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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 April 2012 (12.04.2012)

PCT

(10) International Publication Number
WO 2012/047604 A1

(51) International Patent Classification:
E21B 43/10 (2006.01) *E21B 23/02* (2006.01)
E21B 29/10 (2006.01)

(21) International Application Number:
PCT/US2011/053348

(22) International Filing Date:
27 September 2011 (27.09.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/901,122 8 October 2010 (08.10.2010) US

(71) Applicant *(for all designated States except US)*: **BAKER HUGHES INCORPORATED** [US/US]; P.O. Box 4740, Houston, TX 77210-4740 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **O'CONNOR, Keven** [US/US]; 901 E 24th Street, Houston, TX 77009 (US). **LEHR, Joerg** [DE/DE]; Riethkamp 44, 29229 Celle (DE). **ADAM, Mark K.** [US/US]; 1036 Algregg, Houston, TX 77009 (US). **GRUETZMANN, Ines** [DE/DE]; Braunsberger Str. 27, 31275 Lehrte-arpke (DE).

(74) Agent: **RIDDLE, J. Albert**; Baker Hughes Incorporated, P.O. Box 4740, Houston, TX 77210-4740 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM,

[Continued on next page]

(54) Title: PUMP DOWN SWAGE EXPANSION METHOD

(57) Abstract: The tubular string to be expanded is run in on a running string. The swage assembly has a seal from the running string to the existing tubular and the top of the tubular string to be expanded also has a similar seal against the existing tubular. Annulus pressure around the running string drives the swage assembly to support the expanded tubular to the existing tubular and to continue expansion to the end of the tubular. Cementing then takes place followed by reconfiguring the swage assembly to engage the liner hanger seal with the result being a monobore connection in a single trip including the cementing.

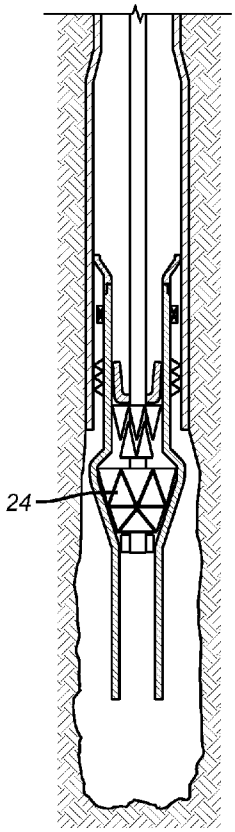

FIG. 3

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AO, AT, AU, AZ, BA, BB, BG, BH, 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, KM, 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, 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, MD, 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, 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))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

PUMP DOWN SWAGE EXPANSION METHOD

Inventors: Keven O'Connor; Joerg Lehr; Mark K. Adam and Ines Gruetzmann

FIELD OF THE INVENTION

[0001] The field of the invention is a method of expansion of tubulars downhole and more particularly expanding one tubular into contact with an existing tubular where the added tubular is expanded into a supporting position by advancing a swage through the new tubular by moving it downhole using pressure from the surface.

BACKGROUND OF THE INVENTION

[0002] Monobore applications using expansion have integrated cementing through a shoe while covering a recess at the end of an existing string with a removable cover that comes off after cementing. A string with a swage is placed in position and the swage is energized to grow in diameter before being advanced through the newly added tubular until the swage exits the top of the added tubular to fixate it into the recess at the lower end of the existing tubular. The result is a monobore well. These designs have also disclosed a deployable shoe that can be delivered with the string prior to expansion and then tagged and retained as a swage moves through the string only to be reintroduced into the expanded string and sealingly fixated to it for the cementing operation. Examples of one or more of these method steps are illustrated in USP: 7,730,955; 7,708,060 ; 7,552,772 ; 7,458,422 ; 7,380,604 ; 7,370,699 ; 7,255,176 and 7,240,731. Other patents relating to expansion by moving a cone uphole from within a bell at a lower end of a liner to be supported to a recess in existing tubing and creating a monobore as well as expansion of tubulars downhole are as follows:

