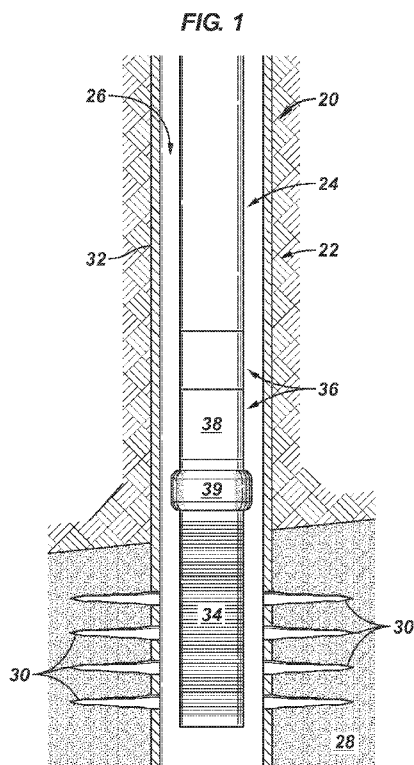




- (51) International Patent Classification:
E21B 43/08 (2006.01) *E21B 17/00* (2006.01)
- (21) International Application Number:
PCT/US2013/049015
- (22) International Filing Date:
2 July 2013 (02.07.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/671,872 16 July 2012 (16.07.2012) US
13/714,009 13 December 2012 (13.12.2012) US
- (71) Applicant (for CA only): **SCHLUMBERGER CANADA LIMITED** [CA/CA]; 525-3rd Avenue Southwest, Calgary, Alberta T2P-0G4 (CA).
- (71) Applicant (for FR only): **SERVICES PETROLIERS SCHLUMBERGER** [FR/FR]; 42 rue Saint Dominique, F-75007 Paris (FR).
- (71) Applicant (for GB, JP, NL only): **SCHLUMBERGER HOLDINGS LIMITED** [GB/GB]; P.O. Box 71, Craigmuir Chambers, Road Town, Tortola, Virgin Islands, British, 1110 (VG).
- (71) Applicant (for all designated States except AE, AO, BH, CA, CN, FR, GB, GH, IN, JP, LY, MA, MZ, NA, NG, NL, PH, SD, SY, US, VN): **SCHLUMBERGER TECHNOLOGY B.V.** [NL/NL]; Parkstraat 83-89m, NL-2514 JG The Hague (NL).
- (71) Applicant (for AE, AO, BF, BH, BJ, CF, CG, CI, CM, CN, GA, GH, GN, GQ, GW, IN, KM, LY, MA, ML, MR, MZ, NA, NE, NG, PH, SD, SN, SY, TD, TG, VN only): **PRAD RESEARCH AND DEVELOPMENT LIMITED** [GB/GB]; P.O. Box 71, Craigmuir Chambers, Road Town, Tortola, Virgin Island, British, 1110 (VG).
- (71) Applicant (for US only): **SCHLUMBERGER TECHNOLOGY CORPORATION** [US/US]; 300 Schlumberger Drive, Sugar Land, Texas 77478 (US).
- (72) Inventor: **RIISEM, Edvin Eimstad**; Monsamyrveien 3 apartment 307, N-4324 Sandnes (NO).

[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR SAND AND INFLOW CONTROL



(57) Abstract: A system and methodology utilizes a technique for filtering sand. For example, a sand control system may be provided with a base pipe having a non-permeable section and a permeable section in which the permeable section is created via at least one opening formed laterally through a wall of the base pipe. The sand control system also comprises at least one drainage tube positioned along an exterior of the base pipe and coupled to the base pipe in fluid communication with the at least one opening. The drainage tube is permeable and enables the inflow of fluid while preventing the influx of sand. The inflowing fluid is delivered along an interior of the drainage tube and through the opening into an interior of the base pipe for production.



(74) **Agent:** MATTHEWS, David, G.; 10001 Richmond Avenue, IP Administration Center of Excellence, Room 4720, Houston, Texas 77042 (US).

(81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

SYSTEM AND METHOD FOR SAND AND INFLOW CONTROL

BACKGROUND

[0001] In many hydrocarbon wells, well fluid passes through a sand screen which filters out particulates from the inflowing fluid, e.g. oil or gas. Generally, the sand screen comprises a perforated base layer or base pipe surrounded by a mesh material or other filter media disposed along the length of the base pipe. The filter media filters out sand, e.g. particulates and other solid materials, from the inflowing hydrocarbon fluid. After the hydrocarbon fluid passes through the filter media, the fluid enters the base pipe through the perforations disposed along the length of the base pipe. However, many conventional sand screen systems tend to be expensive to manufacture.

SUMMARY

[0002] In general, a system and methodology is provided for filtering sand. For example, a sand control system may be provided with a base pipe having a non-permeable section and a permeable section in which the permeable section is created via at least one opening formed laterally through a wall of the base pipe. The sand control system also comprises at least one drainage tube positioned along an exterior of the base pipe and coupled to the base pipe in fluid communication with the at least one opening. The drainage tube is permeable and enables the inflow of fluid while preventing the influx of sand. The inflowing fluid is delivered along an interior of the drainage tube and through the opening into an interior of the base pipe for production. Flow through the at least one opening also may be controlled via an inflow control device.

[0003] However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:

[0005] Figure 1 is a schematic illustration of a well system comprising an example of a sand control system deployed in a wellbore, according to an embodiment of the disclosure;

[0006] Figure 2 is a cross-sectional view of an example of a sand control system, according to an embodiment of the disclosure;

[0007] Figure 3 is a schematic illustration of an example of a sand control system, according to an embodiment of the disclosure;

[0008] Figure 4 is a schematic illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0009] Figure 5 is a schematic cross-sectional illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0010] Figure 6 is a schematic cross-sectional illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0011] Figure 7 is a schematic cross-sectional illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0012] Figure 8 is a schematic illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0013] Figure 9 is a schematic illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0014] Figure 10 is a schematic cross-sectional illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0015] Figure 11 is a schematic cross-sectional illustration of another example of a sand control system, according to an embodiment of the disclosure;

[0016] Figure 12 is a schematic cross-sectional illustration of another example of a sand control system which has a changing inflow profile, according to an embodiment of the disclosure;

[0017] Figure 13 is a schematic cross-sectional illustration of another example of a sand control system which has a generally constant inflow profile, according to an embodiment of the disclosure; and

[0018] Figure 14 is a schematic illustration of another example of a sand control system, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0019] In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0020] The present disclosure generally relates to a system and methodology for filtering sand from flowing fluid, such as from inflowing hydrocarbon fluid in a production well. As explained in greater detail below, the system and methodology also may be employed to control the inflow of fluid into a base pipe for production to a desired collection location. The design of the sand control system also allows the system to be manufactured at a substantially reduced cost compared to many conventional sand screen systems.

[0021] According to an embodiment, a well system is provided with a sand influx control system which also may be used to control the inflow of fluid, e.g. hydrocarbon fluid. In this example, the sand control system utilizes a base pipe having a non-permeable section which has a solid wall without perforations. The base pipe also comprises a permeable section which is permeable via at least one opening formed laterally through a wall of the base pipe. At least one drainage tube is positioned along an exterior of the base pipe and coupled to the base pipe in fluid communication with the at least one opening. The drainage tube is permeable and enables inflow of fluid into an interior of the drainage tube while preventing the influx of sand. The fluid flowing into the drainage tube interior moves along that interior and is directed to the at least one opening at the permeable section of the base pipe. The inflowing fluid flows from the drainage tube, through the opening, and into an interior of the base pipe for production.

