(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 January 2017 (05.01.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/003993 A1

(51) International Patent Classification:
E21B 43/02 (2006.01) *E21B 17/00* (2006.01)
E21B 43/08 (2006.01)

(21) International Application Number:
PCT/US2016/039730

(22) International Filing Date:
28 June 2016 (28.06.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14/754,198 29 June 2015 (29.06.2015) US

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(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, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, 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, SA, 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, ST, 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).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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

WO 2017/003993 A1

(54) Title: ANNULAR SCREEN COMMUNICATION SYSTEM

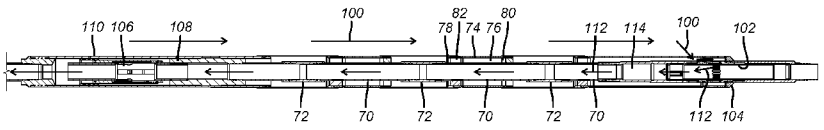


FIG. 7

(57) Abstract: Screen sections have opposed open ends near the threaded connection of a base pipe and on opposed ends. The base pipes have premium threads for connection. A shroud is placed over the premium bases pipe connection that spans from one open ended screen section to another that is adjacent. Collectively a long annular space is created under the screens and alternating shrouds with access to within the base pipes provided preferably at opposed ends. The valve on one end takes returns during gravel packing and the other takes production to the surface.

ANNULAR SCREEN COMMUNICATION SYSTEM

Inventor: Wilfred Provost

FIELD OF THE INVENTION

[0001] The field of the invention is multi-zone completions and more particularly completions that link screen sections with external shrouds mounted over connected base pipe with a single access to all the screen through a bottom isolation valve and production through all the screens with a top isolation valve.

BACKGROUND OF THE INVENTION

[0002] Multi-zone completions present conflicting design parameters that need to be considered. The need for versatility in being able to shut off individual screens has to be balanced with the resistance to flow that comes from additional tubulars associated with individual screens and the difficulty in channeling flow from one screen through small passages external to the central production flow path. Addition of tubular sections to create such communication paths between screens can also impede subsequent production by reducing the drift diameter available for such flow. The reduced drift dimension also makes access further downhole more complex or impossible in some cases.

[0003] FIG. 1-3 illustrate one such system. In FIG. 1 a port **10** on a sliding sleeve valve **12** is in the open position for taking gravel pack returns through screen **14**. Arrows **16** represent the gravel slurry flow to the annular space outside screens **14**, **20** and **22**. Arrows **18** represent the gravel slurry return flow to the surface with the gravel **24** deposited outside screens **14**, **20** and **22** as shown in FIG.2. Because sliding sleeve valve **26** is closed all the return flow represented by arrow **18** is through ports **10** while connecting paths between screens such as **28** are closed. When it is time for production valves **12** and **26** are both opened as shown in FIG. 3. However, the path of least resistance is represented by arrows **30** and **32** as opposed to connecting paths such as **28**. As a result, high velocities occur through the screens such as **14** and **22** causing erosion that can put a hole in such screens and further creating uneven flow from the formation as little flow gets to the surface through screen **20** that represents a path of higher resistance than flow coming in radially through screen **14** or **22**. Apart from the above issues the presence of

sleeves such as **30** to create the network of connecting passages **28** results in a smaller drift dimension for production flow and can reduce the production rate. Apart from this the assembly of such a string is fairly complex and presents many leak path opportunities. It fails to accomplish an objective of maximizing production in an even manner across the screens of the entire zone and is further expensive to construct and install into the borehole.

[0004] FIGS. 4-6 represent another prior system where perforations **32**, **34** and **36** are sequentially made with a perforating gun that is not shown and the completion is assembled in the hole in stages as shown in FIGS. 4-6. Screen assemblies **36** and **38** are the same and they comprise a screen **40** covered internally by an inner pipe **42** to create an annular space **44** that is accessible by a sliding sleeve valve **46** to take returns when gravel packing. Valve **46** can then be closed when the screen that is associated with it is fully gravel packed. Further access to the annular space **44** is provided by pressure sensitive valves such as **48**. These can operate in response to a pressure of a predetermined value that arms each of the similarly situated valves such as **50** and **52** such that when the pressure is released all the valves will open at the same time. The production can then ensue through screen assemblies **36** and **38** into the production string **54** that extends through production packer **56**. Flow through screen assembly **58** passes through packer **60** and production packer **56** to come up around the production string **54** as represented by arrows **62**. Arrows **64** represent the flow coming through screen assemblies **36** and **38** into the production string **54**. The issue with this system is that once the zones are opened with valves **48**, **50** and **52** the screens either cannot be closed off, or it is not economical to do so. The same valves can be inadvertently open with a pressure spike in the bottom hole assembly. The use of discrete inner tubulars such as **42** inside each screen also reduce drift diameter that can restrict production.

