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(54) Inflow control device with fluid loss and gas production controls

(57) An inflow control device (26)for restricting flow into a passage of a tubular string in a wellbore includes at least two of a flow restrictor section (32), a fluid discriminator section (30) and a reverse flow preventer section (34), and the inflow control device is configured so that fluid which flows between an exterior of the tubular string and the passage also flows through each of the at least two sections. A well screen or liner includes a filter (20) or inlet portion and an inflow control device including a flow restrictor section, a fluid discriminator section, and a reverse flow preventer section, the inflow control device being configured so that fluid which flows through the filter portion also flows through the flow restrictor, fluid discriminator and reverse flow preventer sections.

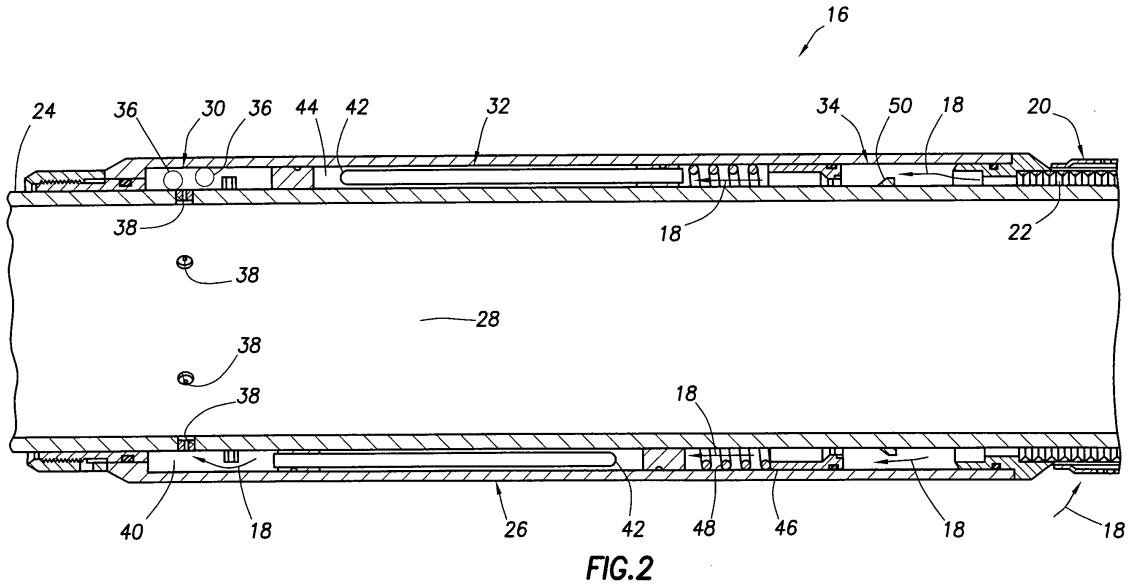

FIG.2

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Description

[0001] The present invention relates generally to equipment utilized and operations performed in conjunction with subterranean wells and, in an embodiment described herein, more particularly provides inflow control devices for sand control screens and open hole liners, such as but not limited to, slotted or perforated liners and any configuration of screens, liners and inflow control devices.

[0002] Certain well installations benefit from having a flow restriction device in a well screen. For example, such flow restriction devices have been useful in preventing water coning, balancing production from long horizontal intervals, etc. These flow restriction devices are sometimes referred to as "inflow control devices."

[0003] Unfortunately, typical inflow control devices do not provide fluid loss and gas production control. Thus, prior inflow control devices may be unsuited for certain situations where an overbalanced condition may exist, or restriction of gas production may be desired.

[0004] Therefore, it may be seen that improvements are needed in the art of well screens having inflow control devices. It is among the objects of the present invention to provide such improvements.

[0005] One aspect of the present invention provides an inflow control device as recited in the appended independent claim 1.

[0006] Ideally, the at least two flow sections includes the flow restrictor section, the flow restrictor section includes at least one tube, and the fluid which flows between the exterior of the tubular string and the passage also flows through an interior of the tube. The tube may be shaped so that the fluid which flows through the interior of the tube is forced to change momentum within the interior of the tube. Ideally, the at least two flow sections includes the fluid discriminator section, the fluid discriminator section including at least one body which increasingly restricts flow through at least one opening in response to an increased proportion of an undesired component in the fluid. The body may have a density less than that of oil, so that the body increasingly restricts flow through the opening when an increased proportion of gas is present in the fluid. The body may have a density approximately equal to that of formation water, so that the body increasingly restricts flow through the opening when an increased proportion of formation water is present in the fluid. Optionally, the at least two flow sections includes the reverse flow preventer section, and the reverse flow preventer section includes a check valve. The check valve may be positioned upstream of the flow restricting section.

[0007] A second aspect of the present invention provides an inflow control device as recited in the appended independent claim 4.

[0008] Ideally, the flow restrictor section includes at least one tube, and the fluid which flows between the exterior of the tubular string and the passage also flows through an interior of the tube. The tube may be shaped so that the fluid which flows through the interior of the tube is forced to change momentum within the interior of the tube.

[0009] The fluid discriminator section may include at least one body which increasingly restricts flow through at least one opening in response to an increased proportion of an undesired component in the fluid. The body may have a density less than that of oil, so that the body increasingly restricts flow through the opening when an increased proportion of gas is present in the fluid. The body may have a density approximately equal to that of formation water, so that the body increasingly restricts flow through the opening when an increased proportion of formation water is present in the fluid.

[0010] A third aspect of the present invention provides a well screen as recited in the appended independent claim 8.

[0011] The flow restrictor, fluid discriminator and reverse flow preventer sections may be configured in series, so that the fluid which flows through the filter portion also flows through each of the flow restrictor, fluid discriminator and reverse flow preventer sections.

[0012] The fluid which flows through the filter portion also flows through the reverse flow preventer section, then through the flow restrictor section, and then through the fluid discriminator section.

[0013] Ideally, the flow restrictor section includes at least one tube, and the fluid which flows through the filter portion also flows through an interior of the tube. The tube may be shaped so that the fluid which flows through the interior of the tube is forced to change momentum within the interior of the tube.

[0014] The fluid discriminator section may include at least one body which increasingly restricts flow through at least one opening in response to an increased proportion of an undesired component in the fluid. The body may have a density less than that of oil, so that the body increasingly restricts flow through the opening when an increased proportion of gas is present in the fluid. The body may have a density approximately equal to that of formation water, so that the body increasingly restricts flow through the opening when an increased proportion of formation water is present in the fluid.

[0015] A fourth aspect of the present invention provides a method as recited in the appended independent claim 10.

[0016] The at least two flow sections may be configured in series, and wherein the flowing step may further comprise the fluid flowing through each of the at least two flow sections in series. Ideally, the flowing step further comprises the fluid flowing between the exterior of the tubular string and the passage via each of the at least two flow sections.