[0022] By way of example, the drainage tube may serve the function of a screen by having openings through which fluids can pass while remaining small enough to block

passage of sand. In some embodiments, the openings are distributed along the length of the drainage tube and the drainage tube is oriented to provide flow in the direction of the well along the length of the sand control system. The drainage tube is coupled with the base pipe to direct flow into the opening. In some examples, an inflow control device, e.g. an inflow control nozzle, is positioned in cooperation with the opening to control the inflow of fluid into an interior of the base pipe. In some examples, a plurality of drainage tubes and inflow control devices may be positioned around the base pipe to provide a desired throttling or other control over the fluid flowing into the base pipe.

[0023] Depending on the specifics of a given application, the sand control system may comprise a variety of arrangements, constructions, components, and/or cooperating components in many types of well strings or other tubular flow systems. For example, a plurality of drainage tubes may be coupled to the base pipe at different angles around a joint of the base pipe. At least one drainage tube may be coupled to the base pipe directly or via at least one housing assembly. The drainage tubes may be fastened to the base pipe via a plurality of techniques and mechanisms, including welding, brackets, and/or other fasteners. If brackets are used, the brackets also may be designed to centralize the base pipe within a casing or open wall of the wellbore. In some applications, a protective structure, such as a shroud, may be disposed around the drainage tube or tubes and the protective structure may be fastened to the drainage tube(s) to provide structural support. Additionally, the drainage tubes may have a variety of cross-sectional shapes including shapes that generally match the curvature of the base pipe and/or production tubing.

[0024] In some applications, the drainage tube may be constructed as a mesh tube. Additionally, the drainage tube may be constructed as a solid tube with slits or other openings sized to filter sand down to a desired particle size while allowing passage of fluid to an interior of the drainage tube. It should be noted that “sand” is used herein to generally indicate particulates which may include gravel, debris, and/or other types of particulates which are larger than a predetermined size. (The predetermined size may vary depending on the specific application.) The openings created by the mesh, slits, or other forms of openings serve as a filter media and may be varied along the length of the

drainage tube to create different types of inflow profiles. For example, the drainage tubes may be designed to provide a higher inflow area towards an end of the drainage tube opposite the end which delivers fluid to the base pipe opening and the inflow control device.

[0025] Referring generally to Figure 1, an embodiment of a system, e.g. a well system, for removing sand from a fluid and for controlling flow of the fluid is illustrated. By way of example, the system may comprise a sand control system coupled into a well string located in a wellbore. The sand control system and the overall well system may comprise many types of components and may be employed in many types of applications and environments, including cased wells and open-hole wells. The well system also may be utilized in vertical wells and deviated wells, e.g. horizontal wells.

[0026] Referring again to Figure 1, a schematic example of a system 20, e.g. a well system for use in a well 22, is illustrated. Well 22 may comprise a production well for producing a desired fluid, e.g. gas or oil; and/or well 22 may comprise an injection well for injecting a desired fluid, e.g. gas or water. In the example illustrated, well system 20 comprises a well string 24 deployed in a wellbore 26 which extends through a formation 28. The formation 28 may be perforated via a plurality of perforations 30 and/or fractured to facilitate flow of hydrocarbon fluid into wellbore 26. In some applications, the wellbore 26 is lined with a casing 32, although the well string 24 may be deployed in an open wellbore. A sand control system 34 is illustrated as coupled into the well string 24 to facilitate removal of sand from the inflowing well fluid and to control the flow of well fluid into well string 24 for production to a collection location, e.g. a surface collection location. The sand control system 34 may be used in cooperation with a variety of other well string components 36, including artificial lift systems 38, e.g. electric submersible pumping systems, packers 39, completion components, and/or other well system components.

[0027] In Figures 2 and 3, an embodiment of sand control system 34 is illustrated. In this embodiment, sand control system 34 comprises a base pipe 40 and at least one

drainage tube 42 coupled with the base pipe 40. The base pipe 40 comprises a non-permeable section 44 which is solid, i.e. without lateral openings, to prevent fluid flow from an external region to an interior 46 of the base pipe 40. The base pipe 40 also comprises a permeable section 48 having at least one opening 50 extending laterally, e.g. radially, through a wall 52 of the base pipe 40. In the example illustrated, opening 50 is in fluid communication with drainage tube 42 at, for example, an end of the drainage tube 42. It should be noted the drainage tube 42 is illustrated as having a rectangular cross-section although the drainage tube may be formed with other cross-sectional shapes, including triangular shapes, circular shapes, shapes matching the base pipe profile, and other suitable shapes.

[0028] The drainage tube 42 is designed with a permeable sidewall having a plurality of openings 53 through which fluid, e.g. well fluid, enters an interior 54 of the drainage tube 42. The drainage tube 42 is further designed to conduct fluid flow along the interior 54 of the drainage tube 42 to the permeable section 48 and through opening 50 into the interior 46 of base pipe 40. In some embodiments, an inflow control device 56 (ICD) is appropriately positioned and used in cooperation with opening 50 to control the flow of fluid from drainage tube 42 into base pipe 40. As explained in greater detail below, the sand control system 34 also may comprise a plurality of drainage tubes 42 coupled to a corresponding plurality of openings 50 used in cooperation with inflow control devices 56. A variety of inflow control devices 56 may be employed, and examples comprise ICD nozzles, tortuous flow ICDs, adjustable ICDs, autonomous ICDs, ICD nozzles with corresponding check valves, or other suitable types of ICDs.

[0029] As illustrated in Figures 2 and 3, the drainage tube 42 is positioned external to base pipe 40. For example, the drainage tube 42 may be positioned to extend longitudinally along an exterior surface 58 of base pipe 40 or along at least a substantial portion of the length of base pipe 40. Consequently, the interior 54 of drainage tube 42 is external to the outer diameter of the base pipe 40. In the example illustrated, the drainage tube 42 comprises a filter media 60 which, in turn, also comprises openings 53 to enable lateral flow of fluid into the interior 54 of drainage tube 42. In some embodiments, the

filter media 60 is designed to extend along the longitudinal length of the drainage tube 42 or along a substantial portion of the longitudinal length of the drainage tube 42. The drainage tube 42 may be coupled to base pipe 40 via a housing 62 which routes fluid flow from interior 54 of drainage tube 42, through opening 50, and into the interior 46 of base pipe 40. The housing 62 may be constructed as a housing assembly which operates in cooperation with inflow control device 56. Additionally, the housing 62 and/or drainage tube 42 may be coupled to the base pipe 40 via a variety of suitable fastening techniques, including welds, fasteners, adhesives, brackets, or other suitable fastening techniques. In some applications, an opposite end of drainage tube 42 is at least partially capped with an end cap 63 to help ensure flow of fluid through filter media 60.