6712154; 7185710; 7410000; 7350564; 7100684; 7195064; 7258168; 7416027; 7290616; 7121352; 7234531; 7740076; 7100685; 7556092; 7516790; 7546881; 6328113; 7086475; 6745845; 6575240; 6725919; 6758278; 6739392; 7201223; 7204007; 7172019; 7325602; 7363691; 7146702; 7172024; 7308755; 6568471; 6966370; 7419009; 7040396; 6684947; 6631769; 6631759; 7063142; 6705395; 7044221; 6857473; 7077213; 7036582; 7603758; 7108061; 6631760; 6561227; 7159665;

7021390; 6892819; 7246667; 7174964; 6823937; 7147053; 7299881; 7231985; 7168499; 7270188; 7357190; 7044218; 7357188; 7665532; 7121337; 7434618; 7240729; 7077211; 7195061; 7198100; 6640903; 7438132; 7055608; 7240728; 7216701; 6604763; 6968618; 7172021; 7048067; 6976541; 7159667; 7108072 and 6557640.

[0003] Particularly noteworthy with regard to the present invention is USP 7,121,351, which uses a seal to drive a swage up from below to expand a tubular.

[0004] Methods that mechanically advance a swage through a tubular require the rig equipment to not only support the weight of the string to be expanded but also to be able to handle the applied force to the swage to advance it through the tubular to enlarge the diameter. The present invention reduces the surface equipment capacities needed to perform an expansion to create, for example, a monobore. The method features a top down expansion using a plurality of adjustable swages that get built at different times and that are driven from applied annulus pressure delivered around a workstring. The tubular to be expanded is placed in an overlapping position with an existing tubular. The swage assembly is pushed on a guide extending from the running string by virtue of a cup seal around the running string and another peripheral seal on the top of the liner to be expanded to prevent pressure bypassing as the swage assembly is run into the liner string to support the liner without sealing it. A further swage is built to a larger diameter than the first expansion in the liner at a location below the support point to the existing liner and the balance of the liner is expanded to bottom while engaging the cement shoe as the swage assembly leaves the lower end of the now expanded liner. The shoe is repositioned and set at the lower end of the expanded liner and a cement job follows with a subsequent circulating out of excess cement. The swage assembly is pulled through the liner and another swage is built before it is pushed down through the liner top to set the seal of the liner hanger or optionally to go though past the slips of the liner hanger to create a constant drift though the expanded liner top. The assembly is removed to create a monobore with a recessed liner shoe for a future monobore installation.

[0005] The method of the present invention uses running string and liner peripheral seals to move a swage assembly for gaining liner support. It continues in that mode with building another swage after support of the liner in the existing tubular. In the same trip the shoe is secured and the liner cemented followed by engaging the seal of the liner hanger with manipulation of the running string. These features along with others that are explained in detail in the discussion of the preferred embodiment and the associated drawings will become more apparent to those skilled in the art from a review of those sections, while recognizing that the full scope of the invention is to be found in the appended claims.

SUMMARY OF THE INVENTION

[0006] The tubular string to be expanded is run in on a running string. The swage assembly has a seal from the running string to the existing tubular and the top of the tubular string to be expanded also has a seal against the exiting tubular. Annulus pressure around the running string drives the swage assembly to support the expanded tubular to the exiting tubular and to continue expansion to the end of the tubular. Cementing then takes place followed by reconfiguring the swage assembly to engage the liner hanger seal with the result being a monobore connection with recessed shoe in a single trip including the cementing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 shows the liner supported by the running string in the desired location at the lower end of the existing tubular;

[0008] FIG. 2 is the view of FIG. 1 showing the advancing swage assembly supporting the liner to the surrounding tubular;

[0009] FIG. 3 is the view of FIG. 2 showing the swage assembly having passed the lower end of the existing tubular and being built to finish the expansion;

[0010] FIG. 4 is the view of FIG. 3 showing the swage assembly out the lower end of the expanded tubular and ready to locate and set a cementing shoe at the lower end to facilitate the cementing step;

[0011] FIG. 5 is the view of FIG. 4 after cementing is done and the swage assembly is raised out of the liner and built again to set the liner hanger seal;

[0012] FIG. 6 shows the swage assembly brought down from the FIG. 5 position to set the liner hanger seal;

[0013] FIG. 7 is the view of FIG. 6 with the running string removed;