[0017] Preferably, the at least two flow sections includes the flow restrictor section, the flow restrictor section includes at least one tube, and the flowing step further comprises the fluid flowing between the exterior of

the tubular string and the passage via an interior of the tube. The tube may be shaped so that the fluid which flows through the interior of the tube is forced to change momentum within the interior of the tube. The at least two flow sections may include the fluid discriminator section, and the flowing step may further comprise at least one body of the fluid discriminator section increasingly restricting flow through at least one opening in response to an increased proportion of an undesired component in the fluid. The body may have a density less than that of oil, so that the body increasingly restricts flow through the opening when an increased proportion of gas is present in the fluid. The body may have a density approximately equal to that of formation water, so that the body increasingly restricts flow through the opening when an increased proportion of formation water is present in the fluid. The at least two flow sections may include the reverse flow preventer section, and the reverse flow preventer section may include a check valve. The method may further comprise the step of expanding the inflow control device radially outward in the wellbore.

[0018] Further features of the present invention are provided as recited in the appended dependent claims.

[0019] In carrying out the principles of the present invention, a well screen and associated inflow control device are provided which solve at least one problem in the art. One example is described below in which the inflow control device is configured so that it performs multiple functions in controlling flow downhole. Another example is described below in which the inflow control device is conveniently constructed so that the multiple functions are performed in series as fluid flows between the interior and exterior of a tubular string in a well.

[0020] In one aspect, an inflow control device for controlling flow into a passage of a tubular string in a wellbore is provided. The inflow control device includes at least two of a flow restrictor section, a fluid discriminator section and a reverse flow preventer section. The inflow control device is configured so that fluid which flows between an exterior of the tubular string and the passage also flows through the at least two sections.

[0021] In another aspect, a well screen or other tubular string (such as a slotted or perforated liner, etc.) is provided which includes a filter portion and an inflow control device. The inflow control device includes a flow restrictor section, a fluid discriminator section, and a reverse flow preventer section. The inflow control device is configured so that fluid which flows through the filter portion also flows through the flow restrictor, fluid discriminator and reverse flow preventer sections.

[0022] These and other features, advantages, benefits and objects of the present invention will become apparent to one of ordinary skill in the art upon careful consideration of the detailed description of representative embodiments of the invention hereinbelow and the accompanying drawings, in which similar elements are indicated in the various figures using the same reference numbers.

[0023] In the accompanying drawings:

FIG. 1 is a schematic partially cross-sectional view of a well system embodying principles of the present invention;

FIG. 2 is an enlarged scale cross-sectional view of a well screen which may be used in the system of FIG. 1, the well screen including an inflow control device embodying principles of the present invention;

FIG. 3 is a cross-sectional view of the well screen with a reverse flow preventer section of the inflow control device being in a closed configuration;

FIG. 4 is an elevational view of the well screen with an outer housing of the inflow control device removed, and with the reverse flow preventer section in an open configuration;

FIG. 5 is an elevational view of the well screen with an outer housing of the inflow control device removed, and with the reverse flow preventer section in a closed configuration;

FIG. 6 is a cross-sectional view of an alternate configuration of the well screen including an alternate configuration of the inflow control device embodying principles of the present invention; and

FIG. 7 is an elevational view of the well screen of FIG. 6 with an outer housing of the inflow control device removed.

[0024] It is to be understood that the various embodiments of the present invention described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., and in various configurations, without departing from the principles of the present invention. The embodiments are described merely as examples of useful applications of the principles of the invention, which is not limited to any specific details of these embodiments.

[0025] In the following description of the representative embodiments of the invention, directional terms, such as "above", "below", "upper", "lower", etc., are used for convenience in referring to the accompanying drawings. In general, "above", "upper", "upward" and similar terms refer to a direction toward the earth's surface along a wellbore, and "below", "lower", "downward" and similar terms refer to a direction away from the earth's surface along the wellbore.

[0026] Representatively illustrated in FIG. 1 is a well system 10 which embodies principles of the present invention. A production tubing string 12 is installed in a wellbore 14 of a well. The tubing string 12 includes multiple well screens 16 positioned in an uncased generally horizontal portion of the wellbore 14.

[0027] One or more of the well screens 16 may be po-

sitioned in an isolated portion of the wellbore 14, for example, between packers 17 set in the wellbore. In addition, or alternatively, many of the well screens 16 could be positioned in a long, continuous portion of the wellbore 14, without packers isolating the wellbore between the screens.

[0028] The well screens 16 could alternatively be perforated or slotted liner, etc. Thus, it should be clearly understood that it is not necessary for the tubing string 12 to include any particular element and the term "well screen" can include elements such as slotted or perforated liners, etc.

[0029] Gravel packs could be provided about any or all of the well screens 16, if desired. A variety of additional well equipment (such as valves, sensors, pumps, control and actuation devices, etc.) could also be provided in the well system 10.

[0030] It should be clearly understood that the well system 10 is merely representative of one well system in which the principles of the invention may be beneficially utilized. However, the invention is not limited in any manner to the details of the well system 10 described herein. For example, the screens 16 could instead be positioned in a cased and perforated portion of a wellbore, the screens could be positioned in a generally vertical portion of a wellbore, the screens could be used in an injection well, rather than in a production well, etc.

[0031] Referring additionally now to FIG. 2, an enlarged scale schematic cross-sectional view of the screen 16 is representatively illustrated. The well screen 16 may be used in the well system 10, or it may be used in any other well system in keeping with the principles of the invention.

[0032] A fluid 18 flows inwardly through a filter portion 20 of the screen 16. The filter portion 20 is depicted in FIG. 2 as being made up of wire wraps with an outer shroud, but other types of filter material (such as mesh, sintered material, pre-packed granular material, etc.) may be used in other embodiments. If the screen 16 is a perforated or slotted liner, etc., then the filter portion 20 could be the slots, perforations, or other inlet portion thereof.

[0033] The fluid 18 enters an annular space 22 between the filter portion 20 and a tubular base pipe 24 of the screen 16. The fluid 18 then passes through an inflow control device 26, and via openings 38 into a flow passage 28 extending longitudinally through the screen 16. When interconnected in the tubing string 12 in the well system 10 of FIG. 1, the flow passage 28 is a part of a flow passage extending through the tubing string.

[0034] Although the flow passage 28 is depicted in FIG. 2 and others of the drawings as extending internally through the filter portion 20, it will be appreciated that other configurations are possible in keeping with the principles of the invention. For example, the flow passage could be external to the filter portion, in an outer shroud of the screen 16, etc.

[0035] The inflow control device 26 includes a fluid discriminator section 30, a flow restrictor section 32 and a reverse flow preventer section 34. These sections 30, 32, 34 are preferably configured in series, so that the fluid 18 flows through the sections in succession. Although three of the sections 30, 32, 34 are illustrated in FIG. 2 and described below, it should be understood that, in appropriate circumstances, any two of the sections could be used instead.

[0036] As depicted in FIG. 2, the fluid 18 flows first into the filter portion 20, then through the reverse flow preventer section 34, then through the flow restrictor section 32, then through the fluid discriminator section 30, and then into the passage 28. However, it should be clearly understood that any order of these elements may be used in keeping with the principles of the invention. For example, the reverse flow preventer section 34 could be downstream of the flow restrictor 32 and/or fluid discriminator 30 sections, the filter portion 20 could be downstream of the inflow control device 26, etc.

