped by the ESP 16 can flow through the ESP interface portion 100 and into the inner chamber 110 via the production port 112 and bypass port(s) 116. This allows produced fluids to be pumped to surface via the production tubing 14.

[0049] FIGS. 8a and 8b provide partial cross-sectional views side-by-side to illustrate the injection and production flow paths. It can be observed that the inner chamber of the housing ensures that injected fluids are directed to the exterior of the housing in the injection configuration and are permitted to flow from the outlet of the ESP 16 in the production configuration. The ports in the sleeve 114 can be slid into alignment with such ports in the housing.

[0050] FIG. 9 illustrates a schematic view of the sliding sleeve 114 in isolation to illustrate the plurality of bypass ports 116 aligned with a circumferential collet 120 and circumferential collet pocket 121. By aligning the collet 120 with the bypass ports 116, the bypass ports 116 can be selectively positioned adjacent the injection port 104 or the production port 112 when seated in the respective collet pocket 121.

[0051] FIG. 10 provides an enlarged view of the interface between the sliding sleeve 114 and the inner chamber 110 and/or tubing interface portion 108. This enlarged view illustrates in greater detail a seal 142 seated in a seal pocket 144 to inhibit leakage of fluids between portions of the housing as discussed above.

[0052] FIG. 11 provides an end view of the bypass mechanism 140 and FIG. 12 provides a cross-sectional end view of the bypass mechanism 140 to illustrate the flow areas provided by the injection port 104. These end views illustrate an upper cabling slot 200 and a lower cabling slot 202. One of these slots 200, 202 can be used to pass cabling for the ESP 16 through the bypass mechanism 140. The other of the slots 200, 202 can be used to pass instrumentation cabling, such as capillary lines (e.g., ½” and/or ¼”) for bottomhole temperature and pressure measurements, through the bypass mechanism 140. Also shown are a set of alignment notches/ridges 204 that can be used to enforce alignment of the sliding sleeve 114 in the inner chamber 110 to inhibit axial rotation of the sliding sleeve 114. The notches/ridges 204 can be used to maintain alignment of the ports 116, 104, 112 when converting the bypass mechanism 114 between the injection and production configurations.

[0053] Turning now to FIG. 13, a flow chart is provided which illustrates operations that can be performed in injecting and producing fluids in a production well as illustrated in FIGS. 2-3. At 300 the bypass mechanism 40, 140 can be coupled to an output of the pump, e.g., the ESP 16. At 302, the bypass mechanism 40, 140 can be coupled to production tubing 14 to position the bypass mechanism between the production tubing and the pump. In this example, it can be assumed that the bypass mechanism 40, 140 is in (or can be converted to) the injection configuration. At 304, the pump 16, bypass mechanism 40, 140 and production tubing 14 can be deployed into the wellbore, e.g., into the production well 10. At 306, fluids can be injected into the wellbore via the production tubing 14, thus diverting fluids around the pump 16 in the injection phase. At 308, the bypass mechanism 40, 140 can be converted from the injection configuration to a production configuration to permit the pump 16 and production tubing 14 to be used in a production phase. In this way, at 310, the pump 16 can be used to produce fluids via the production tubing 14.

[0054] For simplicity and clarity of illustration, where considered appropriate, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the examples described herein. However, it will be understood by those of ordinary skill in the

Date Reçue/Date Received 2020-12-02

art that the examples described herein may be practiced without these specific details. In other instances, well-known methods, procedures and components have not been described in detail so as not to obscure the examples described herein. Also, the description is not to be considered as limiting the scope of the examples described herein.

[0055] The examples and corresponding diagrams used herein are for illustrative purposes only. Different configurations and terminology can be used without departing from the principles expressed herein. For instance, components and modules can be added, deleted, modified, or arranged with differing connections without departing from these principles.

[0056] The steps or operations in the flow charts and diagrams described herein are just for example. There may be many variations to these steps or operations without departing from the principles discussed above. For instance, the steps may be performed in a differing order, or steps may be added, deleted, or modified.

[0057] Although the above principles have been described with reference to certain specific examples, various modifications thereof will be apparent to those skilled in the art as outlined in the appended claims.

Date Reçue/Date Received 2020-12-02

Claims:

1. A system for injecting and producing fluids in a production well, comprising:
production tubing extending into a wellbore;
a bypass mechanism coupled at a first side thereof to a distal end of the production tubing; and
a pump coupled at an outlet thereof to a second side of the bypass mechanism;
wherein the bypass mechanism is configured to divert fluids injected via the production tubing around the pump in an injection configuration and to permit fluids to be produced via the pump and production tubing in a production configuration.

2. The system of claim 1, wherein the production tubing is positioned within a slave string that is positioned within the wellbore.

3. The system of claim 2, wherein a blanket gas is provided in an annulus between the production tubing and the slave string.

4. The system of any one of claims 1 to 3, wherein the pump is an electric submersible pump.

5. The system of any one of claims 1 to 4, wherein the bypass mechanism comprises an actuation feature for converting the bypass mechanism from the injection configuration to the production configuration.

6. The system of claim 5, wherein the actuation feature comprises a sliding actuation of the bypass mechanism.

7. The system of claim 6, further comprising a ball drop mechanism to activate the actuation feature.

8. The system of claim 7, wherein a ball used in the ball drop mechanism is dissolvable or meltable in the produced fluids.

Date reçue/Date received 2023-03-31

9. The system of claim 6, further comprising a shifting tool to convert the bypass mechanism between the injection and production configurations.

10. The system of any one of claims 1 to 4, wherein the bypass mechanism comprises:

a housing, the housing comprising:

a pump interface to couple the bypass mechanism to the outlet of the pump;

a tubing interface to couple the bypass mechanism to a distal end of the production tubing;

an injection port positioned between the tubing interface and the pump interface, the injection port providing fluid communication between the production tubing and an exterior of the housing; and

a production port positioned between the injection port and the pump interface, the production port providing fluid communication between the production tubing and the pump interface;

a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in the injection configuration and to be aligned with the production port in the production configuration; and

a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

11. The system of claim 10, wherein the sliding sleeve comprises a plurality of bypass ports aligned circumferentially about the sliding sleeve.

12. The system of claim 10 or claim 11, wherein the sliding actuation feature comprises an edge of the sliding sleeve.

13. The system of claim 12, wherein the edge is beveled.

14. The system of any one of claims 10 to 13, wherein the housing comprises a sleeve ball profile.

Date reçue/Date received 2023-03-31

15. The system of any one of claims 10 to 14, wherein the sliding actuation feature comprises at least one shifting profile to engage a shifting tool insertable within the sliding sleeve.

16. The system of any one of claims 10 to 15, wherein the housing comprises an inner chamber to inhibit fluids from entering the pump outlet when the bypass mechanism is in the injection configuration.

17. The system of claim 16, wherein the bypass mechanism comprises at least one seal between the inner chamber and the sliding sleeve.

18. The system of claim 17, further comprising one or more collets to position the sliding sleeve within the inner chamber, the one or more collets interfacing with corresponding collet pockets in the inner chamber.

19. The system of any one of claims 10 to 18, wherein the housing and the sliding sleeve are keyed to inhibit rotational movement relative to each other.

20. The system of claim 19, wherein the housing and sliding sleeve are keyed using at least one complementary notch and ridge.

21. The system of any one of claims 10 to 20, wherein the housing comprises a slot to permit passage of cabling for the pump.

22. The system of any one of claims 10 to 21, wherein the housing comprises a slot to permit passage of instrumentation cabling.