[0014] FIG. 8 is a more detailed view of the assembly shown as it is being run in with the liner to be expanded;

[0015] FIG. 8a shows the swage assembly in its various operating modes;

[0016] FIG. 9 is the view of FIG. 8 with the anchor set to the existing tubular;

[0017] FIG. 10 shows the swage assembly sheared from the liner top while the liner is still retained by the running string at a lower location;

[0018] FIG. 11 shows the swage assembly driven to support the liner to the existing tubular;

and the swage assembly bottoming on the running tool to release the liner;

[0019] FIG. 12 shows the second swage fully built and bypass on the cup seal on the swage assembly being opened;

[0020] FIG. 13 shows the anchor on the running string released from the existing tubular;

[0021] FIG. 14 shows the bypass closed on the swage assembly seal and the running string repositioned for completing the expansion to the lower end of the liner;

[0022] FIG. 15 shows the cement shoe engaged before the balance of expansion begins;

[0023] FIG. 16 shows grabbing the cement shoe to remove it from the liner bottom as the swage assembly approaches the liner bottom;

[0024] FIG. 17 shows the shoe out of the liner bottom as the swage assembly approached the liner bottom;

[0025] FIG. 18 shows the swage assembly out of the liner bottom;

[0026] FIG. 19 shows a pickup force to bring the running string up against the swage assembly to open the bypass on the swage assembly seal;

[0027] FIG. 20 shows the cement shoe back in the liner and sealingly secured to the liner for cementing;

[0028] FIG. 21 shows circulating out excess cement after the cementing job;

[0029] FIG. 22 shows picking up the work string to open the swage assembly bypass and then building another swage in the assembly with flow to set the seal for the liner hanger;

[0030] FIG. 23 shows the largest swage built with circulation;

[0031] FIG. 24 shows expanding the liner hanger seal into the surrounding tubular;

[0032] FIG. 25 shows collapsing the swage assembly and pulling out of the hole with the swage assembly seal in the open position; and

[0033] FIG. 26 shows a section through a folded version of the liner to be expanded showing the running tool location in the form of parallel guides for the expansion.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0034] FIGS. 1-7 illustrate the method in general terms and will be used as an introduction before discussing the specifics in greater detail. An existing tubular **10** has a bottom bell **12**. As an option there can be an open hole where at least portions thereof have no existing tubular **10**. A running string **14** has a lower end **16** that initially and releasably supports the tubular string or liner **18**. A swage assembly **20** has three segmented swage rings **22**, **24** and **26**. While three adjustable swages are preferred, the various expansions can be done with at least one swage that is adjustable to differing expansions diameters to perform the various method steps at the time those method steps need to occur and providing the targeted degree of expansion at each step. A swage assembly seal **28** is mounted to the running string**14** for tandem movement and extends radially for initial sealing contact with the bell **12**. The liner **18** has a top seal **30** that is allowed to engage the bell **12** when the expansion starts to engage the slips **32** to the bell **12**. A seal **34** is set against the bell **12** by expansion after cementing takes place. The lower end **16** acts as a travel stop for the swage assembly **20**. The swage assembly **20** and the seal **28** can move relatively to the running string **14**. The running string **14** is preferably anchored to the existing tubular **10** when pressure against seal **28**

drives the swage assembly **20** relative to the running string **14** until the travel stop at the lower end **16** is reached.

[0035] FIG. 2 shows annulus pressure around the running string **14** and against the seal **28** driving the swage assembly **20** along the running string **14** that is now anchored to the existing tubular **10**. Note that the seal **30** at the top of the liner **18** is against the bell **12** so that the seal **28** can still be driven into the liner **18** to the point where the travel stop at the lower end **16** is engaged and the slips **32** being set to support the liner **18** to the bell **12**.

[0036] In FIG. 3, the swage **24** is built in place and the pressure against seal **28** continues so that the swage assembly **20** is driven out the lower end of the liner **18** as shown in FIG. 4. A bell **36** is now created in the lower end of the liner **18**. While the expansion reached the lower end **38**, a cement shoe that is not shown was grabbed and put out beyond the end **38** and then brought back after the swage assembly **20** was pushed past the lower end **38**. When the cement shoe is brought back into the bell **36** it is secured and sealed to the bell **36** and the connection is pressure tested before the cement delivery begins as shown in FIG. 5.