[0030] Referring generally to Figure 4, another embodiment of the sand control system 34 is illustrated. In this example, sand control system 34 utilizes drainage tube 42 in the form of a mesh tube having a mesh tube section 64 in which the walls of the drainage tube 42 are formed with a mesh material 66. The mesh material 66 serves at least in part as filter media 60. By way of example, the mesh tube section 64 may be manufactured with sintered woven wire mesh having either single or multiple layers arranged to form the walls of the drainage tube 42 and to naturally create the openings 53 which allow lateral flow into drainage tube 42. The number of mesh layers and the construction of those layers may be selected according to the desired rigidity of the mesh tube section 64. The length of the mesh tube section 64 also may vary and may terminate at sheet material, e.g. sheet-metal used to form housing 62. In this embodiment, inflow control device 56 also may be used in cooperation with opening 50. As with the other embodiments described herein, the drainage tube 42 and the filter media 60 may be designed to extend substantially along the length of the base pipe 40 and sand control system 34.

[0031] As discussed above, the sand control system 34 may utilize a plurality of drainage tubes 42 coupled to the base pipe 40 in cooperation with corresponding openings 50. In some embodiments, an inflow control device 56 is used in cooperation with each of the openings 50. In Figure 5, an embodiment is illustrated in which two

separate drainage tubes 42 are positioned along the exterior of base pipe 40 and are circumferentially spaced approximately 180° apart on the base pipe 40. In some applications, a protective structure 68 may be positioned around the drainage tubes 42 to protect the drainage tubes. The protective structure 68 may be employed with this embodiment and other embodiments described herein. By way of example, protective structure 68 may be in the form of a shroud coupled to the drainage tubes 42.

[0032] In another example, three separate drainage tubes 42 are positioned along the exterior of base pipe 40, as illustrated in Figure 6. With multiple drainage tubes 42, the tubes may be circumferentially spaced according to the desired function of the overall sand control system 34. In the illustrated example, the three drainage tubes 42 are circumferentially spaced approximately 120° apart along the exterior surface 58 of base pipe 40. In Figure 7, an embodiment is illustrated with four separate drainage tubes 42 that are circumferentially spaced around the exterior of base pipe 40. By way of example, the drainage tubes 42 may be circumferentially spaced at approximately 90° apart along the exterior surface 58 of base pipe 40. However, other numbers and arrangements of drainage tubes and corresponding openings 50 may be employed for a given sand control system 34. Additionally, the multiple drainage tubes 42 may be constructed to extend longitudinally along the base pipe 40 from one end of the base pipe 40 to the opposite end of the base pipe.

[0033] Referring generally to Figure 8, another embodiment of sand control system 34 is illustrated. In this embodiment, the drainage tube 42 is wrapped around the base pipe 40. For example, the drainage tube 42 may be helically wrapped around the base pipe 40 from a first end of the base pipe 40 to a second end of the base pipe 40. In this embodiment, housing assembly 62 is formed as a concentric ring 70 disposed around the base pipe 40 at, for example, an end of the base pipe 40. The concentric ring 70 is designed to cover permeable section 48 of base pipe 40, and individual or plural openings 50 may be disposed beneath concentric ring 70 for communication with drainage tube 42. In some examples, inflow control devices 56 are disposed in the openings 50. Fluid entering the drainage tube 42 is directed along the interior 54 and into the interior of

concentric ring 70 of housing assembly 62. The flow is then directed through the inflow control devices 56 and into interior 46 of base pipe 40. Although a single drainage tube 42 is illustrated, a plurality of the helically wrapped (or otherwise wrapped) drainage tubes 42 may be positioned along base pipe 40 and routed into cooperation with housing assembly 62 so as to direct fluid to the plurality of openings 50/inflow control devices 56.

[0034] In a well related operation, the sand control system 34 is run in hole on well string 24 and positioned adjacent formation 28. In some applications, the sand control system 34 may include or may be used in cooperation with packer 39 to isolate the wellbore region containing perforations 30. The sand control system 34 is anchored into the wellbore 26 to create an annulus between the base pipe 40 and the wall of the wellbore 26. In some applications, a gravel packing operation may be performed to place gravel in the annulus between the base pipe 40 and the wall of wellbore 26 adjacent the one or more drainage tubes 42. However, some applications may utilize the sand control system 34 without performing a gravel packing operation.

[0035] During production operations, well fluid flows from the formation 28, through perforations 30, and into the annulus surrounding base pipe 40. The well fluid flows into the drainage tube or tubes 42 as openings 53/filter media 60 remove sand from the well fluid. The filtered well fluid flows along the interior 54 of the drainage tube(s) 42 and to the permeable section 48 of base pipe 40. The fluid is then directed into the interior 46 of base pipe 40 through the corresponding opening or openings 50. In embodiments utilizing inflow control devices 56, the fluid flow is directed through the inflow control device which throttles or otherwise controls the flow of fluid into base pipe 40 for production to a desired collection location. For example, the fluid may be produced to a surface location for collection and/or further processing.

[0036] Referring generally to Figure 9, another embodiment of sand control system 34 is illustrated in which openings 50 and inflow control devices 56 are distributed along a length of the base pipe 40. In this example, a single drainage tube 42 is illustrated as having a plurality of outlets 72 connected to the base pipe 40 to direct

fluid through the corresponding openings 50 and inflow control devices 56. However, a plurality of separate drainage tubes 42 may be coupled with the base pipe 40 along its length and in fluid communication with the corresponding inflow control devices 56.

[0037] In Figures 10 and 11, additional embodiments are illustrated in which the drainage tubes 42 are combined with various protective features. In the embodiment illustrated in Figure 10, for example, the drainage tube 42 comprises a relatively stiff, e.g. metal, inner tube 74 having a permeable structure via openings 53. The inner tube 74 is surrounded by a mesh tube 76, and the mesh tube 76 may be protected by the optional protective structure 68. In this example, protective structure 68 comprises a housing 78 disposed over the drainage tube 42 and connected to base pipe 40 by a suitable fastener 80, such as a weldment or other appropriate fastener. The housing 78 comprises a plurality of housing openings 82 which allow fluid flow to drainage tube 42.

[0038] In Figure 11, the drainage tube 42 is formed such that its interior flow path 54 is bounded in part by the exterior surface 58 of base pipe 40. In this example, the drainage tube 42 comprises an inner permeable support structure 84 having openings 53. The inner permeable support structure 84 is covered by an inner drainage layer 86. Additionally, an internal mesh layer 88 serves as filter media 60 and is disposed between the inner drainage layer 86 and an outer drainage layer 90 positioned along an exterior of the mesh layer 88. This embodiment also may comprise protective structure 68 similar to the embodiment of Figure 10, in which the protective structure 68 is formed with housing 78 having a plurality of openings 82 to enable flow of fluid to the interior 54 of the drainage tube 42. The protective structure 68 may be used to secure the other components of drainage tube 42 along the exterior of base pipe 40 by suitable fasteners 80.

[0039] The pattern of openings 53 along drainage tube 42 may be changed along the length of the drainage tube to facilitate a controlled inflow of fluid to the interior flow path 54 of the drainage tube 42. For example, the openings 53 may have greater flow area at a position farther away from opening 50 and a more restricted flow area at a

position closer to opening 50. In the graphical illustration of Figure 12, the pattern of openings 53 is consistent along the length of the drainage tube 42 which results in increased fluid inflow along the drainage tube 42 moving towards opening 50, as indicated by graph 92.