23. A method of bypassing a pump in a production well, comprising:

coupling a bypass mechanism to an outlet of the pump;

coupling the bypass mechanism to production tubing to position the bypass mechanism between the production tubing and the pump, wherein the bypass mechanism is in an injection configuration which diverts fluids injected via the production tubing around the pump;

deploying the pump, bypass mechanism and production tubing into a wellbore; and injecting fluids into the wellbore via the production tubing, wherein the injected fluids are diverted around the pump by the bypass mechanism.

24. The method of claim 23, further comprising:

converting the bypass mechanism from the injection configuration to a production configuration to permit fluids to be produced via the pump; and

using the pump to produce fluids via the production tubing.

25. The method of claim 22 or claim 23, wherein the production tubing is positioned within a slave string that is positioned within the wellbore.

26. The method of claim 25, further comprising adding a blanket gas in an annulus between the production tubing and the slave string.

27. The method of any one of claims 23 to 26, wherein the pump is an electric submersible pump.

28. The method of any one of claims 23 to 27, wherein the bypass mechanism comprises an actuation feature for converting the bypass mechanism from the injection configuration to the production configuration.

29. The method of claim 28, wherein the actuation feature comprises a sliding actuation of the bypass mechanism.

30. The method of claim 29, further comprising using a ball drop mechanism to activate the actuation feature.

31. The method of claim 30, wherein a ball used in the ball drop mechanism is dissolvable or meltable in the produced fluids.

32. The method of claim 29, further comprising using a shifting tool to convert the bypass mechanism between the injection and production configurations.

33. The method of any one of claims 23 to 27, wherein the bypass mechanism comprises:

a housing, the housing comprising:

a pump interface to couple the bypass mechanism to the outlet of the pump;

a tubing interface to couple the bypass mechanism to a distal end of the production tubing;

an injection port positioned between the tubing interface and the pump interface, the injection port providing fluid communication between the production tubing and an exterior of the housing; and

a production port positioned between the injection port and the pump interface, the production port providing fluid communication between the production tubing and the pump interface;

a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in the injection configuration and to be aligned with the production port in the production configuration; and

a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

34. The method of claim 33, wherein the sliding sleeve comprises a plurality of bypass ports aligned circumferentially about the sliding sleeve.

35. The method of claim 33 or claim 34, wherein the sliding actuation feature comprises an edge of the sliding sleeve.

36. The method of claim 35, wherein the edge is beveled.

37. The method of any one of claims 33 to 36, wherein the housing comprises a sleeve ball profile.

38. The method of any one of claims 33 to 37, wherein the sliding actuation feature comprises at least one shifting profile to engage a shifting tool insertable within the sliding sleeve.

39. The method of any one of claims 33 to 38, wherein the housing comprises an inner chamber to inhibit fluids from entering the pump outlet when the bypass mechanism is in the injection configuration.

40. The method of claim 39, wherein the bypass mechanism comprises at least one seal between the inner chamber and the sliding sleeve.

41. The method of claim 40, further comprising one or more collets to position the sliding sleeve within the inner chamber, the one or more collets interfacing with corresponding collet pockets in the inner chamber.

42. The method of any one of claims 33 to 41, wherein the housing and the sliding sleeve are keyed to inhibit rotational movement relative to each other.

43. The method of claim 42, wherein the housing and sliding sleeve are keyed using at least one complementary notch and ridge.

44. The method of any one of claims 33 to 43, wherein the housing comprises a slot to permit passage of cabling for the pump.

45. The method of any one of claims 33 to 44, wherein the housing comprises a slot to permit passage of instrumentation cabling.

46. A bypass mechanism for diverting injected fluids around a downhole pump, comprising:
a housing, the housing comprising:
a pump interface to couple the bypass mechanism to an outlet side of the pump;
a tubing interface to couple the bypass mechanism to a distal end of production tubing extending into a wellbore;
an injection port positioned between the tubing interface and the pump interface, the injection port providing fluid communication between the production tubing and an exterior of the housing; and

a production port positioned between the injection port and the pump interface, the production port providing fluid communication between the production tubing and the pump interface;

a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in an injection configuration and to be aligned with the production port in a production configuration; and

a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

47. The bypass mechanism of claim 46, wherein the sliding sleeve comprises a plurality of bypass ports aligned circumferentially about the sliding sleeve.

48. The bypass mechanism of claim 46 or claim 47, wherein the sliding actuation feature comprises an edge of the sliding sleeve.

49. The bypass mechanism of claim 48, wherein the edge is beveled.

50. The bypass mechanism of any one of claims 46 to 49, wherein the housing comprises a sleeve ball profile.

51. The bypass mechanism of any one of claims 46 to 50, wherein the sliding actuation feature comprises at least one shifting profile to engage a shifting tool insertable within the sliding sleeve.

52. The bypass mechanism of any one of claims 46 to 51, wherein the housing comprises an inner chamber to inhibit fluids from entering the pump outlet when the bypass mechanism is in the injection configuration.

53. The bypass mechanism of claim 52, wherein the bypass mechanism comprises at least one seal between the inner chamber and the sliding sleeve.

54. The bypass mechanism of claim 53, further comprising one or more collets to position the sliding sleeve within the inner chamber, the one or more collets interfacing with corresponding collet pockets in the inner chamber.

55. The bypass mechanism of any one of claims 46 to 54, wherein the housing and the sliding sleeve are keyed to inhibit rotational movement relative to each other.

56. The bypass mechanism of claim 55, wherein the housing and sliding sleeve are keyed using at least one complementary notch and ridge.

57. The bypass mechanism of any one of claims 46 to 56, wherein the housing comprises a slot to permit passage of cabling for the pump.

58. The bypass mechanism of any one of claims 46 to 57, wherein the housing comprises a slot to permit passage of instrumentation cabling.

59. A system for injecting and producing fluids in a well, comprising:

tubing extending into a wellbore;

a bypass mechanism coupled at a first side thereof to a distal end of the tubing; and

equipment coupled at an outlet thereof to a second side of the bypass mechanism;

wherein the bypass mechanism is configured to divert fluids injected via the tubing around the equipment in an injection configuration and to permit fluids to be produced via the equipment and tubing in a production configuration.

60. The system of claim 59, wherein the tubing is positioned within a slave string that is positioned within the wellbore.

61. The system of claim 60, wherein a blanket gas is provided in an annulus between the tubing and the slave string.

62. The system of any one of claims 59 to 61, wherein the equipment comprises a pump.

63. The system of claim 62, wherein the pump is an electric submersible pump.

64. The system of any one of claims 59 to 63, wherein the bypass mechanism comprises an actuation feature for converting the bypass mechanism from the injection configuration to the production configuration.

65. The system of claim 64, wherein the actuation feature comprises a sliding actuation of the bypass mechanism.

66. The system of claim 65, further comprising a ball drop mechanism to activate the actuation feature.

67. The system of claim 66, wherein a ball used in the ball drop mechanism is dissolvable or meltable in the produced fluids.

68. The system of claim 65, further comprising a shifting tool to convert the bypass mechanism between the injection and production configurations.

69. The system of any one of claims 59 to 63, wherein the bypass mechanism comprises:

a housing, the housing comprising:

an equipment interface to couple the bypass mechanism to the outlet of the equipment;

a tubing interface to couple the bypass mechanism to a distal end of the tubing;

an injection port positioned between the tubing interface and the equipment interface, the injection port providing fluid communication between the tubing and an exterior of the housing; and

a production port positioned between the injection port and the equipment interface, the production port providing fluid communication between the tubing and the equipment interface;

a sliding sleeve positioned within the housing, the sliding sleeve comprising at least one bypass port to be aligned with the injection port in the injection configuration and to be aligned with the production port in the production configuration; and

a sliding actuation feature to permit the sliding sleeve to move between the injection and production configurations.