[0037] FIG. 5 shows the cement **38** delivered and the running string **14** picked up to put the swage assembly **20** above the seal **30** so that swage **26** can be built for subsequent setting of the seal **34** against the bell **12** as shown in FIG. 6. After setting the seal **34** against the bell **12** the running string **14** and everything that it supports is removed leaving a cemented monobore connection where the diameter at **40** is the same as the diameter at **42** and a bell **36** is formed the same as the diameter at **12**. Optionally in FIG. 6 the swage **26** can be pushed with pressure past the slips **32** to insure the same dimension **40** at both the slips **32** and the adjacent hanger seal **34**.

[0038] FIG. 8 shows the assembly of FIGS. 1-6 in greater detail. An anchor **44** is attached to the running string **14** and shown in the unset position to allow running in with the running string **14**. There is a hub **46** that supports the anchor **44** and the mandrel **48**. Note that if the tubular **18** is a rounded shape then the mandrel **48** is preferably a tubular rounded shape as well. On the other hand as shown in FIG. 26 if the liner string **18** is folded for example in the manner shown then the mandrel **48** can be a pair of parallel rods **50**

disposed in the folds **52** and **54**. A running tool **56** serves an initial purpose of grip of the liner **18** to the bell **12** until the slips **32** are expanded into the bell **12**. Tool **56** also has a grip assembly **58** that can selectively engage a receptacle **62** in the cement shoe **60** for engaging the grip and seal assembly **64** to the bell **12** as will be explained below. Circulation when running in is represented by arrow **66** showing flow through the running string **14** and through the hub **46** and the mandrel **48** leading out through openings **68** in the shoe **60** as represented by arrows **70**. Returns are represented by arrow **72** showing flow uphole past the seal **28**. A breakable connection **74** temporarily connects the swage assembly **20** to the liner **18**.

[0039] FIG. 8a shows the various positions of the swage assembly **20** with the first view showing all three swage segment rings **22**, **24** and **26** in the unbuilt position for run in, followed by building ring **22** for setting the slips **32**, followed by building the swage **24** for expanding the bell **36** for the balance of the downhole directed expansion followed by relaxing swages **22** and **24** and building swage **26** to expand the hanger seal **34** into the bell **12**. After that the swage **26** is collapsed and the swage assembly **20 and the** mandrel **28** are pulled out with the running string **14**.

[0040] In FIG. 9 pressure applied in the annulus as represented by arrow **76** against the seal **28** sets the anchor **44** as the seal **28** holds pressure against the bell **12**. Doing this isolates the string **14** above the anchor **44** from tensile stress from driving the swage assembly **20** along the mandrel **48** to set the slips **32**. The slips **32** and the seal **34** are positioned within the bell **12** so that they can ultimately be used to support the liner **18**. All the swages in the assembly **20** are collapsed to their smallest dimension at this time. Connection of the swage assembly **20** to the liner 18 at **74** is still intact.

[0041] In FIG. 10 the connection **74** is sheared leaving the liner **18** still supported at running tool **56**. Swage ring **22** is now built and is pushed with pressure against seal **28** represented by arrows **76** so that seal **30** is pushed out radially to the bell **12**. The pressure **76** goes through the open anchor **44**. Expansion of the liner **18** has yet to start. Displaced fluid from the expansion and the seal 28 movement, once it starts will go down annulus **78** and through

openings **68** in the cement shoe **60** and up through the mandrel **48** and into the running string **14** for the trip to the surface.

[0042] FIG. 11 shows the slips **32** set and the seal **34** not yet set. The seal **28** is flexible and has gone into the liner **18**. The seal **30** on the top of the liner **18** is in contact with the bell **12** so that pressure that is applied to seal **28** to drive it and the swage assembly **20** in tandem will not be lost around the outside of the liner **18**. As the swage assembly **20** travels along mandrel **48** it reaches the running tool **56** which is now disengaged from the liner **18** as that connection has been released because the slips **32** are now supporting the liner **18**.