[0037] The fluid discriminator section 30 is configured to prevent, or at least restrict, flow of undesired fluid components (e.g., formation water and/or gas) into the passage 28. Preferably, the section 30 includes multiple bodies 36 which operate to restrict or prevent flow through multiple openings 38 formed in the base pipe 24.

[0038] The bodies 36 may be spherical in shape and the openings 38 may be cylindrical in shape, or other shapes may be used, if desired. Note that some of the bodies 36 may be designed to restrict flow of one undesired fluid component, and others of the bodies may be designed to restrict flow of another undesired fluid component. Alternatively, all of the bodies 36 may be designed to restrict flow of the same undesired fluid component.

[0039] The openings 38 are spaced apart circumferentially about the base pipe 24, so that some of the openings are vertically higher than others of the openings. If the bodies 36 have a density which is less than that of oil, then when the fluid 18 contains a sufficiently large proportion of oil, the bodies will be grouped at the top of a chamber 40 of the section 30, away from most of the openings 38 (as depicted in FIG. 2), and flow of the fluid through the openings will be relatively unrestricted.

[0040] However, as the proportion of gas in the fluid 18 increases, the bodies 36 will be suspended progressively further downward in the chamber 40, and the flow of the fluid will cause the bodies to engage the openings 38 and plug or at least increasingly restrict flow through the openings as the bodies descend in the chamber. If the bodies 36 engage and increasingly restrict, but do not completely prevent, flow through the openings 38, then some significantly reduced flow of the fluid 18 will still be permitted through these openings.

[0041] As another alternative, at least one of the openings 38 could be configured or positioned so that the bodies 36 cannot prevent flow through the opening. This would allow some bypass flow through that opening, even though the bodies 36 may have engaged all of the

other openings 38.

[0042] The fluid discriminator section 30 could, for example, utilize any of the fluid discriminating and/or bypass features described in U.S. patent application no. 10/477440, filed March 29, 2004, the entire disclosure of which is incorporated herein by this reference.

[0043] In the well system 10, this will result in increased restriction of flow through those screens 16 which are producing a greater proportion of gas. Therefore, a greater proportion of oil will be produced from the well.

[0044] If the bodies have a density which is approximately equal to that of formation water, then when the fluid 18 contains a sufficiently large proportion of oil, the bodies will be grouped at the bottom of the chamber 40, away from most of the openings 38, and flow of the fluid through the openings will be relatively unrestricted.

[0045] However, as the proportion of formation water in the fluid 18 increases, the bodies 36 will be suspended progressively further upward in the chamber 40, and the flow of the fluid will cause the bodies to engage the openings 38 and plug or at least increasingly restrict flow through the openings as the bodies ascend in the chamber. If the bodies 36 engage and increasingly restrict, but do not completely prevent, flow through the openings 38, then some significantly reduced flow of the fluid 18 will still be permitted through these openings.

[0046] As another alternative, at least one of the openings 38 could be configured or positioned so that the bodies 36 cannot prevent flow through the opening. This would allow some bypass flow through that opening, even though the bodies 36 may have engaged all of the other openings 38.

[0047] In the well system 10, this will result in increased restriction of flow through those screens 16 which are producing a greater proportion of water. Therefore, a greater proportion of oil will be produced from the well.

[0048] By using a combination of bodies 36, some of which have a density less than that of oil, and some of which have a density approximately equal to that of formation water, production of both undesirable components (gas and formation water) can be reduced. Examples of fluid discriminators which restrict production of both gas and formation water are described in U.S. patent application no. 11/466022, filed August 21, 2006, the entire disclosure of which is incorporated herein by this reference.

[0049] The flow restrictor section 32 preferably includes multiple flow restrictors 42 for restricting flow of the fluid 18. Such flow restriction is desirable in some circumstances, for example, to deter water or gas coning, to regulate flow distribution along a wellbore, etc.

[0050] In the section 32, the restrictors 42 are preferably in the form of tubes, and most preferably the tubes are curved in a manner which forces the fluid 18 to change momentum within the tubes (due to a change in direction of flow within the tube). In addition, the fluid 18 is forced to change direction in flowing between the restrictors 42 in a chamber 44 of the section 32. This change in direction between the restrictors 42 may be more clearly seen in the view of FIG. 4.

[0051] The use of tubes for the restrictors 42 is preferable because the tubes provide relatively large passages therein which are less easily obstructed by debris, as compared to an orifice or nozzle having an equivalent restriction to flow. However, other types of restrictors (such as orifices, nozzles, tortuous passages, etc.) may be used instead of, or in addition to, the tube restrictors 42 if desired. Examples of various combinations of restrictor types are described in U.S. patent application no. 11/668024, filed January 29, 2007, the entire disclosure of which is incorporated herein by this reference.

[0052] Note that functions of the flow restrictor section 32 could be combined with those of the fluid discriminator section 30, if desired. For example, the openings 38 could serve as the flow restrictors of the flow restrictor section 32 if the openings are small enough to induce a significant pressure drop in the flow of the fluid 18 through the openings. In that case, the openings 38 could be provided in the form of nozzles or orifices.

[0053] Of course, the openings 38 could also serve as flow restrictors in addition to the flow restrictors 42, if desired. In that case, the section 30 could perform both the fluid discriminating and flow restricting functions, and the section 32 could perform an additional flow restricting function. Thus, any combination of the functions performed by any of the sections 30, 32, 34 may be performed by any of the other sections, or any combination of the sections, in keeping with the principles of the invention.

[0054] The reverse flow preventer section 34 is preferably used as a fluid loss control device. For example, in completion operations it sometimes occurs that an overbalanced condition results in loss of completion fluids into a formation surrounding a wellbore. This not only causes loss of expensive completion fluid, but can also lead to skin damage in the formation.

[0055] Furthermore, while running a tubular string (such as the tubing string 12 in the well system 10) into a wellbore, it is preferable to be able to circulate through the tubular string. When the tubular string includes well screens, it is desirable to prevent the circulating flow from passing through the screens.

[0056] As depicted in FIG. 2, the reverse flow preventer section 34 permits flow of the fluid 18 into the well screen 16, from an exterior of the tubing string 12 (when used in the well system 10) to the interior passage 28, but prevents a reverse direction of flow. When positioned between the filter portion 20 and the flow restrictor section 32 as shown in FIG. 2, the section 34 permits flow from the filter portion to the flow restrictor section, but prevents flow from the flow restrictor section to the filter portion. Of course, the section 34 could be otherwise positioned in the inflow control device 26 without departing from the principles of the invention.

[0057] The section 34 preferably includes a check valve made up of an annular shuttle 46, a biasing device

48 (such as a spring) and a seat 50. The biasing device 48 biases the shuttle 46 toward the seat 50 to close off flow through the section 34. A sufficient pressure differential across the section 34 will overcome the biasing force exerted by the device 48 and will allow the shuttle 46 to displace away from the seat 50, thereby permitting flow through the section (as depicted in FIG. 2).