Date reçue/Date received 2023-03-31

70. The system of claim 69, wherein the sliding sleeve comprises a plurality of bypass ports aligned circumferentially about the sliding sleeve.

71. The system of claim 69 or claim 70, wherein the sliding actuation feature comprises an edge of the sliding sleeve.

72. The system of claim 71, wherein the edge is beveled.

73. The system of any one of claims 69 to 72, wherein the housing comprises a sleeve ball profile.

74. The system of any one of claims 69 to 73, wherein the sliding actuation feature comprises at least one shifting profile to engage a shifting tool insertable within the sliding sleeve.

75. The system of any one of claims 69 to 74, wherein the housing comprises an inner chamber to inhibit fluids from entering the equipment outlet when the bypass mechanism is in the injection configuration.

76. The system of claim 75, wherein the bypass mechanism comprises at least one seal between the inner chamber and the sliding sleeve.

77. The system of claim 76, further comprising one or more collets to position the sliding sleeve within the inner chamber, the one or more collets interfacing with corresponding collet pockets in the inner chamber.

78. The system of any one of claims 69 to 77, wherein the housing and the sliding sleeve are keyed to inhibit rotational movement relative to each other.

79. The system of claim 78, wherein the housing and sliding sleeve are keyed using at least one complementary notch and ridge.

80. The system of any one of claims 69 to 79, wherein the housing comprises a slot to permit passage of cabling for the equipment.

81. The system of any one of claims 69 to 80, wherein the housing comprises a slot to permit passage of instrumentation cabling.