[0043] FIG. 12 shows continuing application of pressure represented by arrows **80** as the swage assembly is bottomed on the running tool **56**. Such bottoming allows the wedge segment swage **24** to build in place by pushing out the wall of the liner **18** followed by opening a bypass **82** in the seal **28**. Return flow represented by arrow **86** goes back to the surface through the running string **14**. An optional hydraulic stroker tool (not shown) can be employed in the effort to build the swage ring **24** in place before expansion resumes.

[0044] FIG. 13 shows the anchor **44** no longer contacting the bell **12** so that pressure application onto the seal **28** will now drive the swage **26** and running string **14** together to further expand the liner **18**. Note that before the expansion can start the bypass **82** needs to be closed by setting down weight to get the swage assembly **20** out of the running tool **56**. This is because when the swage assembly **20** bottoms on the running tool **56**, the bypass **82** on the seal **28** opens automatically. FIG. 14 shows such slacking off to put the running tool **56** away from the swage assembly **20**. The cup seal **28** is shown schematically without the bypass **82** indicating that such bypass is closed.

[0045] FIG. 15 shows application of annulus pressure represented by arrows **88** and the start of the movement of swage **24** in the built condition along with swage **22** that is below it and is still in the built condition. Fluid displacement from expansion is represented by arrows **90** and is directed to the surface through the running string **14**. Note that the running tool **56** has been

stabbed into the receptacle **62** so that the cement shoe **60** is engaged. This stabbing holds open the openings **68** on the shoe **60**.

[0046] In FIG. 16 the cement shoe **60** is detached from the liner **18** so that the swage assembly can pass out of the liner **18** while retaining the cement shoe **60**. This can be done with pressure and breaking a shear pin shown schematically as **92** or some type of latching dog arrangement can be used to grip the shoe **60** and carry it out through the bottom of the liner **18**. In FIG. 17 the swage assembly **20** is approaching the lower end of the liner **18** while the shoe **60** is further extended from liner **18** by engagement with the running tool **56** at receptacle **62**. Application of set down weight as this is happening prevents the bypass **82** (not shown in this view) from opening in seal **28** so that applied pressure can keep the swage assembly **20** moving toward the lower end of the liner 18. FIG. 18 shows the swages **22** and **24** exiting the lower end of the liner **18**. The expansion of the liner **18** is completed to the lower end and the next thing to happen is preparation for cementing. The swage assembly **20** is allowed to collapse as it exits the liner 18. A pickup force on the string **14** brings up the running tool **56** against the swage assembly **20** which opens the bypass **82** on the seal **28** as shown in FIG. 19.

[0047] What follows is picking up the cement shoe **60** into the liner **18** and setting its seal and grip assembly **64** as shown in FIG. 20. After that is done the string **14** is picked up to remove the running tool **56** from the receptacle **62** and to apply pressure into running string **14** and the annulus **94** with the bypass **82** still open since the swage assembly is sitting on the running tool **56** so that the integrity of the seal and grip assembly **64** can be tested. Having passed the pressure test for the cement shoe, the running tool **56** is lowered back into the receptacle **62** so that the cementing can begin through the shoe **60** and its openings **68**.

[0048] After the cementing is complete, the running tool **56** is picked up from the receptacle **62** as shown in FIG. 21 and fluid is circulated down the running string **14** as represented by arrows **96** and out through the running tool **56** as represented by arrows **98** and through the bypass **82** in seal **28**. The excess cement goes to the surface through annulus **94**. Thereafter the work string **14** is picked up and fluid is pumped down the annulus **94** with the

bypass **82** still open or alternatively pressure can be pumped down the string **14** to move the seal **28** up with respect to the liner **18**. This movement is continued until the swage **26** is above the upper end of the liner **18**. At this point as shown in FIG. 22 the flow rate is increased with the bypass **82** still held open because the swage assembly **20** is against the running tool **56**. This helps to move the cup seal **28** out of the liner **18** with a result that the bypass **82** will close.