[0005] Also relevant to such systems are US 8511380;8225863; 6530431; 2004/0251033; 8281854; 6776241 and 20150034301.

[0006] The present invention seeks to overcome the shortcomings of the prior systems by using shrouds to span over a base pipe joint so as to create a continuous annular space between the screen assemblies and the base pipe so that the formation can flow more uniformly through a larger drift base pipe

because the screens are coupled together. In this manner, a single valve can control return flow when gravel packing. Another valve communicating with the same exterior annular space can be used as the production valve drawing the fluid that is produced through all the screens in the screen assembly. These and other aspects of the present invention will be more readily apparent to those skilled in the art from a review of the description of the preferred embodiment and the associated drawings while recognizing that the full scope of the invention is to be determined from the appended claims.

SUMMARY OF THE INVENTION

[0007] Screen sections have opposed open ends near the threaded connection of a base pipe and on opposed ends. The base pipes have premium threads for connection. A shroud is placed over the premium bases pipe connection that spans from one open ended screen section to another that is adjacent. Collectively a long annular space is created under the screens and alternating shrouds with access to within the base pipes provided preferably at opposed ends. The valve on one end takes returns during gravel packing and the other takes production to the surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 shows a part section view of a prior art screen assembly with internal jumper flow paths between screens during gravel packing;

[0009] FIG. 2 is the view of FIG. 1 showing gravel deposition outside the screens and returns through a single open sliding sleeve valve;

[0010] FIG. 3 is the view of FIG. 2 showing two sliding sleeves open during production;

[0011] FIG. 4 is a schematic view of a prior art triple zone completion with the first zone completed and the second zone perforated;

[0012] FIG. 5 is the view of FIG. 4 with all three zones perforated and completed;

[0013] FIG. 6 is the view of FIG. 5 with the production string tagged into the production packer;

[0014] FIG. 7 is the assembly of the present invention during gravel packing;

[0015] FIG. 8 is the view of FIG. 7 with the well shut in;

[0016] FIG. 9 is the view of FIG. 8 with the well on production;

[0017] FIG. 10 is an end detail of a screen section showing communication openings through an end ring;

[0018] FIG. 11 is a section view along lines 11-11 of FIG. 10;

[0019] FIG. 12 is a view of two joints threaded together before the shroud is advanced to bridge adjacent screens; and

[0020] FIG. 13 is the view with a tubular jumper shroud advanced into position spanning two screen sections.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring to FIG. 7 an alternating assembly of base pipes **70** and couplings **72** is assembled at the surface. Each base pipe **70** has a surrounding screen **74** at a spaced relation to the base pipe **70** to define an annular space **76** that is open on opposing ends 78 and **80**. Spacers **82** leave openings **84** as best seen in FIG. 10. Spacers **82** can be connected to end ring **86** at threads **88** while base pipe **70** is threaded at **90** to the segments **82**. Screen **74** can swaged onto the end ring **86** or fastened in other mechanical ways such as welding. The segments **82** are preferably also welded to the end ring **86**.

[0022] FIG. 12 illustrates the assembly method into the well. A lower screen **70** is supported on the rig floor so that the next joint above can be aligned and the coupling **72** used to connect adjacent base pipes **70** with powered tongs that are not shown in the known manner. The upper base pipe **70** has a screen secured to it in the manner described above. It also can have a seamless tubularly shaped shroud **92** that is initially over the next screen **74** being added to the string. Once the new base pipe **74** is threaded to coupling **72** the shroud is lowered into position as shown in FIG. 13 so that is spans over the threads at opposed ends of the coupling **72**. The shroud can be solid or it can have openings comparable to the opening size in the adjacent screens **74** to aid in gravel distribution during gravel packing. The additional openings in the shrouds **92** allow taking fluid returns through the shrouds when gravel packing, which brings the gravel to the shrouds **92** of a denser gravel pack. The ends of the shrouds **92** can be flexible and the inside diameter of the shroud is somewhat larger than the outside diameter of the underlying screen in FIG. 12 so that the shroud **92** can be manipulated into the FIG. 13 position for attachment to the end rings **86** that appear on opposed ends of screens **74** that mark the gap to be spanned by the shroud **92**. Such attachment can be

with fasteners such as countersunk bolts or circular clamps or the like. It should be noted that the shroud in this case can be a seamless tube or a tube with a welded seam, although seamless is preferred for greater structural integrity and avoidance of issues with chemical reaction with seam weld materials. Alternatively, the shroud **92** can be a split cylindrical shape with a longitudinal opening to allow it to be slipped over the base pipe **70** and the opening closed up. Another variation can be with the use of a hinged connection to allow an opposite side to be opened for advancing over the base pipe **70** and then closed up to secure the longitudinal edges together over the base pipe **70**. The ends of the shroud **92** can then be connected to the end rings **86** in the manner described above.