[0058] The check valve 46, 48, 50 is shown in its closed configuration in FIGS. 3 and 5. The check valve 46, 48, 50 is shown in its open configuration in FIGS. 2 and 4.

[0059] Note that other types of reverse flow preventing devices may be used in keeping with the principles of the invention. For example, descriptions of reverse flow preventing devices for use with well screens are contained in U.S. patent nos. 7108083, 6857476, 6886634 and 7096945, the entire disclosures of which are incorporated herein by this reference.

[0060] Referring additionally now to FIGS. 6 and 7, an alternate configuration of the well screen 16 is representatively illustrated. In FIG. 7, the inflow control device 26 is shown with an outer housing removed therefrom. The configuration of FIGS. 6 and 7 differs significantly from the configuration of FIGS. 2-5, in that the fluid discriminator section 30 is positioned upstream of the reverse flow preventer section 34 and downstream of the filter portion 20, and different types of fluid discriminator and flow restrictor sections 30, 32 are used.

[0061] As depicted in FIG. 6, the fluid discriminator section 30 includes the bodies 36 which have a density approximately equal to that of formation water. The bodies 36 engage and seal off (or at least increasingly restrict flow through) horizontally extending and vertically distributed openings 52 formed through an annular bulkhead 54 as the fluid 18 contains an increased proportion of formation water. The openings 52 could also serve as flow restrictors, for example, in the form of orifices or nozzles, etc., as described above for the openings 38.

[0062] Note that the section 30 could also, or alternatively, include the bodies 36 which have a density less than oil, so that flow is increasingly restricted through progressively more of the openings 52 as the fluid 18 contains an increased proportion of gas. Thus, the section 30 could function to exclude (or at least increasingly restrict) flow of the fluid 18 which includes a substantial proportion of gas and/or formation water. If the bodies 36 engage and increasingly restrict, but do not completely prevent, flow through the openings 52, then some significantly reduced flow of the fluid 18 will still be permitted through these openings.

[0063] As another alternative, at least one of the openings 52 could be configured or positioned so that the bodies 36 cannot prevent flow through the opening. This would allow some bypass flow through that opening, even though the bodies 36 may have engaged all of the other openings 52.

[0064] The fluid discriminator section 30 could, for example, utilize any of the fluid discriminating and/or bypass features described in U.S. patent application no. 10/477440, filed March 29, 2004, the entire disclosure of which is incorporated herein by this reference.

[0065] The flow restrictor section 32 of FIG. 6 includes the flow restrictor 42 in the form of a helical structure which forces the fluid 18 flowing therethrough to follow a helical flowpath. As discussed above, the flow restrictor section 32 may include any type of flow restrictor, any number of flow restrictors, and any combination of different types of flow restrictors.

[0066] The configurations of the well screen 16 described above and depicted in FIGS. 2-7 could be expanded radially outward downhole, if desired. For example, such expansion of the well screen 16 could provide a larger flow passage 28 for production/injection and access, the expanded well screen could provide support for the wellbore 14 to prevent collapse, eliminate or reduce the need for gravel packing, etc.

[0067] To expand the well screen 16, a drift, inflatable membrane or other expansion device may be positioned in the passage 28, and pressure or force may be applied to radially outwardly deform the well screen. Any procedures and equipment may be used to expand the well screen 16 (including the inflow control device 26) in keeping with the principles of the invention.

[0068] It may now be fully appreciated that the well screen 16 has many benefits over prior well screens. One important benefit is due to use of the inflow control device 26 in the well screen 16. For example, the inflow control device 26 is capable of preventing reverse flow through the section 34, desirably restricting flow through the section 32, and reducing flow of undesirable fluid components through the section 30.

[0069] Accordingly, the well screen 16 has been described as including the filter portion 20 and the inflow control device 26 which includes the flow restrictor section 32, the fluid discriminator section 30, and the reverse flow preventer section 34. The inflow control device 26 is preferably configured so that the fluid 18 which flows through the filter portion 20 also flows through the flow restrictor, fluid discriminator and reverse flow preventer sections 32, 30, 34.

[0070] The flow restrictor, fluid discriminator and reverse flow preventer sections 32, 30, 34 may be configured in series, so that the fluid 18 which flows through the filter portion 20 also flows through each of the flow restrictor, fluid discriminator and reverse flow preventer sections. The fluid 18 may flow from the filter portion 20 to the reverse flow preventer section 34, then through the flow restrictor section 32, and then through the fluid discriminator section 30.

[0071] The flow restrictor section 32 may include at least one tube restrictor 42, and the fluid 18 may flow through an interior of the tube. The tube may be shaped so that the fluid 18 which flows through the interior of the tube is forced to change momentum within the interior of the tube.

[0072] The fluid discriminator section 30 may include at least one body 36 which increasingly restricts flow

through at least one opening 38 in response to an increased proportion of an undesired component in the fluid 18. One or more of the bodies 36 may have a density less than that of oil, so that the bodies increasingly restrict flow through the openings 38 when an increased proportion of gas is present in the fluid 18. One or more of the bodies 36 may have a density approximately equal to that of formation water, so that the bodies increasingly restrict flow through the opening when an increased proportion of formation water is present in the fluid 18.

[0073] The reverse flow preventer section 34 may include a check valve 46, 48, 50. The check valve may be positioned downstream of the filter portion 20 and upstream of the flow restricting section 32.

[0074] Of course, a person skilled in the art would, upon a careful consideration of the above description of representative embodiments of the invention, readily appreciate that many modifications, additions, substitutions, deletions, and other changes may be made to these specific embodiments, and such changes are within the scope of the principles of the present invention. Accordingly, the foregoing detailed description is to be clearly understood as being given by way of illustration and example only.

Claims

1. An inflow control device for controlling flow into a passage of a tubular string in a wellbore, the inflow control device comprising:

   at least two flow sections selected from a flow restrictor section, a fluid discriminator section, and a reverse flow preventer section, and
   wherein the inflow control device is configured so that fluid which flows between an exterior of the tubular string and the passage also flows through each of the at least two flow sections.

2. An inflow control device according to claim 1, wherein the at least two flow sections are configured in series, so that the fluid which flows between the exterior of the tubular string and the passage also flows through each of the at least two flow sections.

3. An inflow control device according to claim 2, wherein the fluid which flows between the exterior of the tubular string and the passage also flows through each of the at least two flow sections.

4. An inflow control device for controlling flow into a passage of a tubular string in a wellbore, the inflow control device comprising:

   a flow restrictor section;
   a fluid discriminator section; and
   a reverse flow preventer section, and
   wherein the inflow control device is configured so that fluid which flows between an exterior of the tubular string and the passage also flows through the flow restrictor, fluid discriminator and reverse flow preventer sections.

5. An inflow control device according to claim 4, wherein the flow restrictor, fluid discriminator and reverse flow preventer sections are configured in series, so that the fluid which flows between the exterior of the tubular string and the passage also flows through each of the flow restrictor, fluid discriminator and reverse flow preventer sections.

6. An inflow control device according to claim 5, wherein the fluid which flows between the exterior of the tubular string and the passage also flows through the reverse flow preventer section, then through the flow restrictor section, and then through the fluid discriminator section.