[0049] As shown in FIG. 23 the swage assembly **20** has moved due to flow to the anchor **44** and the swage ring **26** now builds to its maximum dimension in preparation for setting the liner seal **34**. The string **14** is then set down to get the swage **26** at the top of the liner **18** for the expansion of the seal **34**. As shown in FIG. 24, the pressure is then applied in the annulus **94** against seal **28**. This drives the swage **26** into the liner **18** to expand the top of it and seal **34** against the bell **12**. Optionally the swage **26** can be driven past the slips **33** to insure that the top of the liner **18** has the same drift at **40** down to the bell **36**. After that expansion is complete a pickup force on the running string **14** opens the bypass **82** on the seal **28** so that a wet string is not pulled when removing the running string **14**. A pickup force also allows the swage **26** to collapse so that it will pass easily through the drift dimension **40**. After the running string **14** and the equipment it supports removed as shown in FIG. 25, drilling can continue through the cement shoe **60** that is milled up to further extend the monobore well.

[0050] Those skilled in the art will appreciate that reference to a liner **18** is intended to include other tubular strings that are initially circular in shape or folded in any way and can include casing or liner or slotted liner or other types of tubular strings and be within the scope of the invention. The method of the present invention guides the swage assembly while driving it with annulus pressure from the surface so that the liner **18** finds initial support. The liner is then released from the running string **14** and the balance of the liner is expanded with pressure onto seal **28** which preferably is a cup seal although other seal arrangements are contemplated. Seal **30** which can be another cup seal or some other type of seal is used to seal off around the top of the liner **18** for the time that its seal **34** is not energized. The conclusion of the expansion

to the lower end sees the grabbing of the shoe **60** to allow the swage assembly **20** to exit the liner **18** followed by replacement of the shoe **60** back into the liner **18** so that it can be reset in the liner and the pressure tightness of that connection tested before cementing can begin. After cementing the swage assembly **20** is collapsed and brought through the liner **18** so that the swage ring **26** can be built and driven down with fluid pressure onto seal **28** until the seal **34** is set with further expansion of the top of the liner **18**. The running string is pulled and what results is a monobore connection. The cement shoe **60** can then be drilled out as the well is drilled deeper and the method is repeated.

[0051] While constructing a monobore is preferred, the method can be used to hang tubular strings that do not result in a monobore.

[0052] 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.

We claim:

1. A subterranean completion method comprising:

mounting a swage assembly to a running string;

supporting a tubular string to be expanded on said running string;

mounting a running string seal to close off for a time an annular space around said running string, said annular space formed at least in part between said running string and a surrounding tubular or between said running string and a surrounding open hole ;

driving said swage assembly into said tubular to be expanded using pressure delivered to said annular space and against said seal;

expanding and securing said tubular to be expanded by said driving.

2. The method of claim **1**, comprising:

driving said swage assembly with respect to said running string to expand said tubular to be expanded into the surrounding tubular.

3. The method of claim **1**, comprising:

driving said swage assembly through opposed ends of the tubular to be expanded.

4. The method of claim **1**, comprising:

using a plurality of swages of different built diameters for expanding said tubular to be expanded.

5. The method of claim **4**, comprising:

building a second swage of a bigger size than an initial swage used to expand and support said tubular to be expanded to a surrounding tubular;

expanding said tubular to be expanded with said second swage from where said tubular to be expanded does not overlap the surrounding tubular and to an end of said tubular to be expanded.

6. The method of claim **4**, comprising:

building at least one swage in said swage assembly with pressure in said annular space delivered to said seal.

7. The method of claim **1**, comprising:

providing an end seal on said tubular to be expanded that contacts the surrounding tubular or open hole to hold pressure in said annular space after said running string seal enters said tubular to be expanded.

8. The method of claim **5**, comprising:

building said second swage while said second swage is in said tubular to be expanded;

using pressure in said annular space against said running string seal to build said second swage

providing an end seal on said tubular to be expanded that contacts the surrounding tubular or open hole to hold pressure in said annular space after said running string seal enters said tubular to be expanded.

9. The method of claim **5**, comprising:

engaging a cement shoe with said swage assembly as said swage assembly advances toward said end of said tubular to be expanded;

advancing said cement shoe beyond said end of said tubular to be expanded as said swage assembly exits said end of said tubular to be expanded;

sealingly engaging said cement shoe to the now expanded lower end;

delivering cement through said running string that is engaged through said cement shoe and into a second annular space around the now expanded tubular.