[0023] FIGS. 7-9 show the end result of this process and the valves used preferably at opposed ends to facilitate gravel packing, isolation of the formation or production from the formation. FIG. 7 shows gravel slurry represented by arrows **100** entering annular space **76** that extends from gravel pack return valve **102** preferably at the lower end **104** to production valve **106** preferably at the upper end **110**. Segments **108** are open to provide fluid access for screened production fluids to reach the valve **106**. Valve **106** can be of a pressure to operate type or can be opened with mechanical intervention such as with a shifting tool. When valve **102** is open flow represented by arrow **112** enters the base pipe passage **114** leaving the gravel outside the screens and shrouds of the illustrated assembly. FIG. 8 shows the well shut in after gravel packing where valve **102** is closed as is valve **106**. FIG. 9 shows valve **106** open to take production flow through all the screen sections and into the long annular space **76** and then into passage **114** to go to the surface.

[0024] Those skilled in the art will appreciate several advantages of the equipment described above and the method that such equipment enables. The screens communicate with each other outside the base pipes in a continuous annular space that allows the formation to be evenly produced. The drift dimension of the base pipe can be greater than prior designs for the same outer dimension of the screen assembly. A modular system facilitates rapid assembly and a lower overall cost. A single valve controls the elongated annular space for taking returns during gravel packing or for production. The production valve can be opened or closed without intervention such as with

pressure cycles. Multiple zones can be produced and could ostensibly be balanced for even flow with strategically located obstructions to flow at desired locations. The shrouds can have openings to further enhance the distribution of the gravel by creating more fluid return paths. Screen modules are either open on one end or both ends depending on their placement to create an elongated annular space that allows more even flow from the formation into the passage formed by the connected base pipes.

[0025] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

I claim:

1. A screen assembly for subterranean use, comprising:

at least one first screen module (70, 74,76) comprising a base pipe (70) having a surrounding screen (74) to define an annular space (76) therebetween that is open on at least one end (84);

at least one second screen module (70, 74,76) comprising a base pipe (70) having a surrounding screen (74) to define an annular space (76) therebetween that is open on at least one end (84);

said base pipes of said modules are connected with at least one connection (72) such that said annular space open ends face each other; **characterized by**

at least one shroud (92) mounted over said connection (72) and secured on opposed ends to said screens (74) to extend said annular space (76) between said open ends (84);

at least one valve for selectively communicating said annular space (76) and a passage (114) defined within said base pipe (70) and said connection (72).

2. The assembly of claim **1**, wherein:

said first and second screen modules (70, 74,76) comprising spaced members (82) extending in respective said annular gaps between a respective base pipe and an end ring (86), said screen from a respective module is attached (88) to a respective end ring (86).

3. The assembly of claim **2**, wherein:

respective screens from each module are swaged onto associated said end rings (86) for connection thereto.

4. The assembly of claim **2**, wherein:

respective screens from each module are connected to associated said end rings (86) with at least one fastener.

5. The assembly of claim **2**, wherein:

said spaced members *2) are secured to a respective said base pipe with threads;

said spaced members are secured to a respective end ring (86) with threads.

6. The assembly of claim **5**, wherein:

said spaced members are secured to a respective said base pipe (70) with welding;

said spaced members are secured to a respective end ring (86) with welding.

7. The assembly of claim **1**, wherein:

said shroud comprises a tubular shape that is seamless or has a welded seam.

8. The assembly of claim **1**, wherein:

said shroud (92) comprises a longitudinally split tubular shape for placement over said connection, said split further comprising a closure for said split.

9. The assembly of claim **1**, wherein:

said at least one valve (102) comprises two spaced valves (102,106) adjacent opposed ends of said extended annular space (76) to selectively allow flow through said screens (74) during gravel packing and during production.

10. The assembly of claim **9**, wherein:

said two spaced valves (102,106) selectively closed to prevent flow through said screens.

11. The assembly of claim **9**, wherein:

at least one of said valves (102,106) are responsive to applied pressure to open.

12. A completion method for subterranean use, comprising;

running in an assembly of screen joints (74) comprising base pipes ((70) connected with at least one connection (72) **characterized by** at least one shroud (92) spanning between screens on connected base pipes and over said connection to form a continuous elongated annular space (76) between said base pipes (70) and said screens (74) selectively communicated to a passage (114) within base pipes (70) with at least one valve (102);

opening said valve (102) to take flow through said screens (74), said annular space (76) and said passage (114).