[0040] If, however, the pattern of openings 53 is modified to have a reduced inflow area moving towards opening 50 and an increased flow area moving toward the end of drainage tube 42 opposite opening 50, the inflow profile can be adjusted. In some applications, the pattern of openings 53 may be selected to establish a fairly uniform inflow profile along the drainage tube 42, as illustrated by graph 94 in Figure 13. By way of example, the flow area can be increased or decreased by increasing or decreasing, respectively, the size and/or density of the openings 53. In some embodiments, the density of the mesh filter media 60 forming the drainage tube 42 and/or a separate filter media 60 may be constructed to control the flow profile. For example, a denser mesh located at a position towards the opening 50 decreases the flow area and restricts flow to the interior of drainage tube 42 in those areas.

[0041] Referring generally to Figure 14, an example of a drainage tube 42 having a changing flow area along its length is illustrated. In this embodiment, the drainage tube 42 is formed with inner tube 74 surrounded by filter media 60. However, the density of openings 53 through inner tube 74 increases along the length of drainage tube 42 moving in a direction away from opening 50 and inflow control device 56. This arrangement provides increased flow area into the interior 54 of drainage tube 42 at distances farther away from opening 50 and inflow control device 56. Such an arrangement of openings 53 establishes a predetermined flow area through the sidewall and into the interior 54 of drainage tube 42. The predetermined flow area can be used to provide a more even inflow profile (see profile 94 in Figure 13) or to provide other desired flow profiles. Adjustments to the flow profile can be achieved via a variety of mechanisms, such as increased/decreased density of slits or other openings 53, differently sized openings 53, differing densities of filter media, and/or other techniques for adjusting the flow area into

drainage tube 42 along the length of the drainage tube 42 to establish a desired inflow profile.

[0042] The overall system 20 may be constructed to accommodate a variety of flow filtering applications in many types of well environments and other environments in which sand removal and flow control are employed. Accordingly, the number, type and configuration of components and systems within the overall system may be adjusted to accommodate different applications. For example, the size, number and configuration of the sand control systems may vary from one application to another and may be combined with many types of well string equipment. In some applications, the sand control system 34 may be used in cooperation with a gravel pack placed in the wellbore, although other applications may employ the sand control system without a gravel pack. Additionally, some applications may utilize centralizers in cooperation with the sand control system 34 to position the sand control system at a desired radial position within the wellbore.

[0043] Additionally, many types of drainage tube configurations and drainage tube materials may be employed in constructing the drainage tubes. For example, the filter media 60 may be formed via openings through a relatively stiff tube, via formation of a mesh tube, via a filter material, e.g. a mesh material, placed over an inner perforated tube, and/or via other filtering mechanisms. Additionally, individual or plural drainage tubes may be combined with the base pipe. The base pipe also may be formed in a variety of sizes, lengths and configurations. The permeable section of the drain pipe may be concentrated at an individual circumferential location or at a plurality of locations along at least a portion of the length of the base pipe. Similarly, the size, number and/or configuration of the openings through the base pipe wall as well as the configuration of the inflow control devices may be adjusted according to the parameters of a given application.

[0044] The sand control system may be employed with a variety of packers or other seal systems to isolate specific regions of the wellbore. Depending on the types of fluids produced and the environment from which those fluids are produced, the

components used in cooperation with the sand control system or systems may be adjusted. In some applications, for example, artificial lift systems may be positioned to receive the flow of fluid delivered to the interior of the base pipe from the drainage tube or tubes coupled to the base pipe.

[0045] Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

CLAIMS

What is claimed is:

1. A system for use in a well, comprising:
 - a sand control system which facilitates production of fluid from the well, the sand control system comprising;
 - a base pipe having a non-permeable section and a permeable section formed by an opening extending laterally through a wall of the base pipe; and
 - a drainage tube coupled to the base pipe in fluid communication with the opening, the drainage tube being permeable and positioned along an exterior of the base pipe, the drainage tube having a filter media which filters out sand from a production fluid flowing into the drainage tube, through the opening, and into the base pipe for production.
2. The system as recited in claim 1, wherein the opening comprises a plurality of openings and the drainage tube comprises a plurality of drainage tubes coupled to the base pipe in fluid communication with the plurality of openings.
3. The system as recited in claim 2, wherein the drainage tubes of the plurality of drainage tubes are spaced circumferentially around the base pipe.
4. The system as recited in claim 1, further comprising an inflow control device positioned at the opening to control flow into the base pipe through the opening.
5. The system as recited in claim 4, further comprising a housing disposed over the inflow control device, the drainage tube being coupled to the housing.

6. The system as recited in claim 1, wherein the drainage tube comprises a mesh tube which serves as the filter media.
7. The system as recited in claim 1, wherein the drainage tube is helically wrapped around the base pipe.
8. The system as recited in claim 2, further comprising a protective structure positioned around the plurality of drainage tubes.
9. The system as recited in claim 1, wherein the permeability of the drainage tube changes along the length of the drainage tube.
10. The system as recited in claim 9, wherein the permeability is changed along the drainage tube by constructing the filter media with openings providing a different flow area at different positions along the drainage tube.
11. The system as recited in claim 9, wherein the permeability is changed along the drainage tube by constructing the filter media as a mesh material with varying density of mesh material.
12. A method for producing hydrocarbons, comprising:
 - positioning a sand control system in a well string located in a wellbore;
 - providing the sand control system with a base pipe to which a drainage tube is coupled, the drainage tube being oriented along an exterior of the base pipe;
 - using the drainage tube to filter sand from a hydrocarbon fluid before the hydrocarbon fluid enters the base pipe; and
 - directing the hydrocarbon fluid from the drainage tube, through an inflow control device, and into an interior of the base pipe for production up through the well string.

13. The method as recited in claim 12, wherein providing comprises coupling a plurality of drainage tubes to the base pipe to direct flow of the hydrocarbon fluid to an interior of the base pipe.
14. The method as recited in claim 12, further comprising providing the drainage tube with a capped end opposite the inflow control device.
15. The method as recited in claim 12, further comprising forming the drainage tube as a mesh tube.
16. The method as recited in claim 12, further comprising forming the drainage tube with an inflow profile that changes along the length of the drainage tube.
17. The method as recited in claim 12, wherein forming comprises forming the drainage tube to extend along at least a substantial portion of the length of the base pipe of the sand control system.
18. A system, comprising:

a sand control system having a base pipe with a plurality of openings and an inflow control device proximate each opening to control flow of fluid into an interior of the base pipe, the sand control system further comprising a plurality of drainage tubes mounted along an exterior of the base pipe, each drainage tube being permeable to a fluid and having a tube end coupled to the base pipe to deliver the fluid from an interior of the drainage tube, through the inflow control device, and into the interior of the base pipe.
19. The system as recited in claim 18, wherein each drainage tube comprises a mesh material disposed along the length of the drainage tube, and wherein the plurality of drainage tubes is surrounded by a protective shroud.

20. The system as recited in claim 18, further comprising a well string into which the sand control system is mounted to filter sand from an inflowing hydrocarbon fluid.