10. The method of claim **9**, comprising:

releasing said work string from said cement shoe after said delivering;

retracting said swage assembly through said now expanded tubular;

building a third swage that is bigger than said second swage outside said now expanded tubular;

engaging said third swage to said now expanded tubular;

setting an exterior seal between said now expanded tubular and the existing tubular or open hole by further expanding with said third swage.

11. The method of claim **10**, comprising:

building said third swage with pressure in said running string;

running said third swage into said now expanded tubular past the location of exterior slips that support the now expanded tubular to the existing tubular.

12. The method of claim **1**, comprising:

producing a monobore connection by said expanding and securing.

13. The method of claim **1**, comprising:

mounting an anchor to said running string to selectively engage the surrounding tubular or open hole;

providing an end seal on said tubular to be expanded that contacts the surrounding tubular or open hole to hold pressure in said annular space after said running string seal enters said tubular to be expanded;

engaging said anchor to the surrounding tubular or open hole with pressure in said annular space around said running string acting on said running string seal and said end seal.

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

releasing said anchor after said expanding and securing;

increasing the size of said swage assembly while said swage assembly is located in the tubular to be expanded and at a location below an end of the surrounding tubular;

driving said swage assembly in its increased size with pressure in said annular space around said running string acting on said running string seal.

15. The method of claim **1**, comprising:

providing a travel stop on said running string;

automatically opening a bypass for said running string seal when said swage assembly engages said travel stop and closing said bypass when said swage assembly is out of contact with said travel stop.

16. The method of claim **1**, comprising:

releasing said string to be expanded from the running string after said expanding and securing;

providing a travel stop on said running string;

releasing as a result of said swage assembly engaging said travel stop.

17. The method of claim **1**, comprising:

expanding at least a first portion of said tubular to be expanded to a first dimension with said expanding and securing;

subsequently expanding a second portion of said tubular to be expanded to a larger dimension;

using at least two adjustable swages for expanding said first and second portions.

18. The method of claim **17**, comprising:

increasing the dimension of the tubular to be expanded when building a larger of said at least two adjustable swages;

providing an end seal on said tubular to be expanded that contacts the surrounding tubular or open hole to hold pressure in said annular space after said running string seal enters said tubular to be expanded;

using pressure in said annular space around said running string and against said running string seal and said end seal to build said swages.

19. The method of claim **18**, comprising:

using at least three adjustable swages at different times that have different sizes.

initially expanding and securing with a first swage to engage at least one slip to the surrounding tubular;

subsequently expanding the tubular to be expanded below where there is overlap with the surrounding tubular with a second swage the builds to a larger diameter than said first swage;

positioning said swages at an end of said tubular that is now initially expanded and building said third swage to a larger dimension than the built dimension of said second swage;

securing a seal adjacent said slip to the surrounding tubular.

20. The method of claim **19**, comprising:

passing said third swage when built past said seal and said slip.

21. The method of claim **1**, comprising:

driving said swage assembly in tandem with said running string to expand said tubular to be expanded into the surrounding tubular.

22. The method of claim **1**, comprising:

driving said swage assembly through said tubular to be expanded from top to bottom.

23. The method of claim **1**, comprising:

using a single swage that can be built to a plurality of expansion dimensions as said swage assembly.