7. An inflow control device according to claim 4, wherein the reverse flow preventer section includes a check valve positioned upstream of the flow restricting section.

8. A well screen, comprising:

   a filter portion; and
   an inflow control device including a flow restrictor section, a fluid discriminator section, and a reverse flow preventer section, and the inflow control device being configured so that fluid which flows through the filter portion also flows through the flow restrictor, fluid discriminator and reverse flow preventer sections.

9. A well screen according to claim 8, wherein the reverse flow preventer section includes a check valve positioned downstream of the filter portion and upstream of the flow restricting section.

10. A method of controlling flow into a passage of a tubular string in a wellbore, the method comprising the steps of:

    providing an inflow control device including at least two flow sections selected from a flow restrictor section, a fluid discriminator section, and a reverse flow preventer section; and
    flowing a fluid between an exterior of the tubular string and the passage, so that the fluid flows through each of the at least two flow sections.

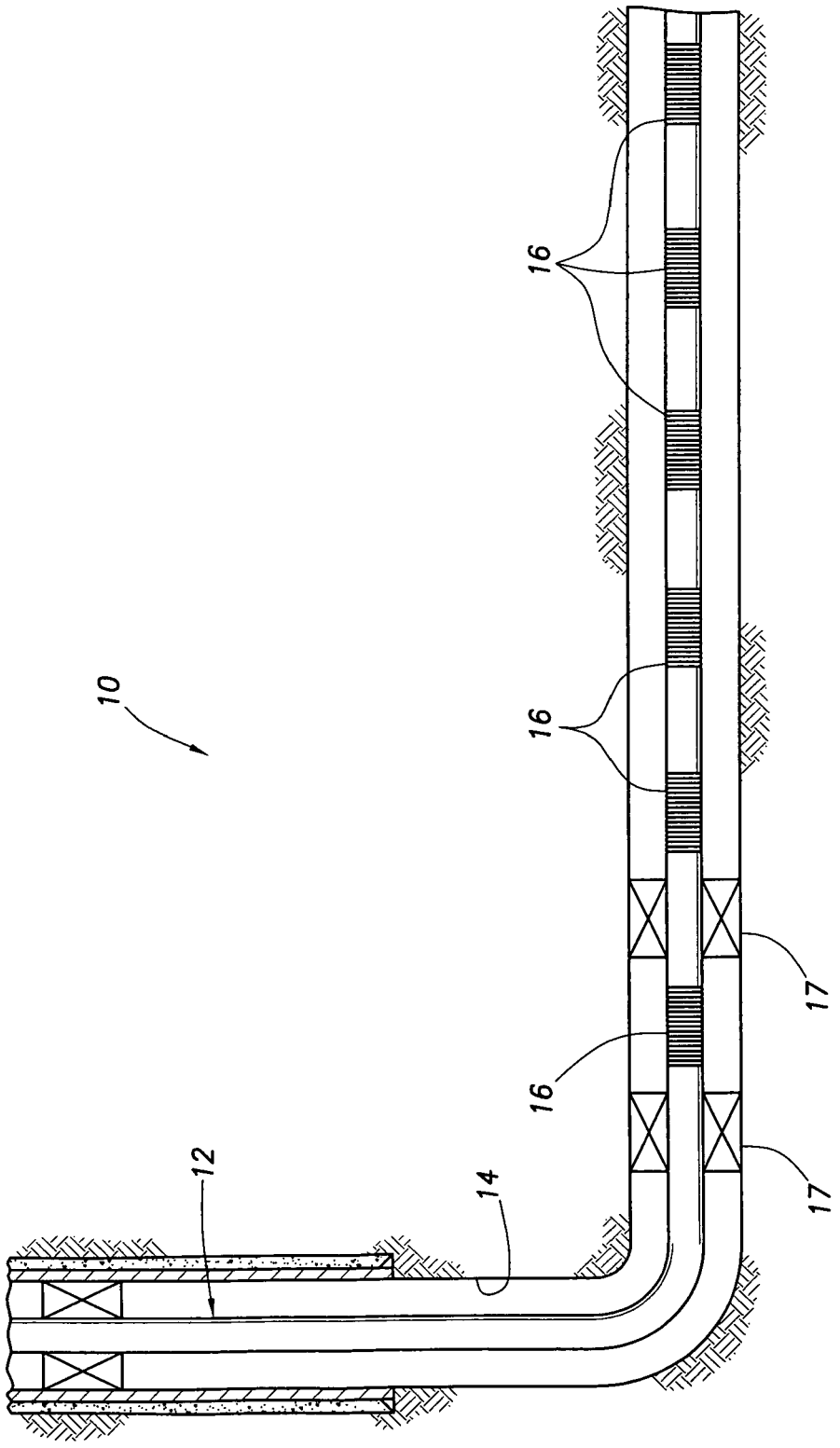

FIG. 1

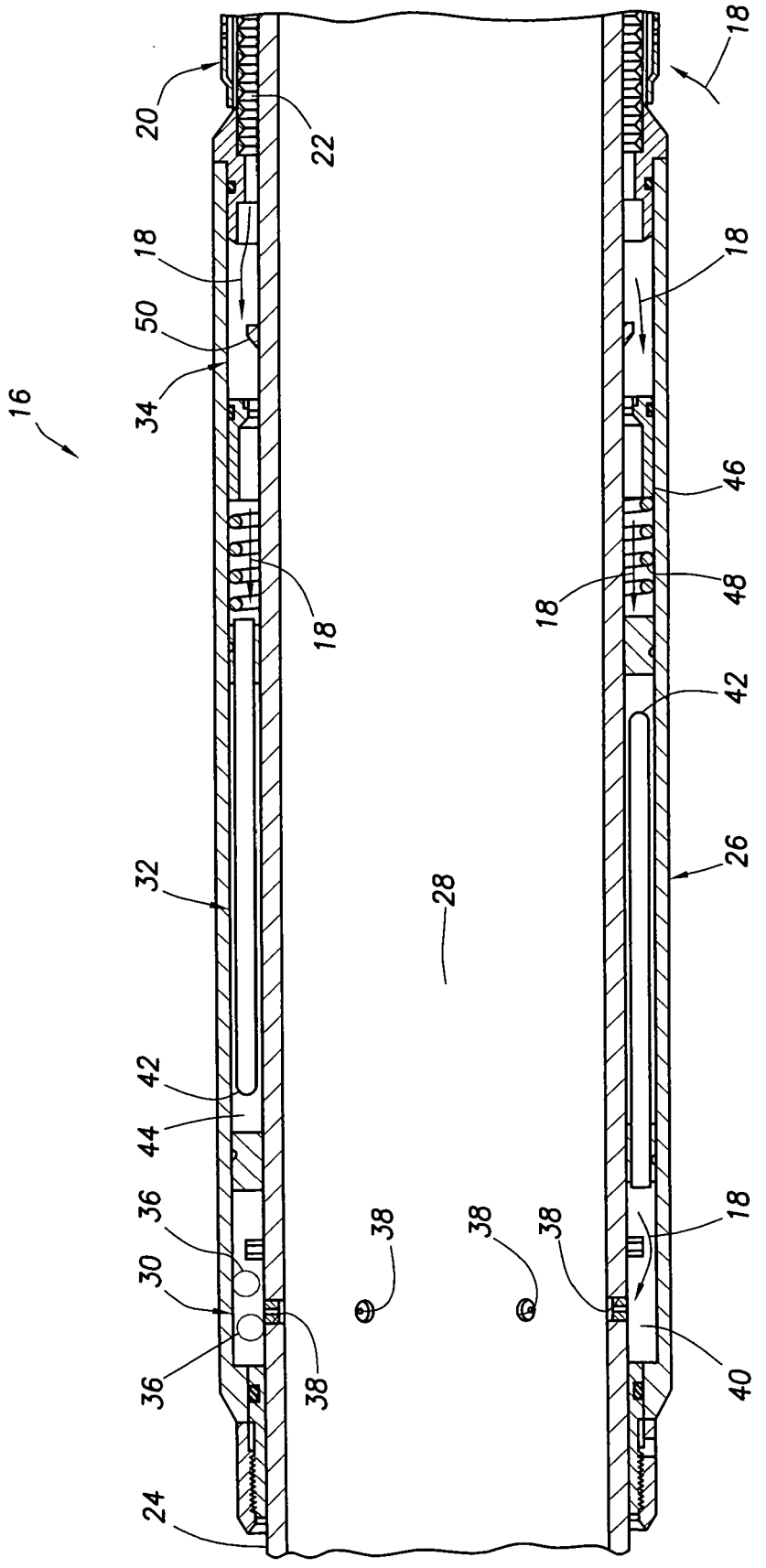
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FIG.2