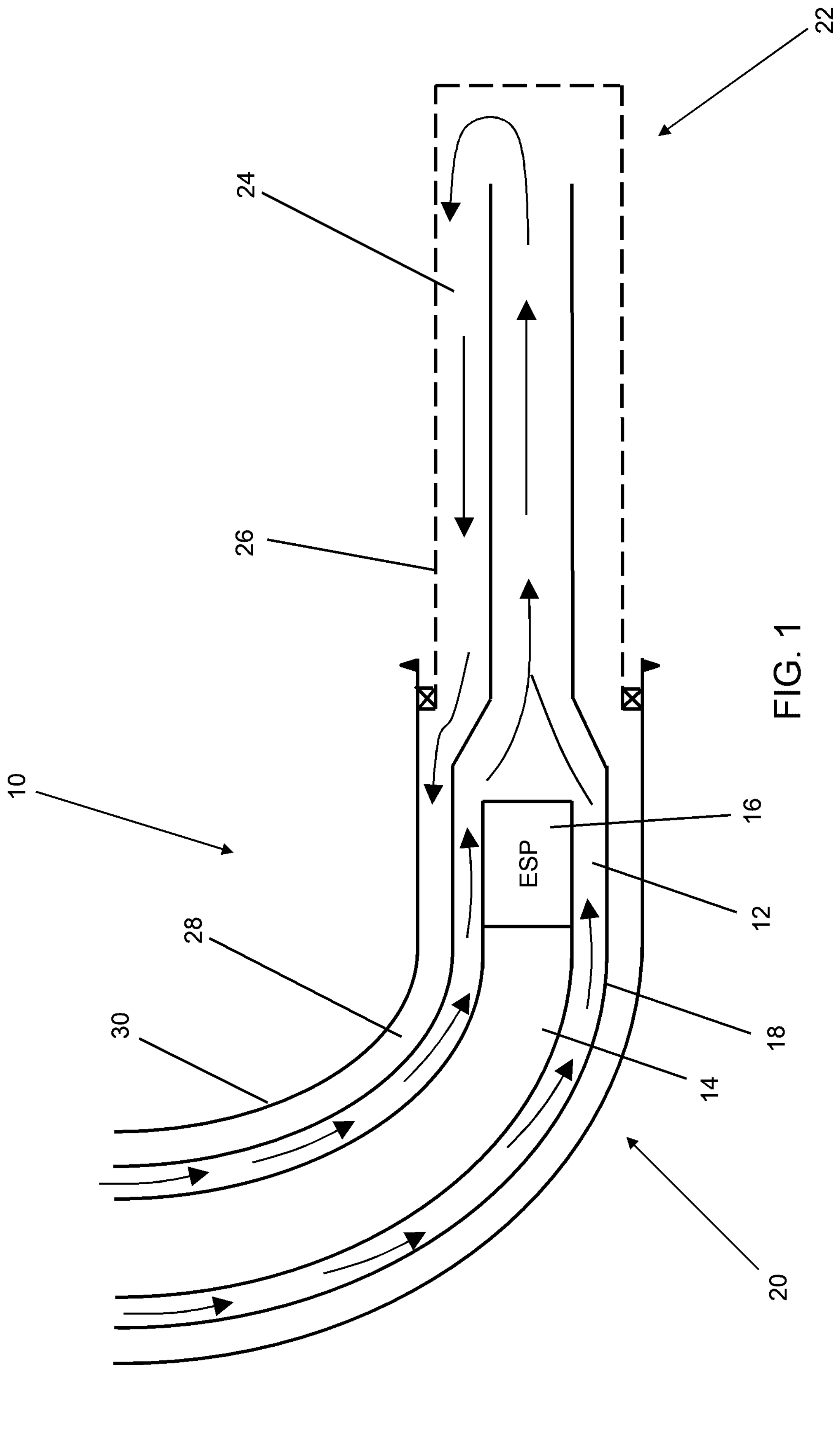


FIG. 1

PRIOR ART

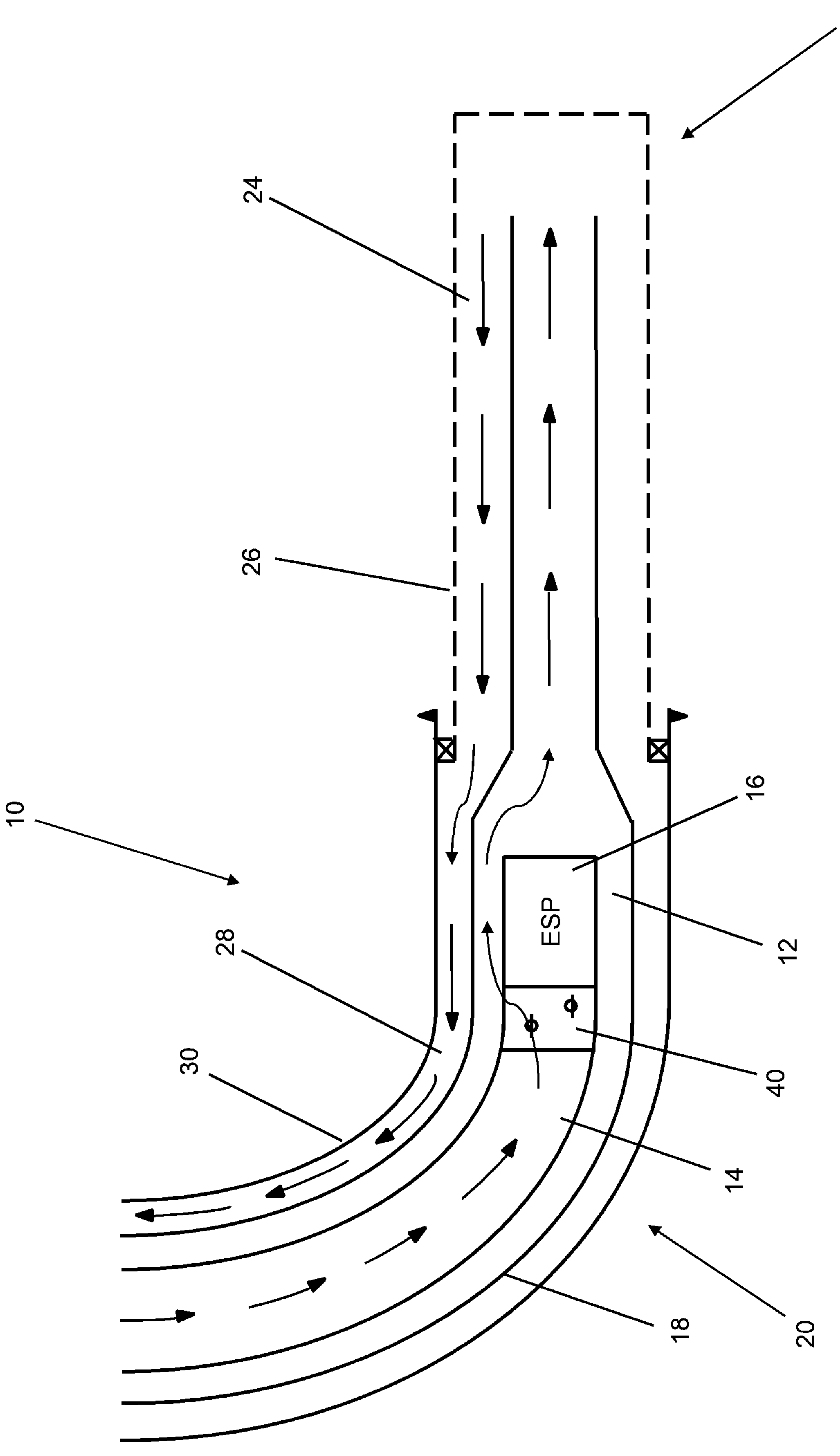


FIG. 2

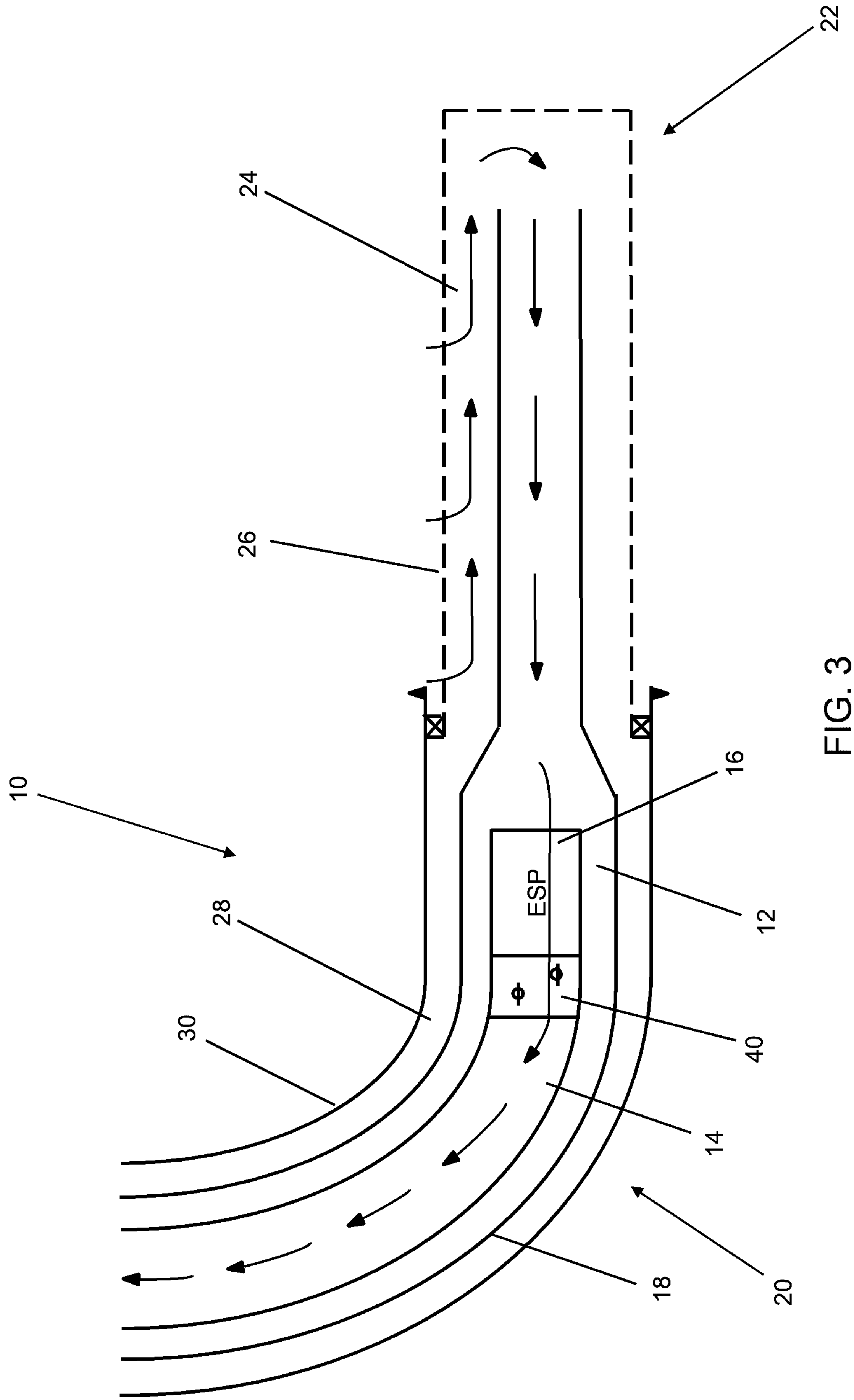


FIG. 3