FIG. 1

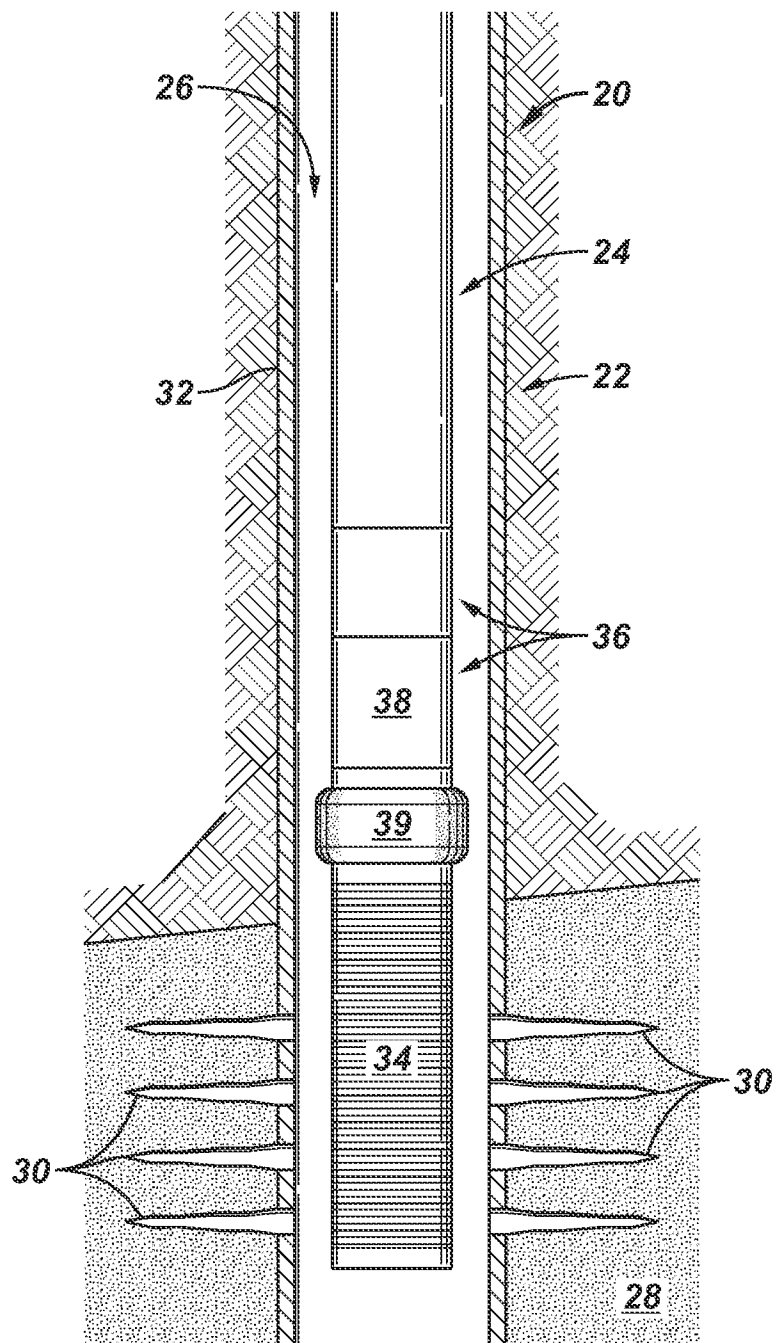


FIG. 2

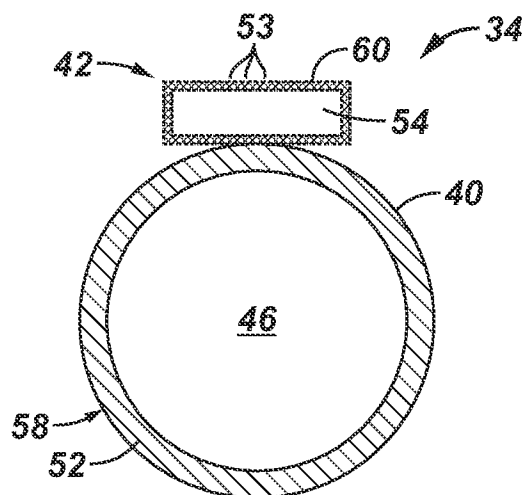
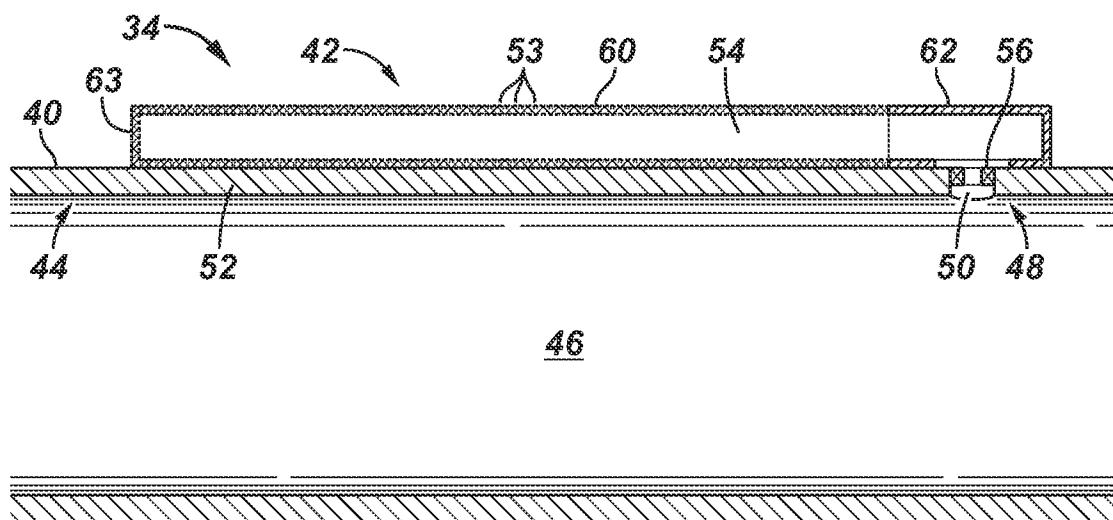