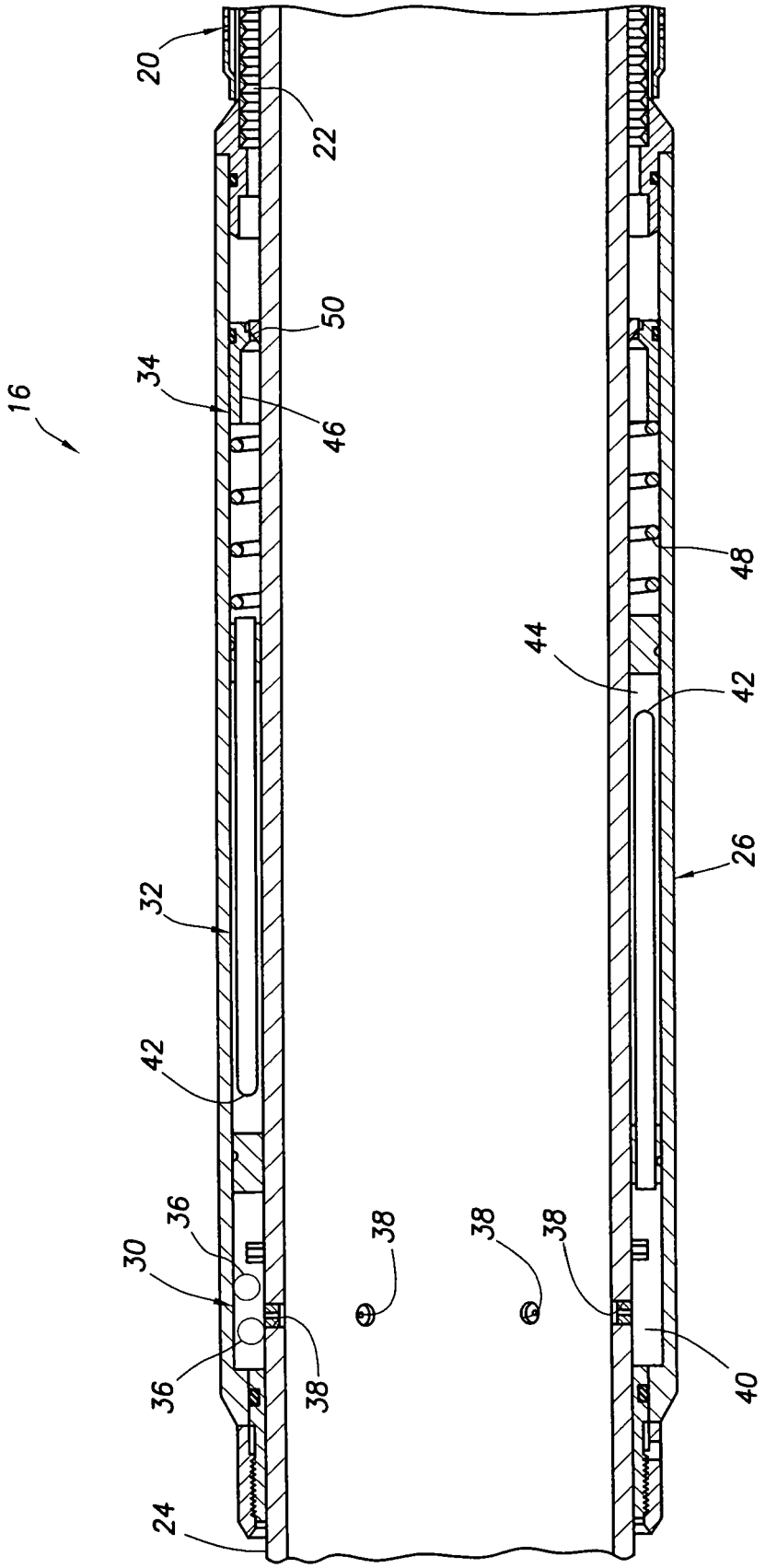

FIG.3

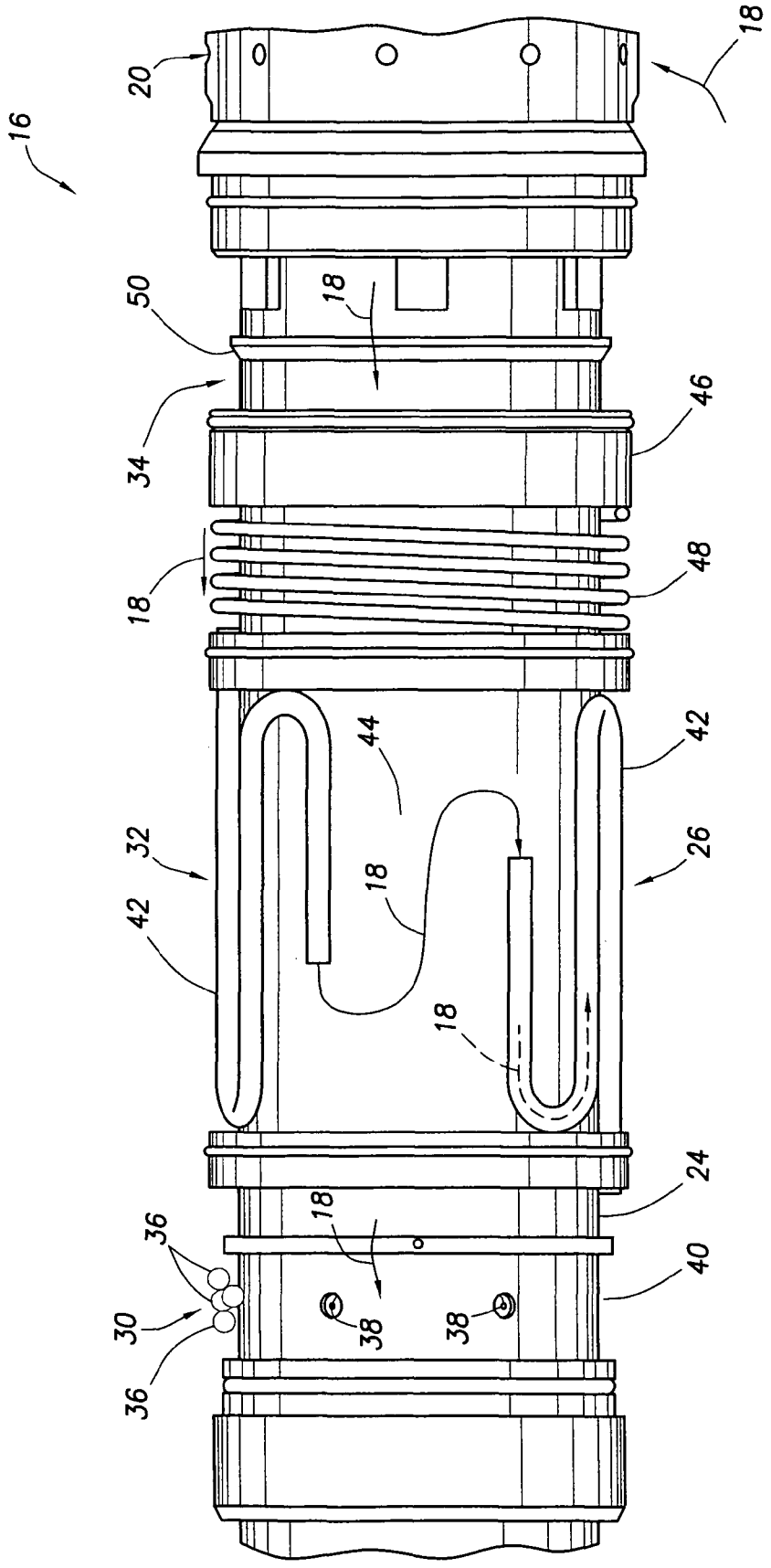

FIG.4

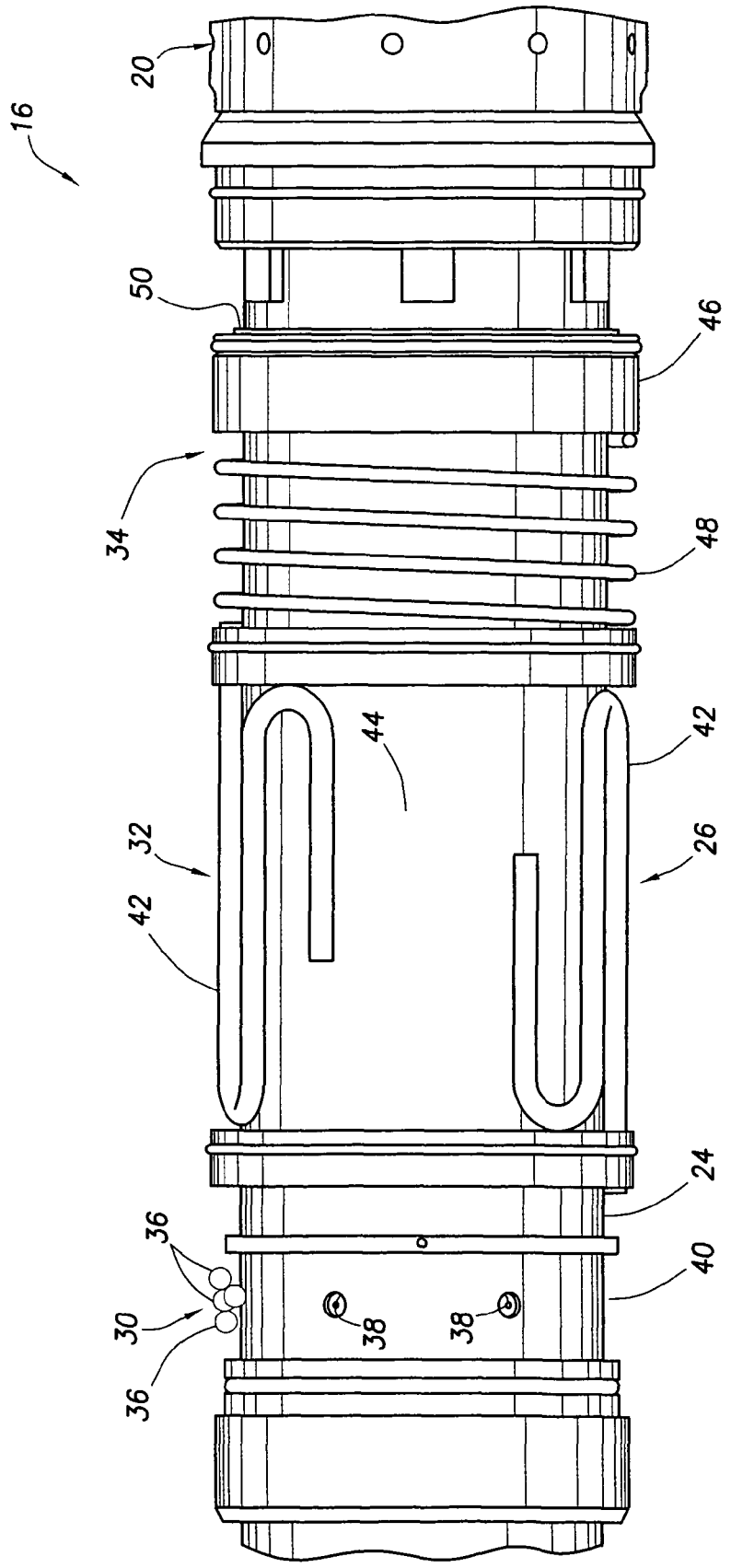