Date Reçue/Date Received 2020-12-02

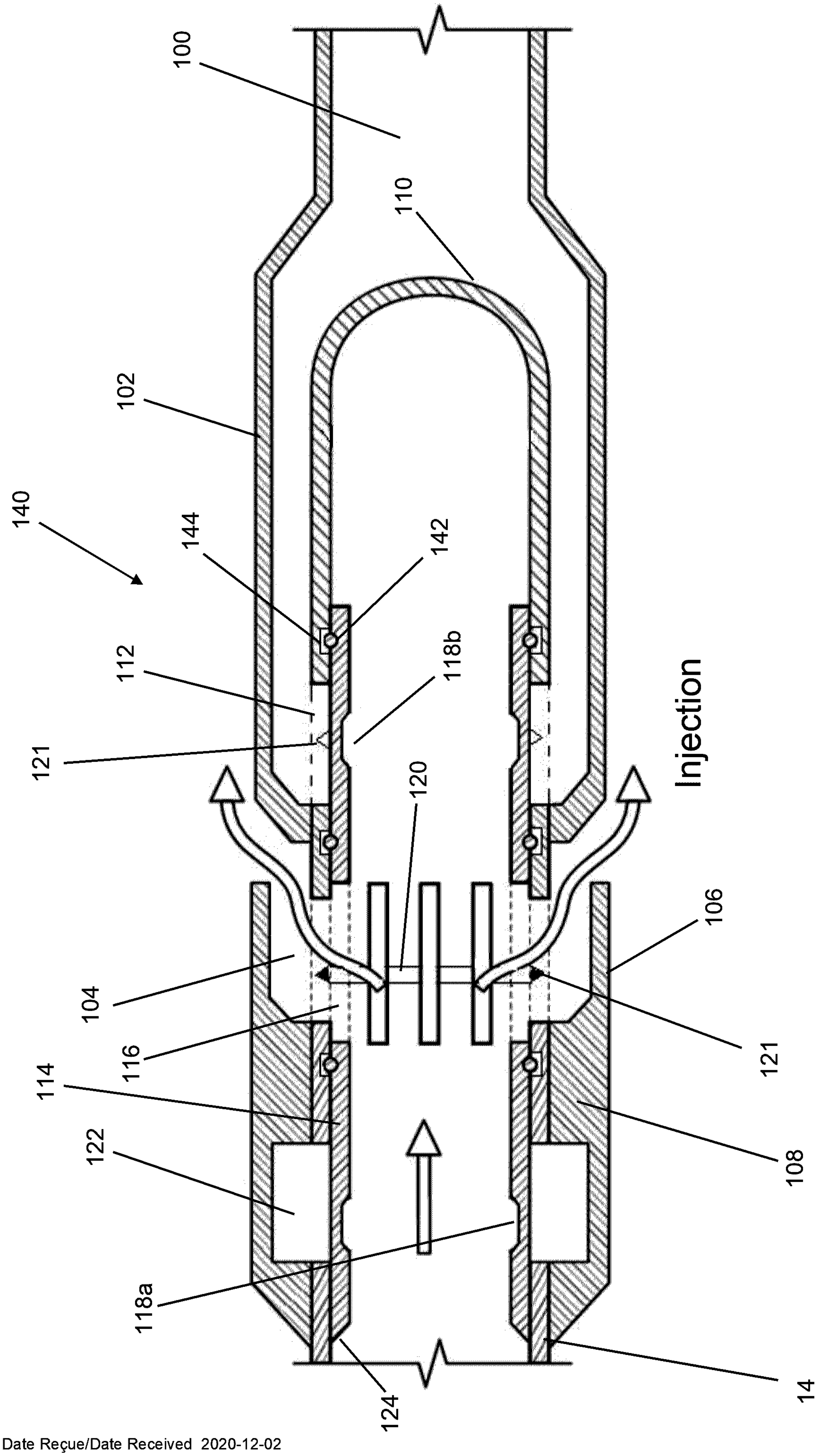

100
110
102
140
144
142
112
118b
121
120
Injection
106
104
116
121
114
108
122
118a
124
14