FIG. 3



3/7

FIG. 4

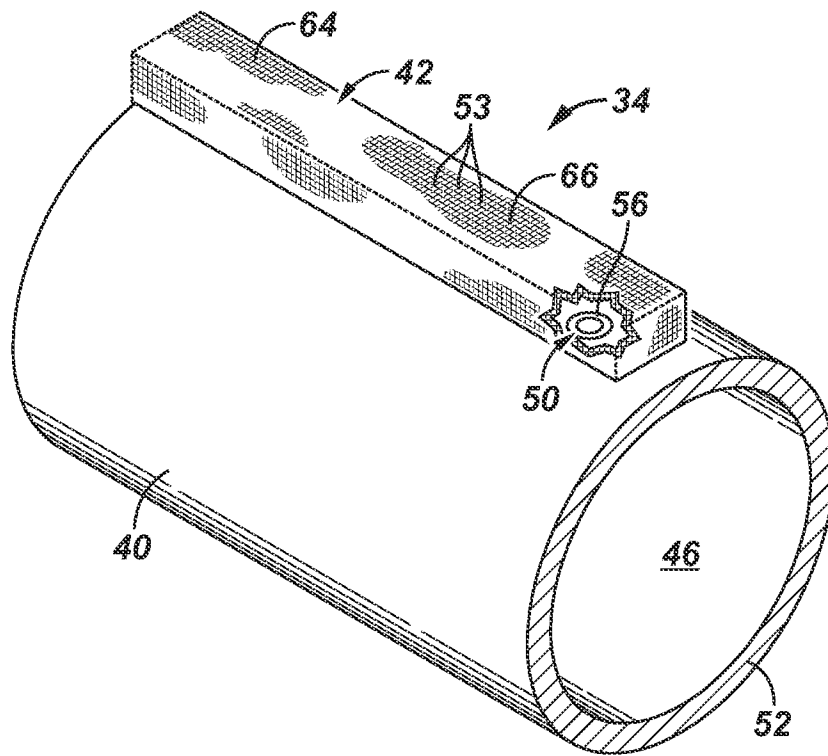


FIG. 5

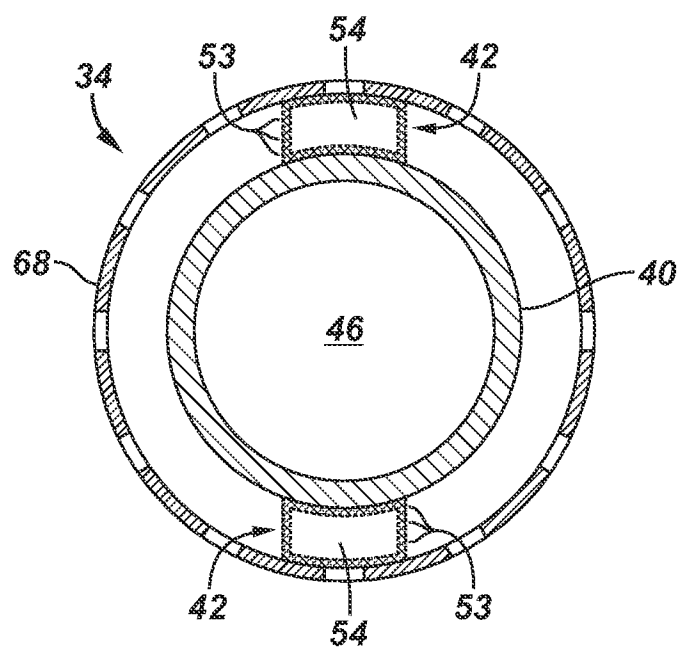


FIG. 6

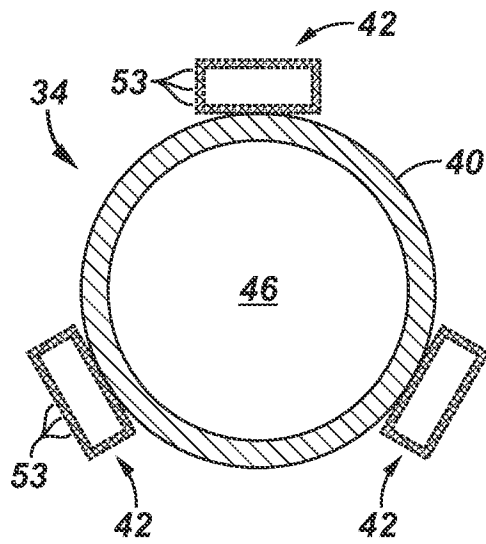


FIG. 7

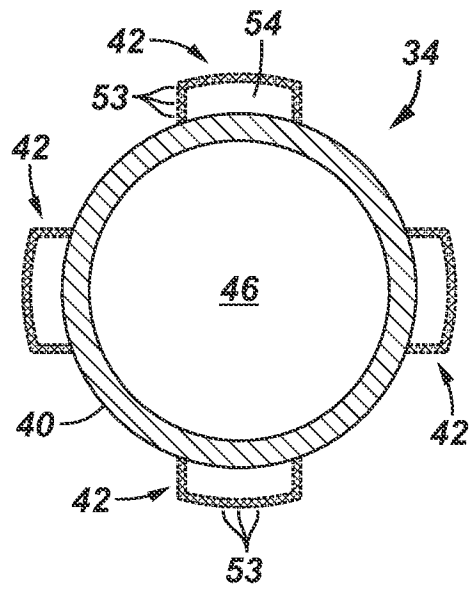


FIG. 8

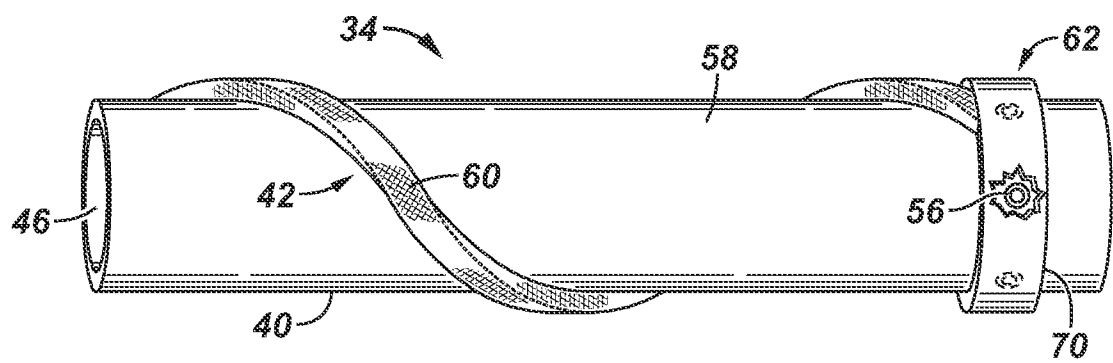


FIG. 9