13. The method of claim **12**, comprising:

providing at as said at least one valve, spaced valves (102,106) selectively communicating to said annular space;

taking returns when gravel packing through a first (102) of said valves;

taking production from a surrounding formation through a second (106) of said valves.

14. The assembly of claim **13**, wherein:

providing distributed flow from across a formation through said screens (74) into said elongated annular space (76).

15. The assembly of claim **12**, wherein:

using spaced members (82) to separate a respective said screen (74) from a respective base pipe (70) while permitting flow therebetween for continuity of said annular space (76).

16. The assembly of claim **12**, wherein:

providing seamless or welded seam tubular as said shroud or a tubular with a closable longitudinal split as said shroud.

17. The assembly of claim **15**, wherein:

using an end ring (86) to retain said segments (82) to a respective base pipe (70);

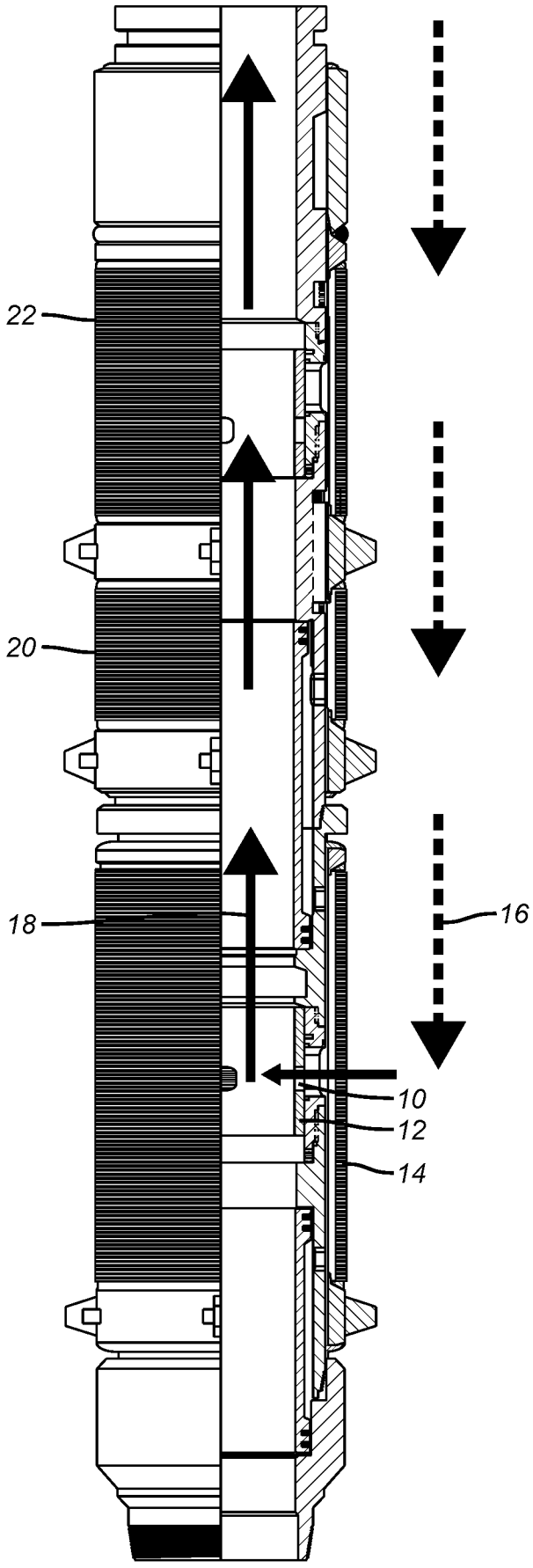
swaging an end of a said screen to said end ring when creating said annular space.

18. The assembly of claim **17**, wherein:

connecting said end ring (86) to said segments (82) and said segments to a respective base pipe (70) with threading or welding.