FIG.5

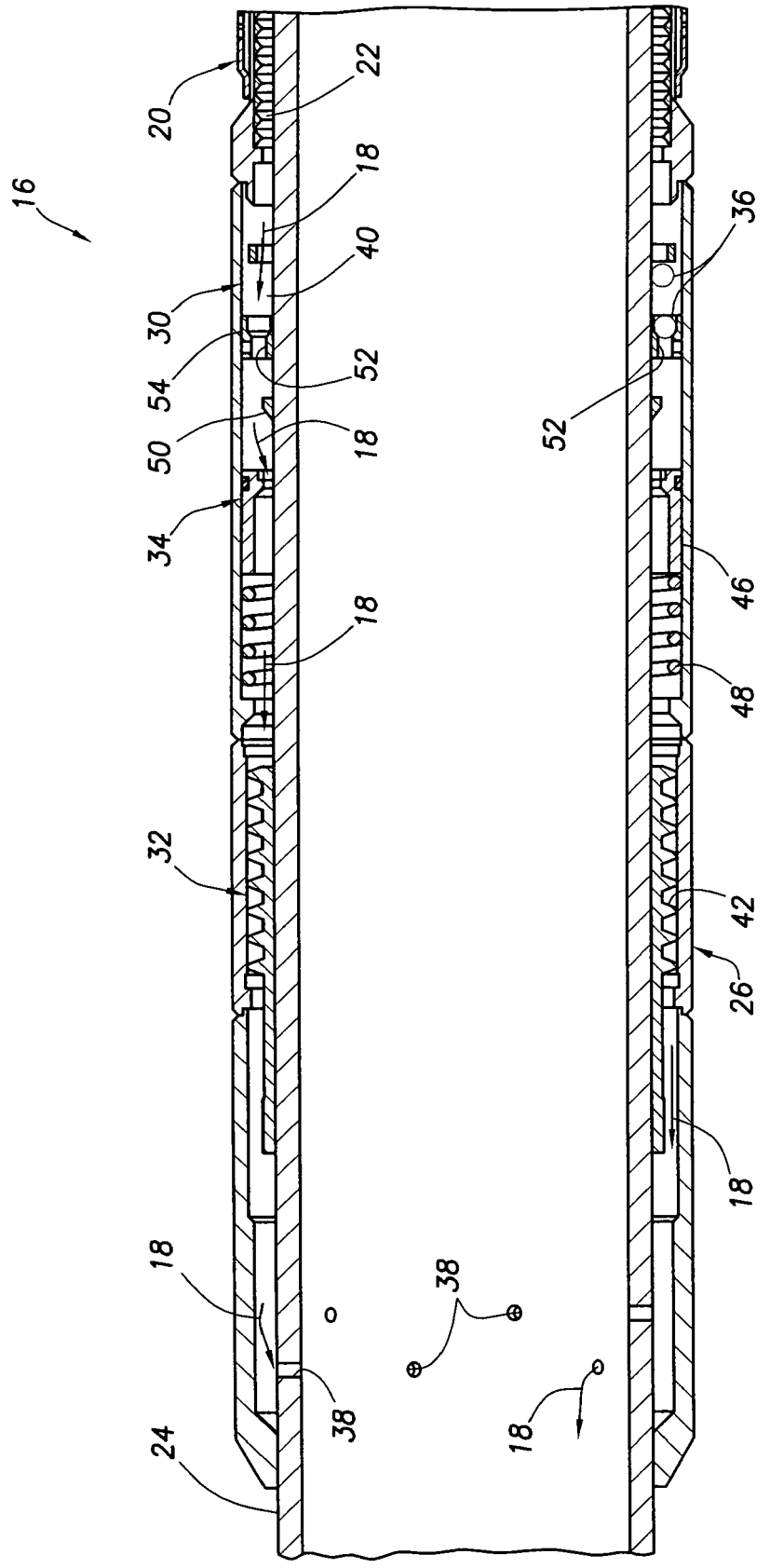
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FIG.6