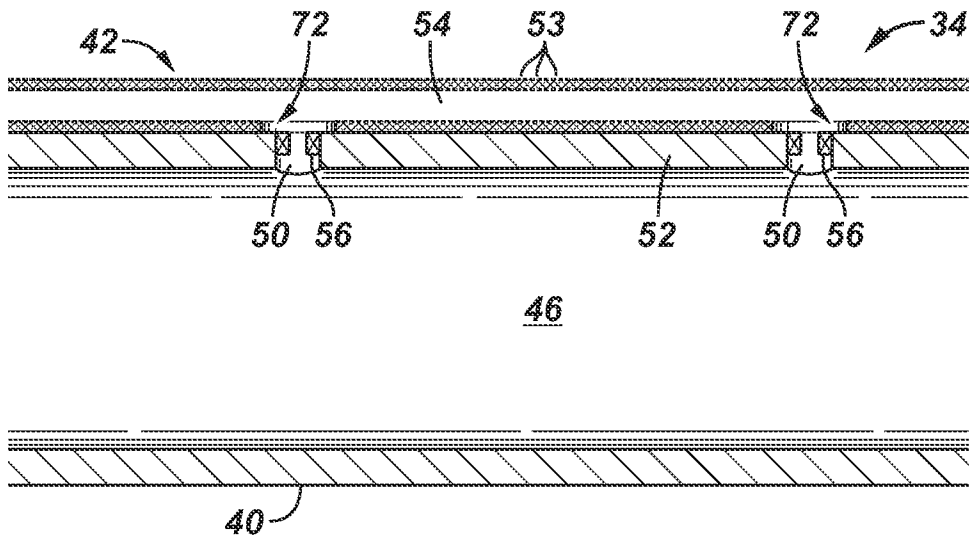


FIG. 10

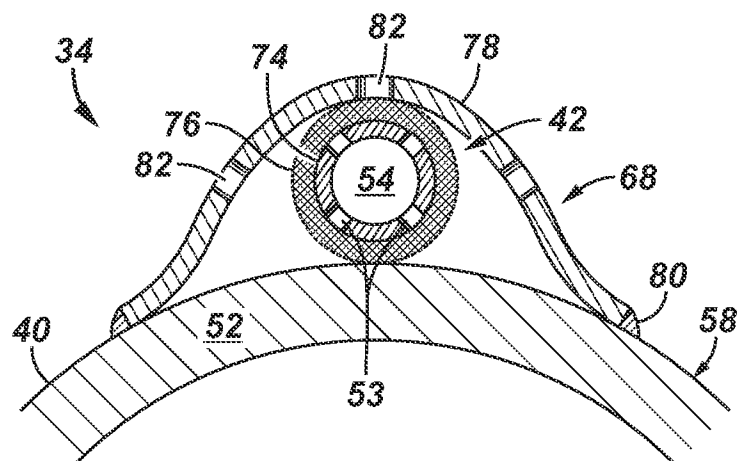


FIG. 11

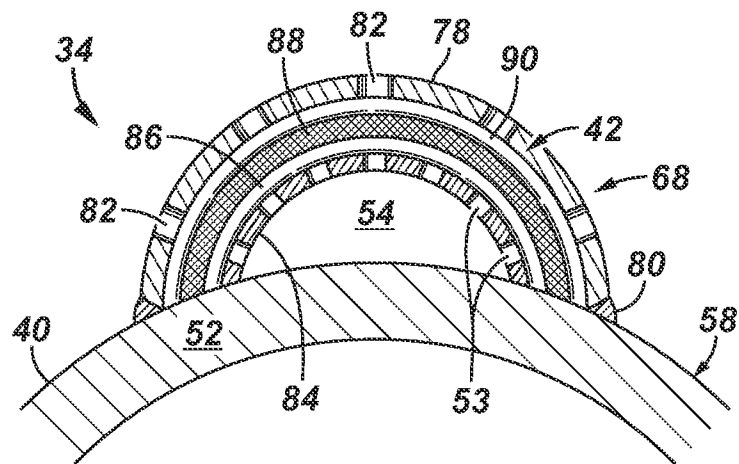


FIG. 12

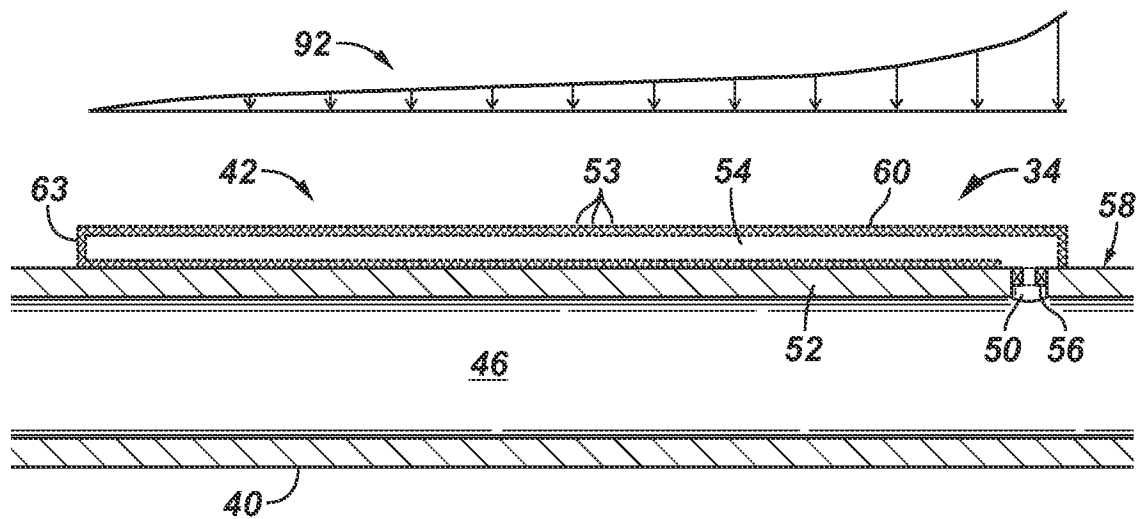


FIG. 13

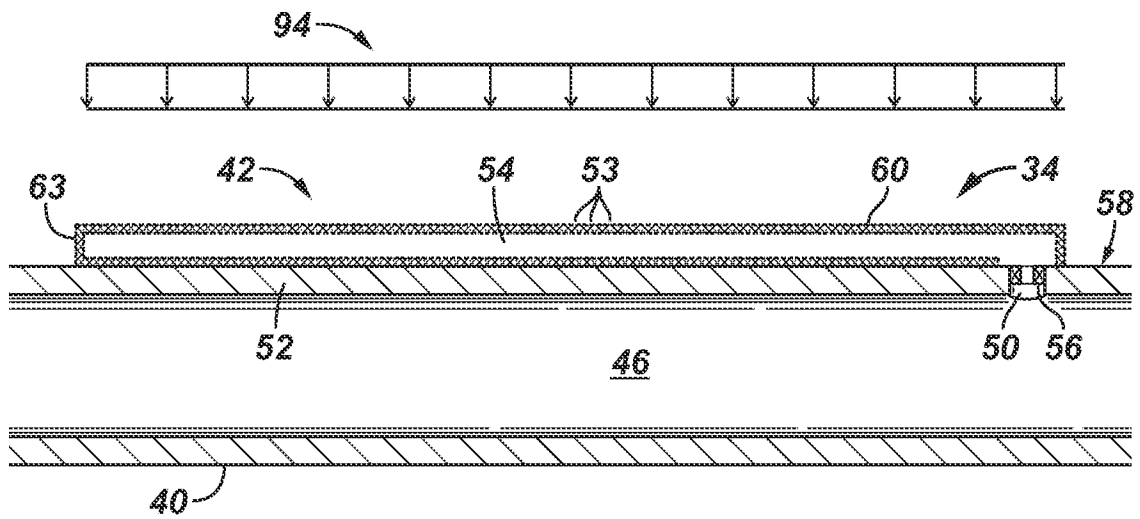
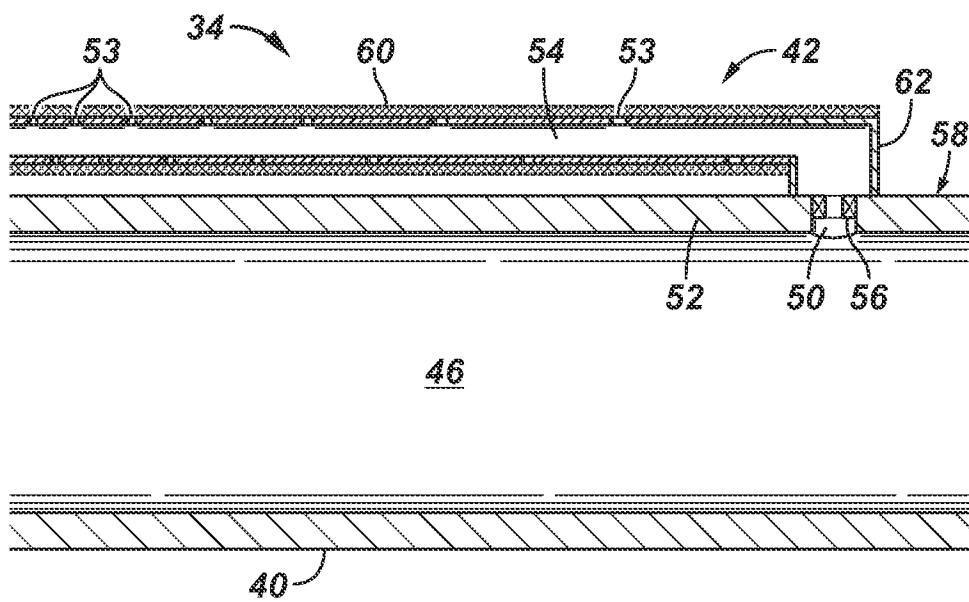