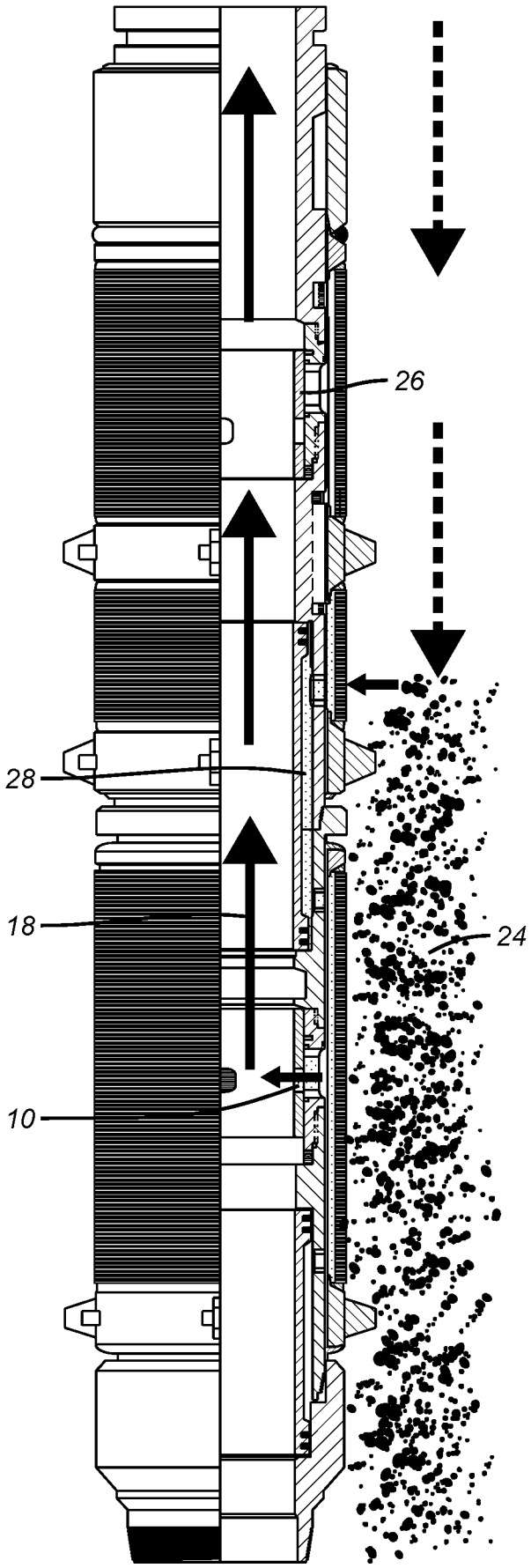
19. The assembly of claim **12**, wherein:

opening said valve (106) with applied pressure in said connected base pipes (70).



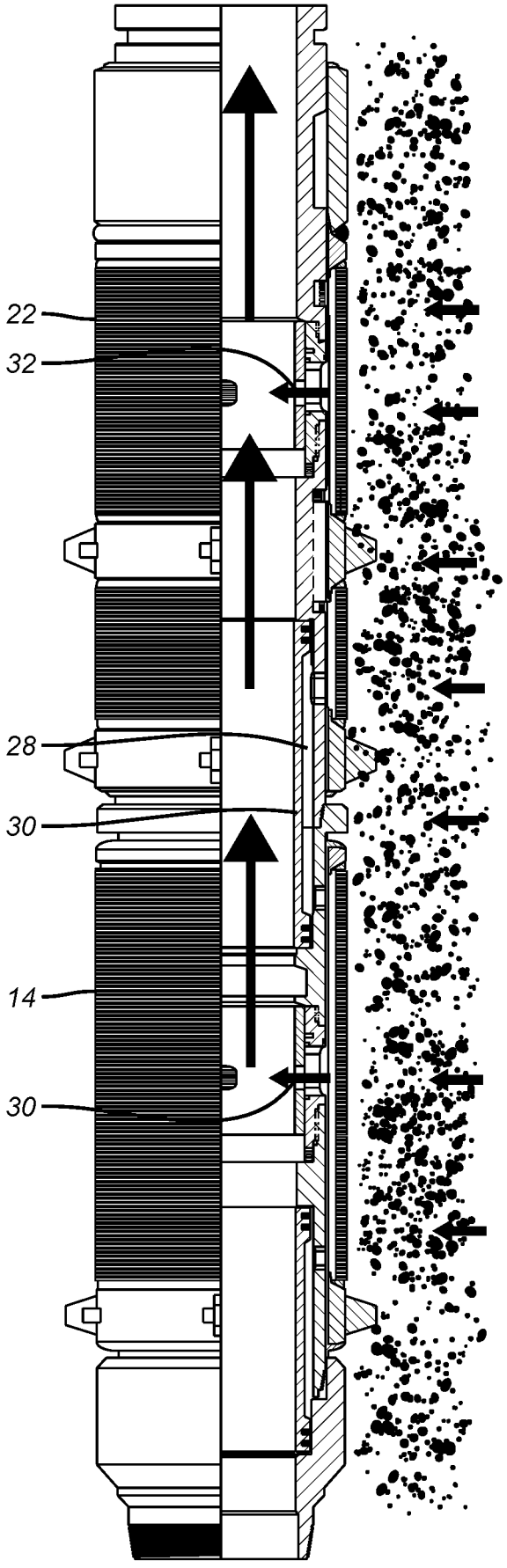
(PRIOR ART)