FIG. 4

Date Reçue/Date Received 2020-12-02

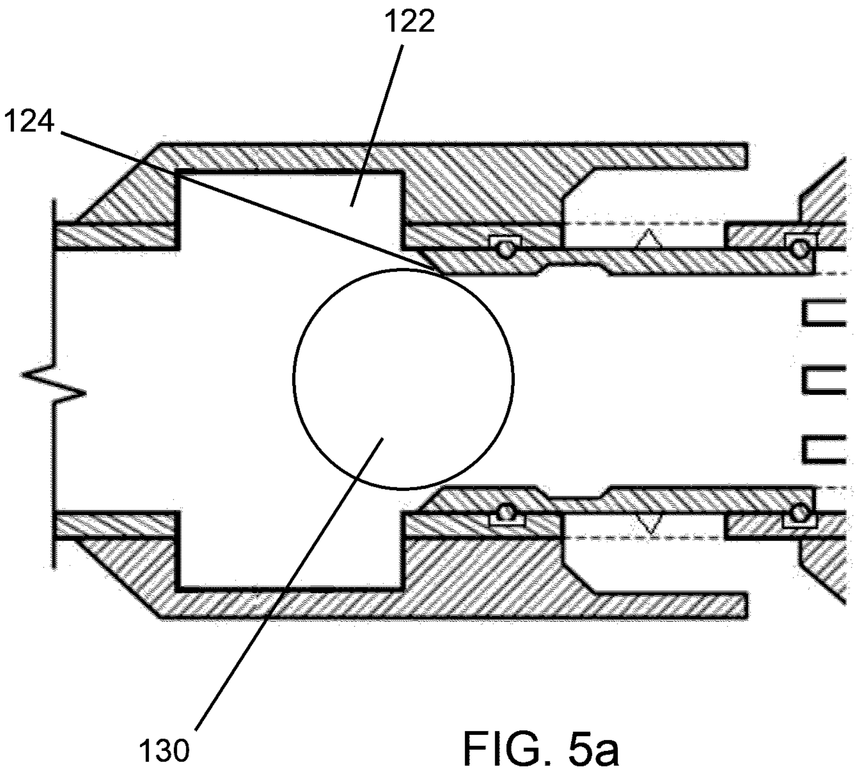


FIG. 5a

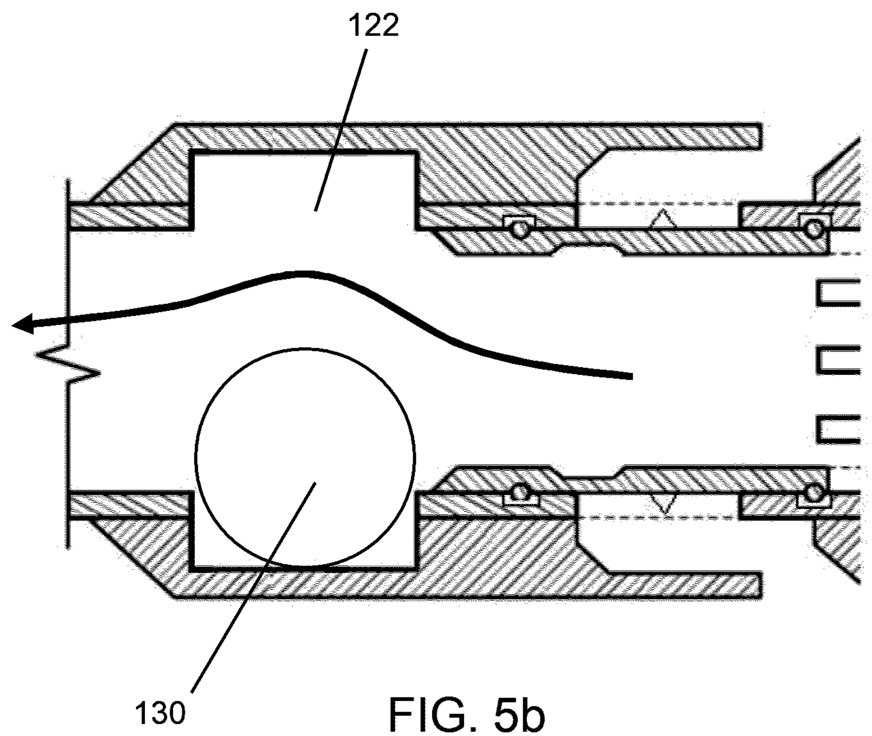


FIG. 5b

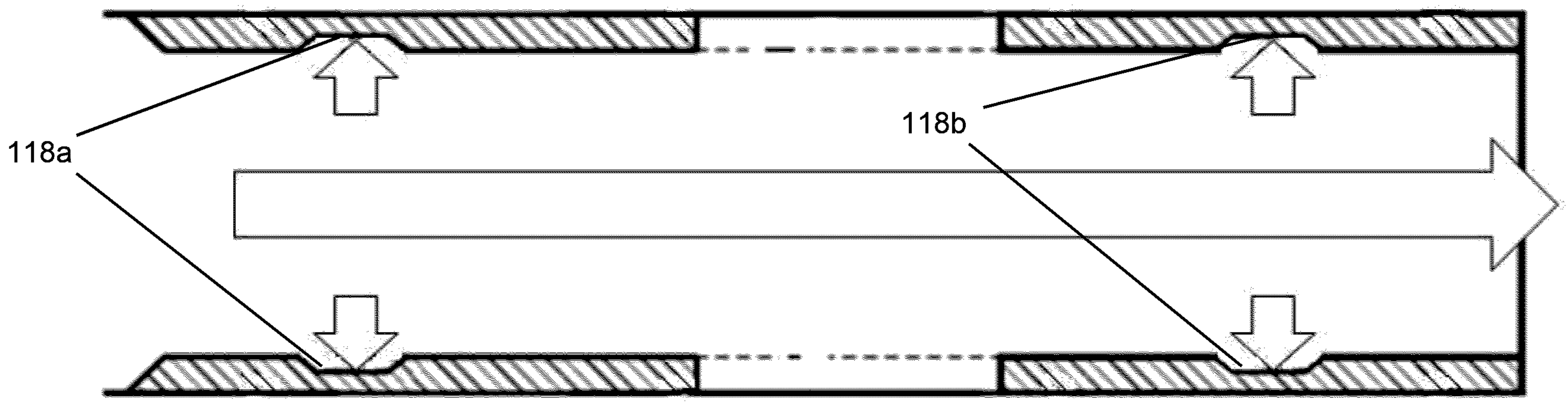
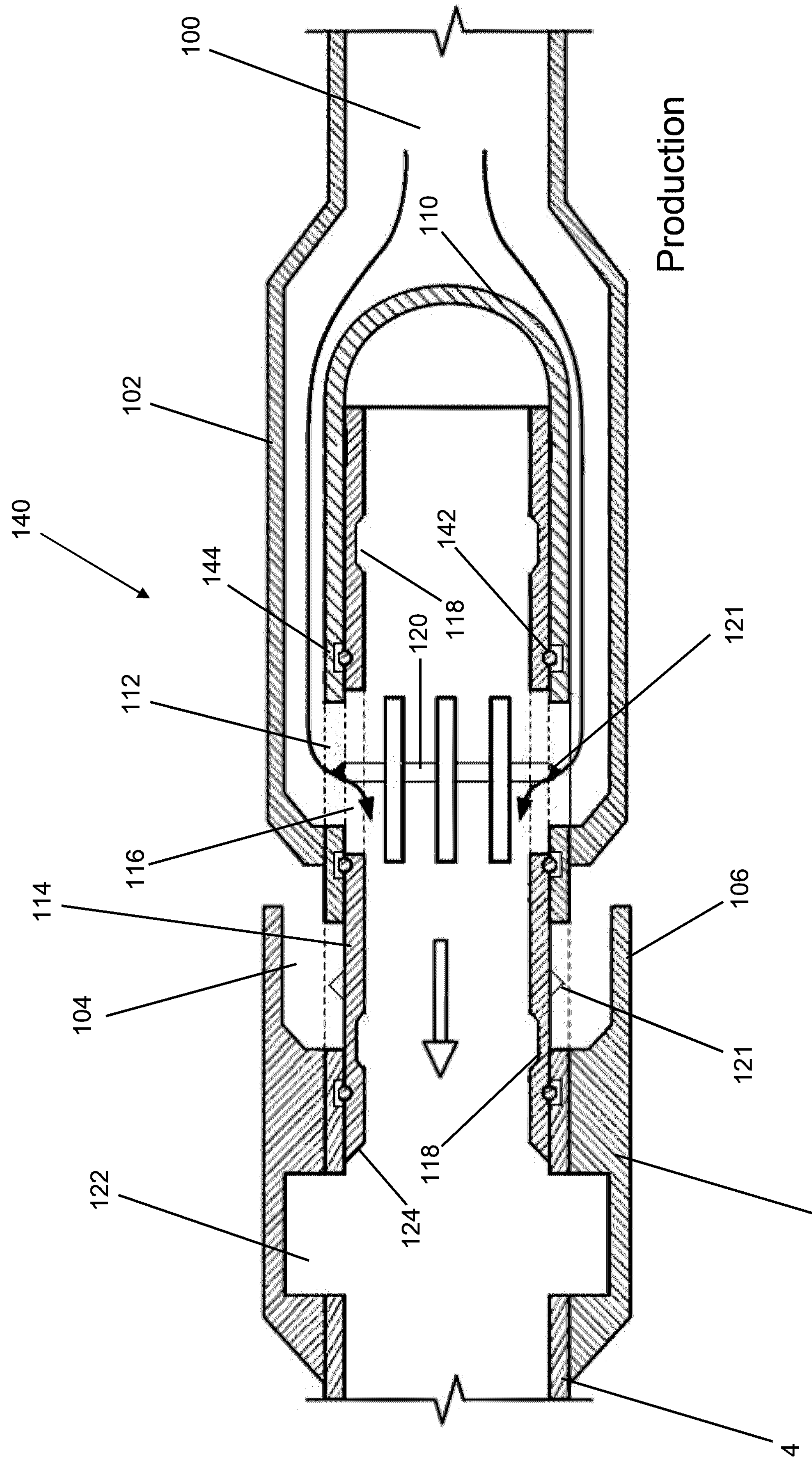