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/049015**A. CLASSIFICATION OF SUBJECT MATTER****E21B 43/08(2006.01)i, E21B 17/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 43/08; E21B 43/12; E21B 43/04; E21B 43/14; E21B 17/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: conduit, filter, sand and inflow

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0247813 A1 (MOEN, TERJE) 13 October 2011 See abstract; paragraphs [0015]-[0027],[0033]-[0034]; and figures 1-3, 6, 9.	1-7,9-18,20
Y		8,19
Y	US 6745843 B2 (JOHNSON et al.) 08 June 2004 See abstract; column 1, lines 45-60; column 6, lines 36-50; and figure 12.	8,19
A	US 6681854 B2 (DANOS, JAKE A.) 27 January 2004 See abstract; column 2, lines 11-24; and figure 2.	1-20
A	US 8011438 B2 (EDWARDS et al.) 06 September 2011 See abstract; column 1, lines 45-67; claim 1; and figure 1.	1-20
A	US 7559375 B2 (DYBEVIK et al.) 14 July 2009 See abstract; and claim 1.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 September 2013 (25.09.2013)

Date of mailing of the international search report

25 September 2013 (25.09.2013)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City,
302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

LEE Chang Ho

Telephone No. +82-42-481-8398



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/049015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0247813 A1	13/10/2011	AU 2011240830 A1	08/11/2012
		EP 2550427 A2	30/01/2013
		US 8316952 B2	27/11/2012
		WO 2011-130168 A2	20/10/2011
		WO 2011-130168 A3	12/01/2012
US 6745843 B2	08/06/2004	GB 0201219 D0	06/03/2002
		GB 2371319 A	24/07/2002
		GB 2371319 B	13/08/2003
		US 2002-096333 A1	25/07/2002
US 6681854 B2	27/01/2004	AU 2000-78800 A1	30/04/2001
		AU 2001-20756 A1	18/06/2001
		CA 2359450 A1	20/04/2002
		CA 2359450 C	13/12/2005
		CA 2360472 A1	03/05/2002
		CA 2360472 C	28/02/2006
		CA 2367859 A1	16/07/2002
		CA 2367859 C	11/07/2006
		CA 2445126 A1	15/04/2004
		CA 2466389 A1	07/11/2004
		CA 2466389 C	23/08/2011
		CA 2513263 A1	20/04/2002
		CA 2513263 C	15/09/2009
		CA 2544643 A1	16/07/2002
		CA 2544643 C	05/10/2010
		CA 2544701 A1	16/07/2002
		CA 2747122 A1	07/11/2004
		CN 1369615 A0	18/09/2002
		GB 0125011 D0	05/12/2001
		GB 2368082 A	24/04/2002
		GB 2369382 A	29/05/2002
		GB 2369382 B	14/05/2003
		GB 2371063 A	17/07/2002
		GB 2375782 A	27/11/2002
		GB 2379690 A	19/03/2003
		GB 2379691 A	19/03/2003
		GB 2379692 A	19/03/2003
		GB 2379693 A	19/03/2003
		GB 2379694 A	19/03/2003
		GB 2382831 A	11/06/2003
		GB 2383058 A	18/06/2003
		GB 2386625 A	24/09/2003
		GB 2404683 A	09/02/2005
		GB 2408527 A	01/06/2005
		GB 2408528 A	01/06/2005
		GB 2408529 A	01/06/2005
		GB 2408530 A	01/06/2005
		GB 2408531 A	01/06/2005

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/049015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		GB 2409692 A	06/07/2005
		GB 2409693 A	06/07/2005
		GB 2409694 A	06/07/2005
		GB 2410263 A	27/07/2005
		GB 2410267 A	27/07/2005
		GB 2410268 A	27/07/2005
		GB 2410269 A	27/07/2005
		GB 2410270 A	27/07/2005
		GB 2410271 A	27/07/2005
		GB 2410272 A	27/07/2005
		GB 2410273 A	27/07/2005
		GB 2420576 A	31/05/2006
		GB 2426019 A	15/11/2006
		US 2002-0023855 A1	28/02/2002
		US 2002-0046840 A1	25/04/2002
		US 2002-0053439 A1	09/05/2002
		US 2002-0092648 A1	18/07/2002
		US 2002-0092649 A1	18/07/2002
		US 2002-0104655 A1	08/08/2002
		US 2002-0125008 A1	12/09/2002
		US 2002-0125009 A1	12/09/2002
		US 2003-0079885 A1	01/05/2003
		US 2003-0079886 A1	01/05/2003
		US 2003-0221829 A1	04/12/2003
		US 2004-0104026 A1	03/06/2004
		US 2004-0163819 A1	26/08/2004
		US 2004-0173350 A1	09/09/2004
		US 2004-0177959 A1	16/09/2004
		US 2004-0182581 A1	23/09/2004
		US 2005-0039927 A1	24/02/2005
		US 2005-0045329 A1	03/03/2005
		US 2005-0087346 A1	28/04/2005
		US 2006-0027376 A1	09/02/2006
		US 2007-0084608 A1	19/04/2007
		US 2007-0102153 A1	10/05/2007
		US 6343651 B1	05/02/2002
		US 6446729 B1	10/09/2002
		US 6575245 B2	10/06/2003
		US 6695054 B2	24/02/2004
		US 6772836 B2	10/08/2004
		US 6789621 B2	14/09/2004
		US 6799637 B2	05/10/2004
		US 6817410 B2	16/11/2004
		US 6848510 B2	01/02/2005
		US 7104324 B2	12/09/2006
		US 7131494 B2	07/11/2006
		US 7134501 B2	14/11/2006
		US 7156180 B2	02/01/2007
		US 7168485 B2	30/01/2007
		US 7182134 B2	27/02/2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/049015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 8011438 B2	06/09/2011	US 7185709 B2	06/03/2007
		US 7222676 B2	29/05/2007
		US 7398831 B2	15/07/2008
		US 7681640 B2	23/03/2010
		US 8091631 B2	10/01/2012
		US 8474526 B2	02/07/2013
		WO 2001-029368 A1	26/04/2001
		WO 2001-042620 A1	14/06/2001
US 8011438 B2	06/09/2011	CA 2537327 A1	23/08/2006
		CA 2537327 C	13/04/2010
		GB 0603395 D0	29/03/2006
		GB 0813053 D0	20/08/2008
		GB 2434599 A	01/08/2007
		GB 2434599 B	18/02/2009
		GB 2448265 A	08/10/2008
		GB 2448265 B	25/03/2009
		NO 20060839 A	24/08/2006
		US 2006-0185849 A1	24/08/2006
US 7559375 B2	14/07/2009	GB 0324351 D0	19/11/2003
		GB 2392187 A	25/02/2004
		GB 2392187 B	01/06/2005
		NO 20011420 A	23/09/2002
		NO 20011420 D0	20/03/2001
		NO 314701 B1	05/05/2003
		NO 314701 B3	08/10/2007
		US 2006-0118296 A1	08/06/2006
		US 2008-0217001 A1	11/09/2008
		US 7419002 B2	02/09/2008
		WO 2002-075110 A1	26/09/2002