FIG. 1



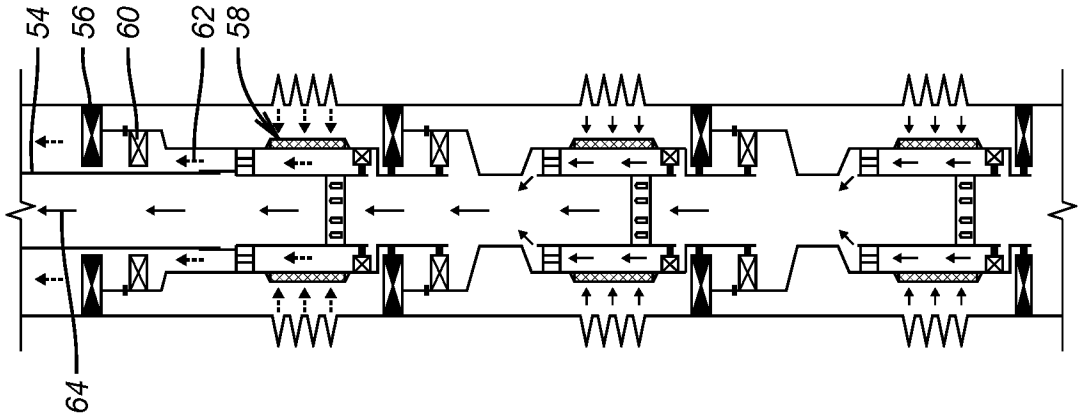
(PRIOR ART)

FIG. 2



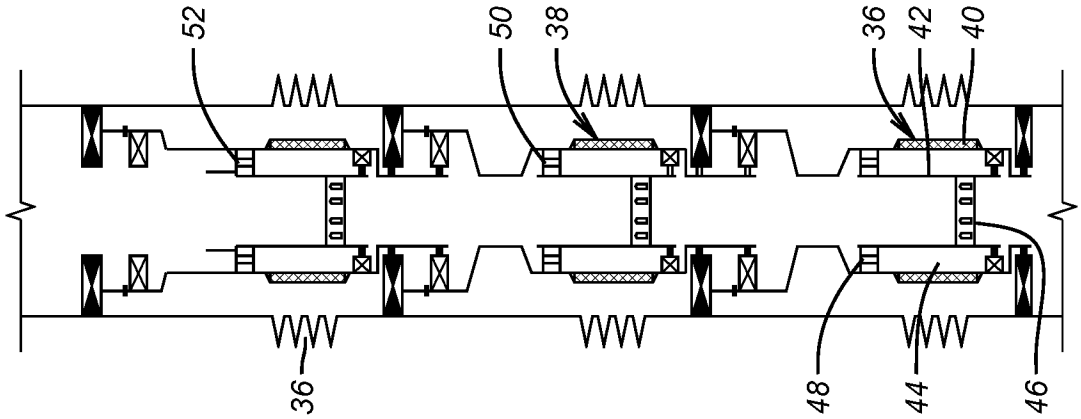
(PRIOR ART)

FIG. 3



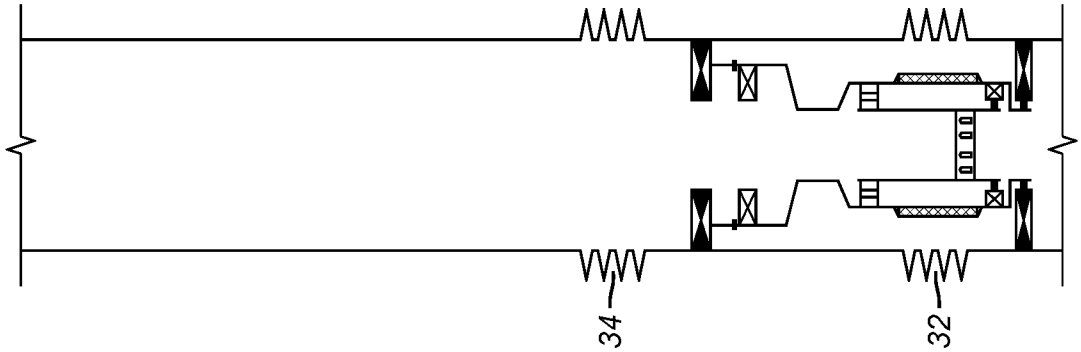
(PRIOR ART)

FIG. 6



(PRIOR ART)

FIG. 5



(PRIOR ART)