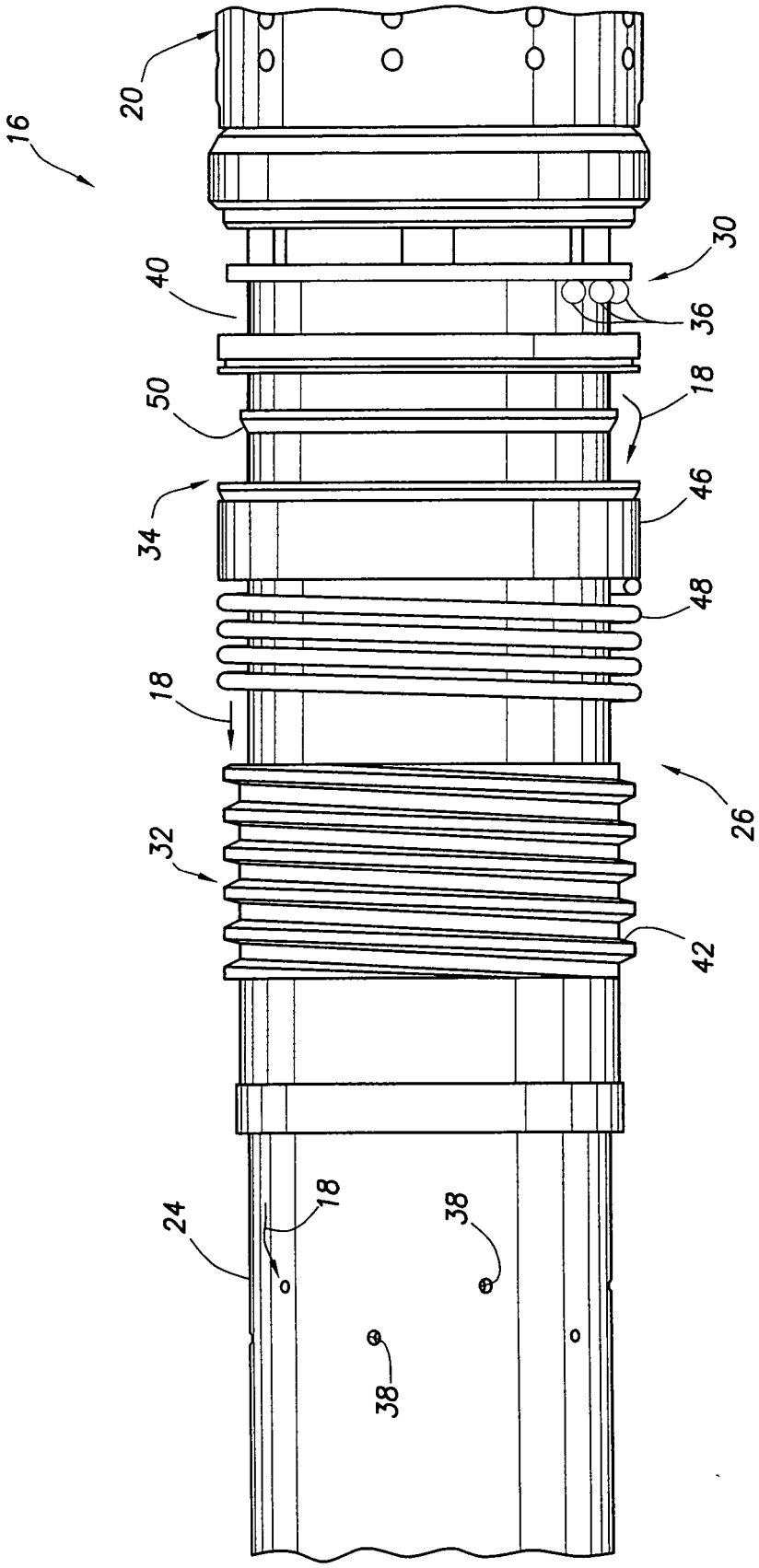

FIG.7

REFERENCES CITED IN THE DESCRIPTION

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