FIG. 6



100
Production
110
102
140
144
142
118
120
121
112
116
114
106
104
121
118
122
124
108
14

FIG. 7

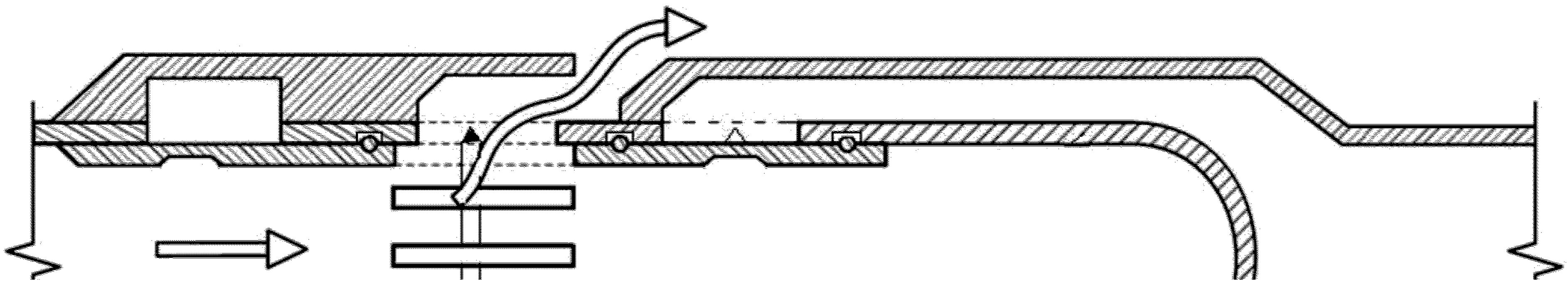


FIG. 8a

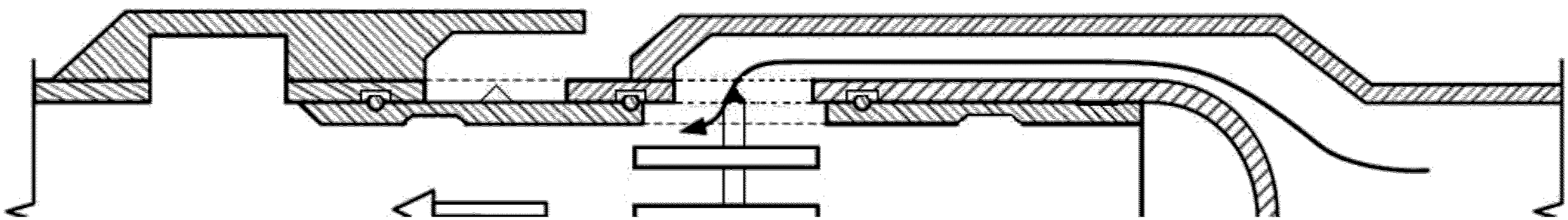


FIG. 8b

Date Reçue/Date Received 2020-12-02

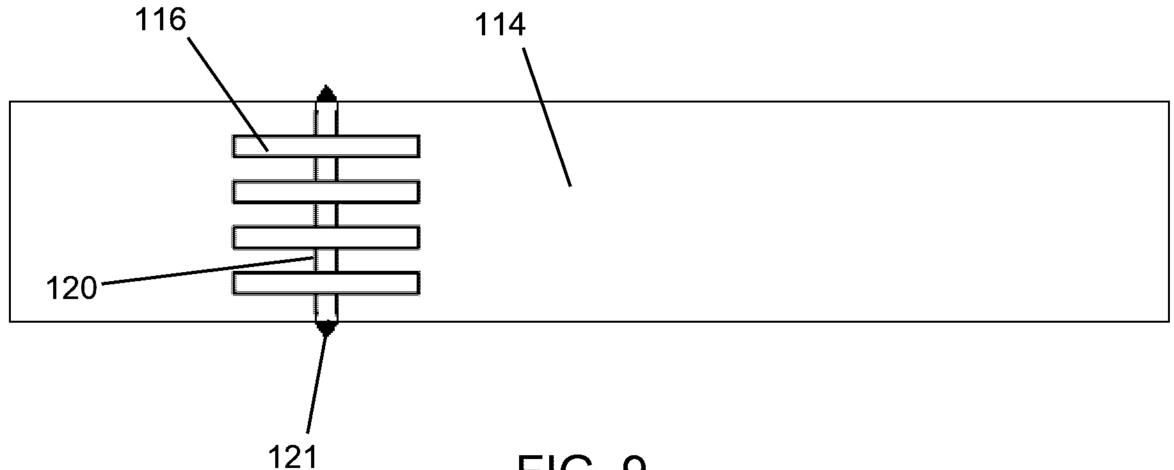


FIG. 9

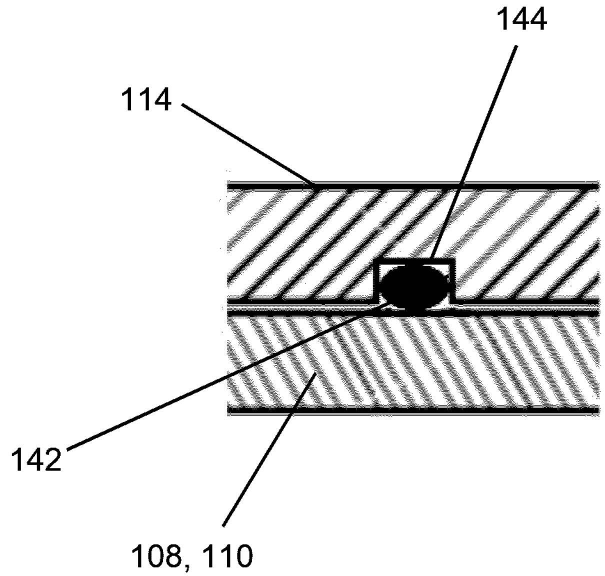


FIG. 10