FIG. 4

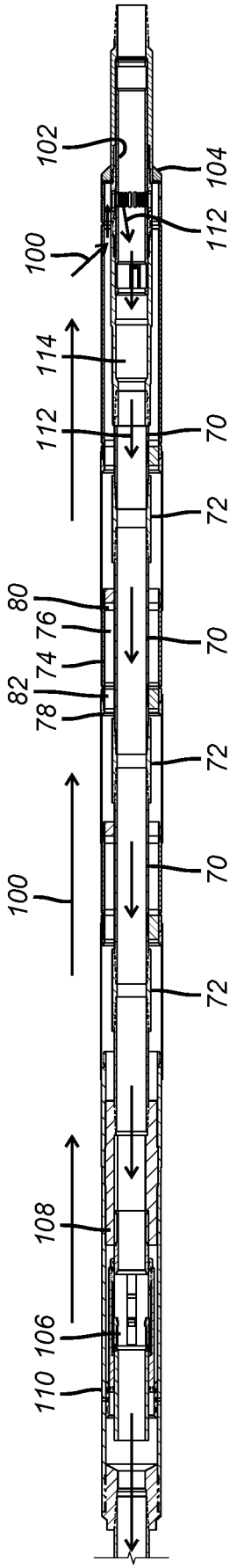


FIG. 7

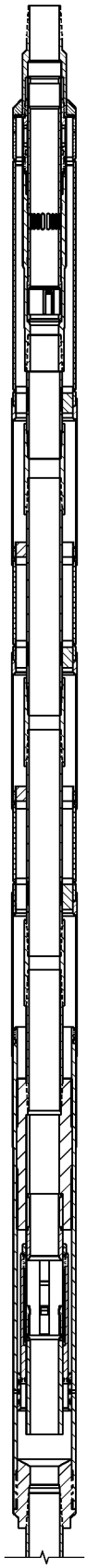


FIG. 8

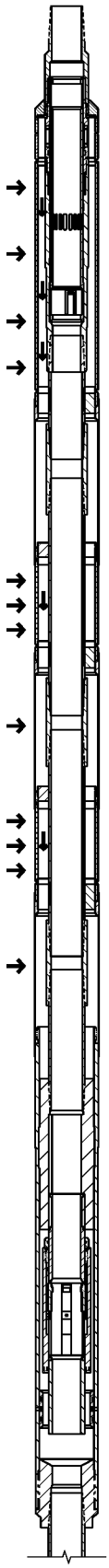


FIG. 9

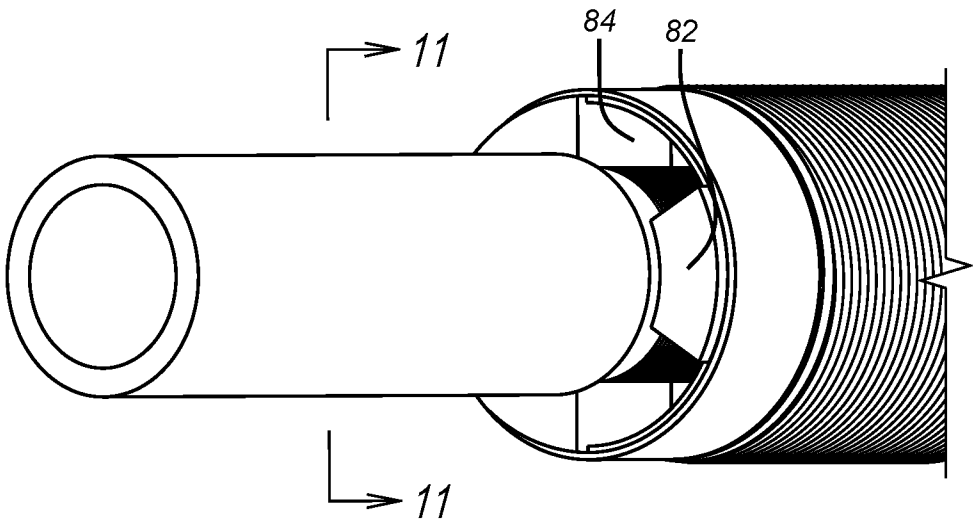


FIG. 10

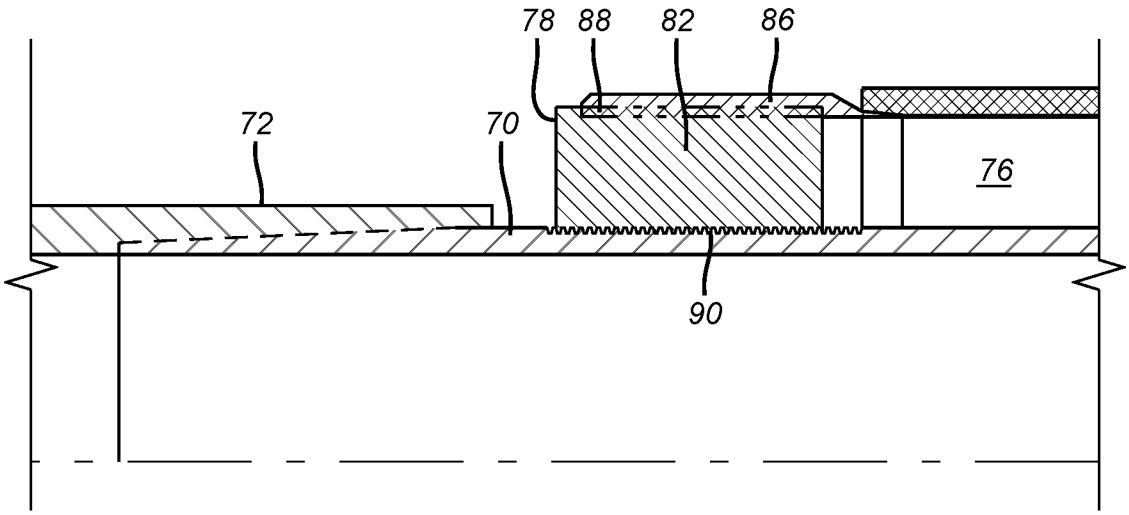


FIG. 11

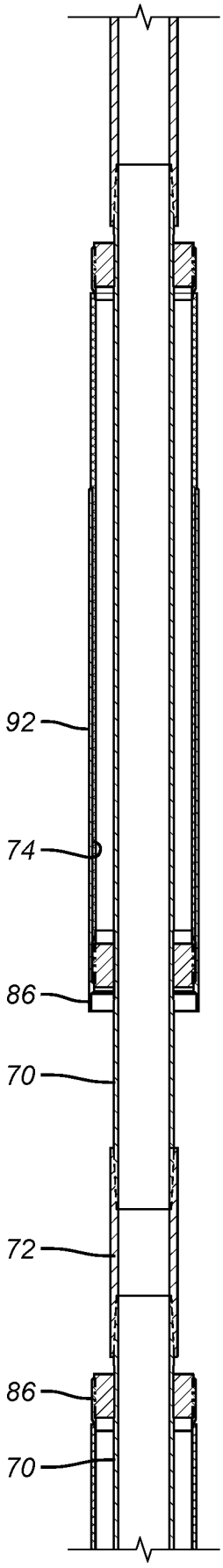


FIG. 12

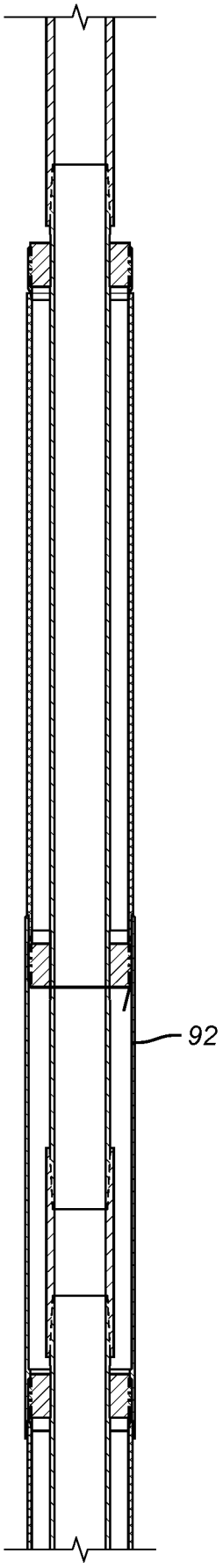


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/039730

A. CLASSIFICATION OF SUBJECT MATTER

E21B 43/02(2006.01)i, 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 43/02; E21B 43/04; E03B 3/18; E21B 43/10; E21B 41/02; E21B 43/08; 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:
production, pipe, screen, spacer, shroud, valve, gravel pack, annular, assembly

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009-048846 A1 (SCHLUMBERGER CANADA LIMITED et al.) 16 April 2009 See paragraphs [0016], [0025]-[0038], [0060]; and figures 1, 3, 9-10.	1,7-14,16,19
Y		2-6,15,17-18
Y	US 2003-0056959 A1 (CASTANO-MEARS et al.) 27 March 2003 See paragraph [0031]; and figure 5.	2-6,15,17-18
A	US 5931229 A1 (LEHR et al.) 03 August 1999 See column 6, lines 16-38; column 10, line 63 - column 11, line 27; and figures 1C-1F, 5.	1-19
A	US 2008-0289815 A1 (MOEN et al.) 27 November 2008 See paragraphs [0026]-[0032]; and figures 4-11.	1-19
A	US 2013-0277053 A1 (YEH et al.) 24 October 2013 See paragraphs [0114]-[0118], [0136]-[0143]; and figures 2, 3A.	1-19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 October 2016 (14.10.2016)	**14 October 2016 (14.10.2016)**

Name and mailing address of the ISA/KR
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2016/039730

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