Date Reçue/Date Received 2020-12-02

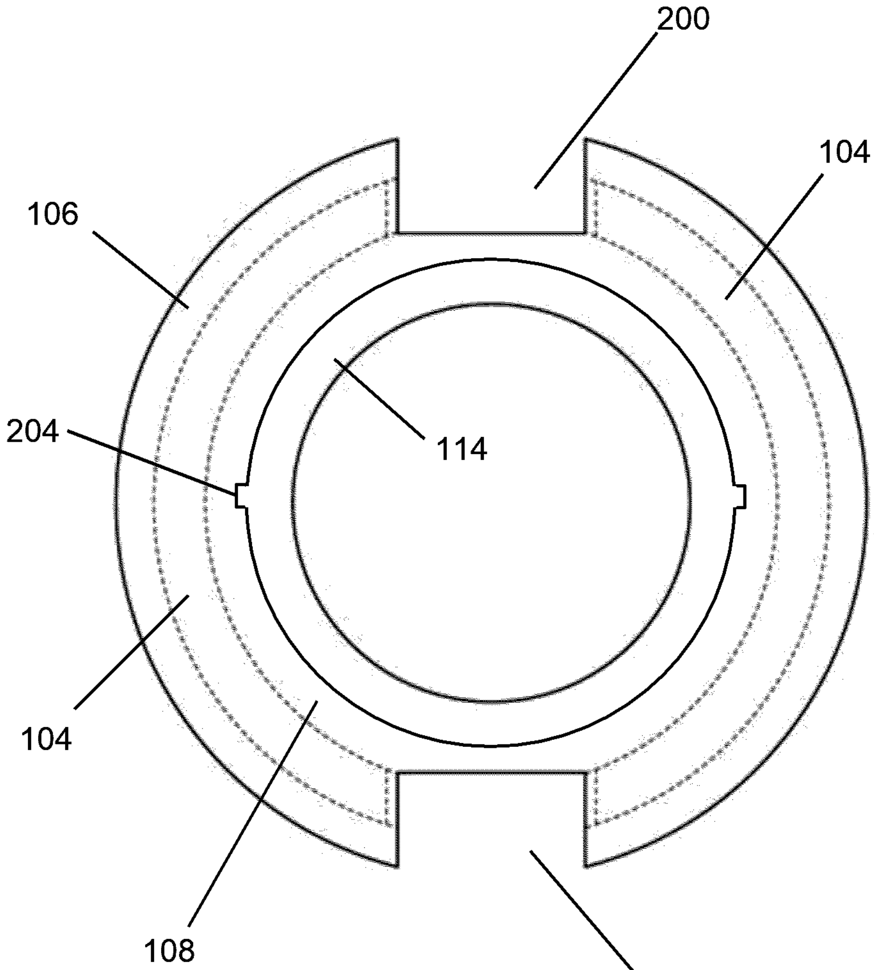


FIG. 11

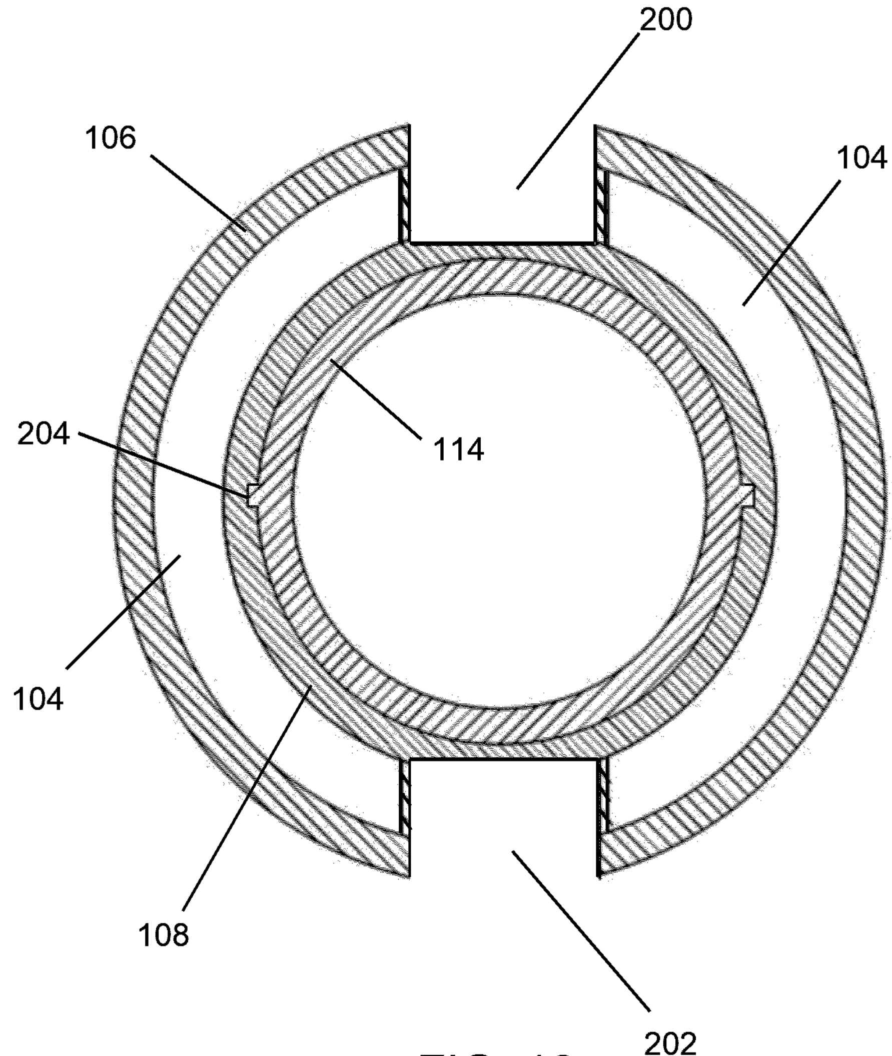


FIG. 12

Date Reçue/Date Received 2020-12-02

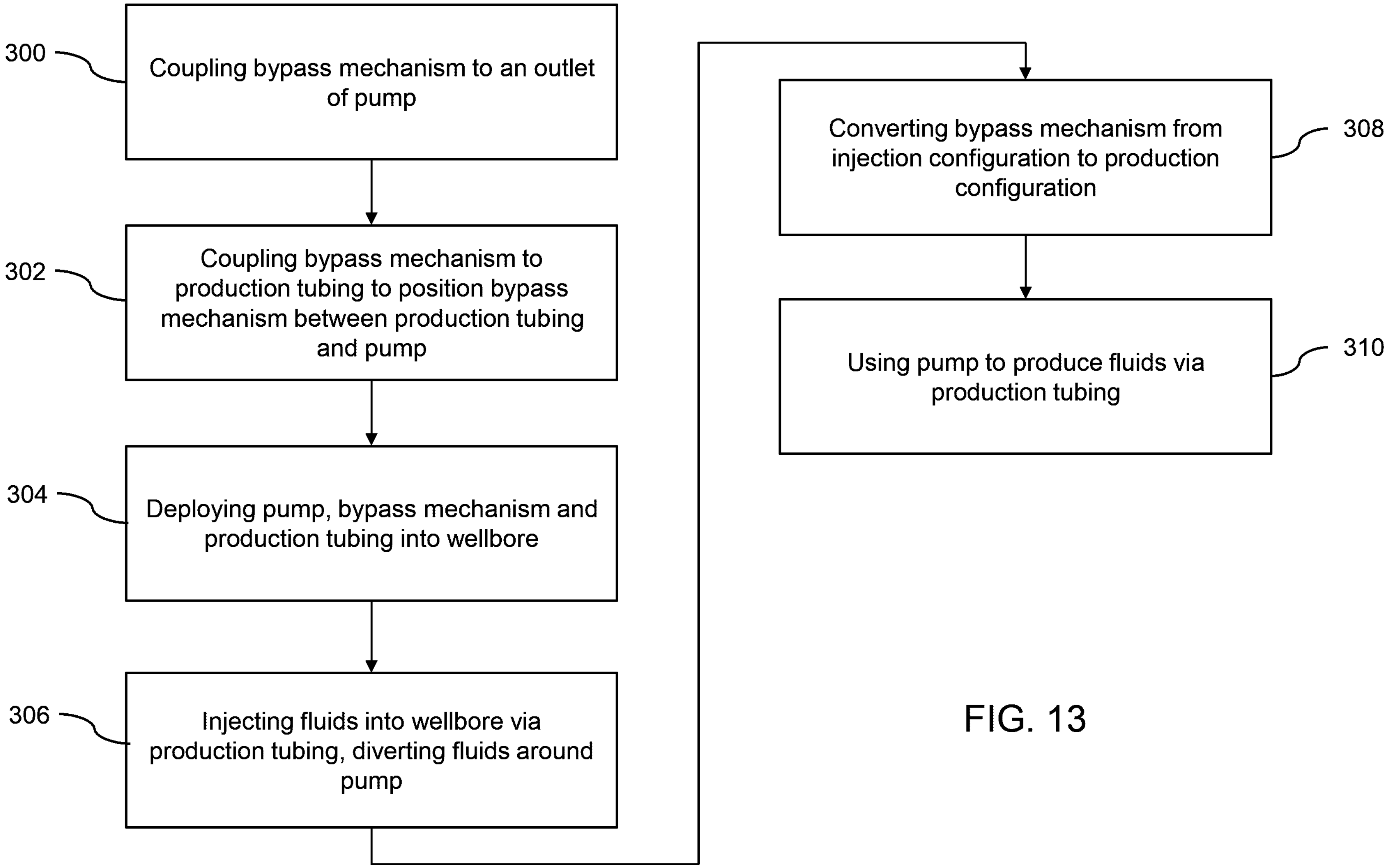
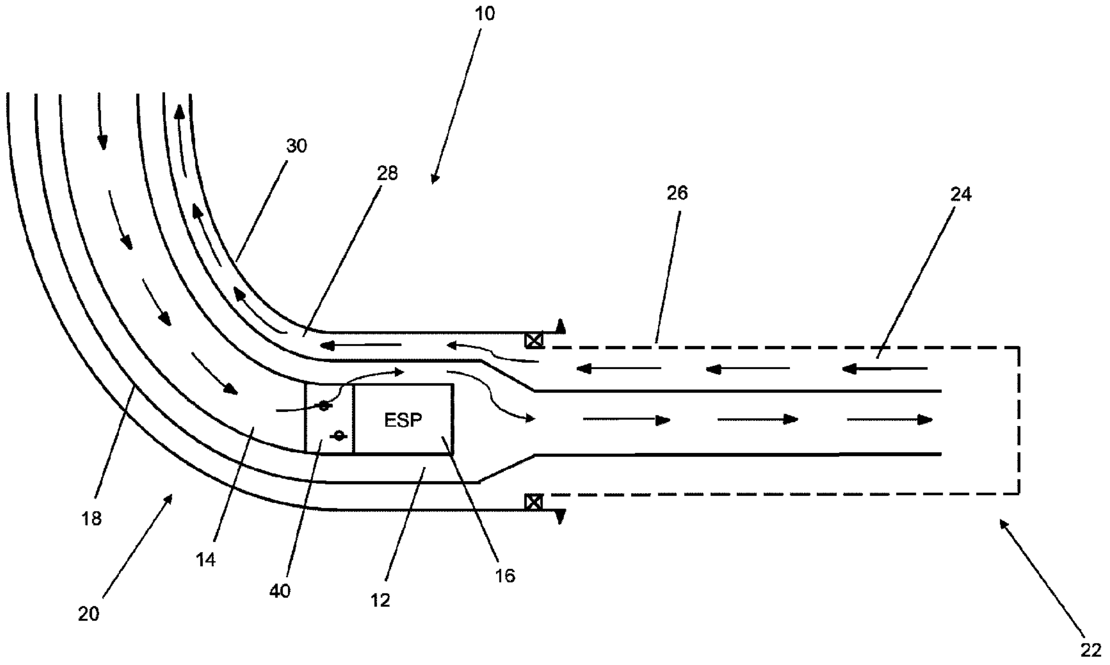


FIG. 13

Date Reçue/Date Received 2020-12-02



10
30
28
26
24
ESP
18
14
40
12
16
20
22