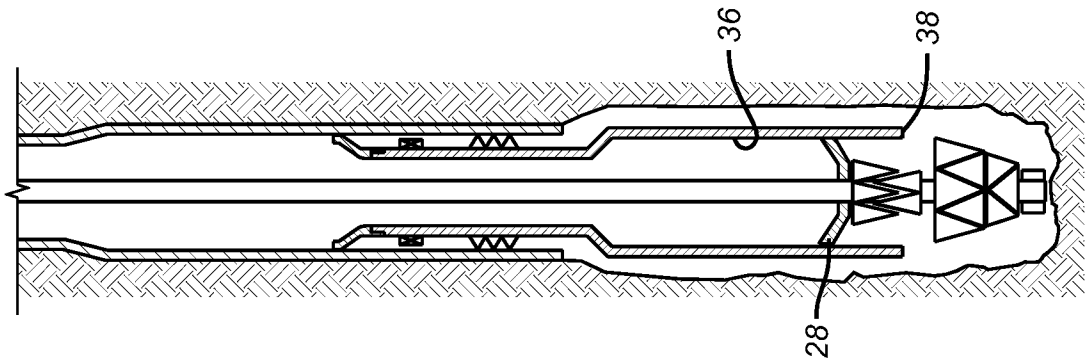

FIG. 4

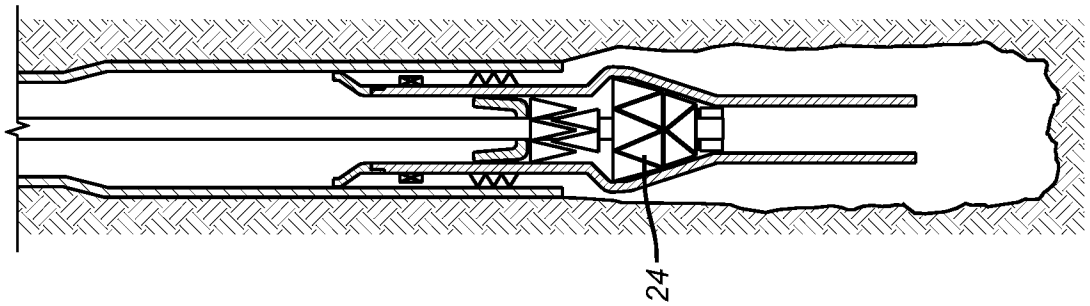

FIG. 3

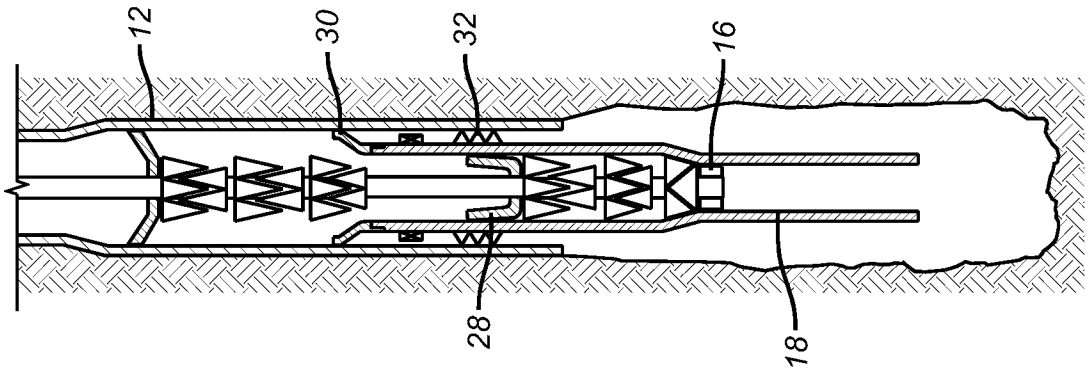

FIG. 2

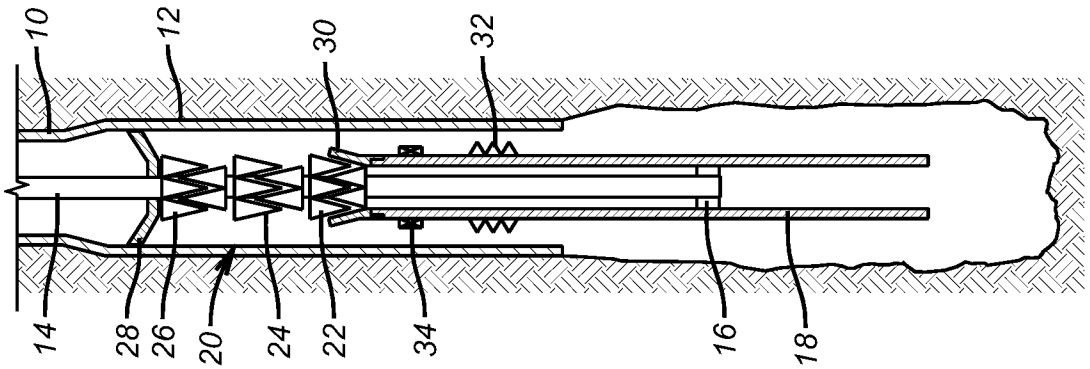

FIG. 1

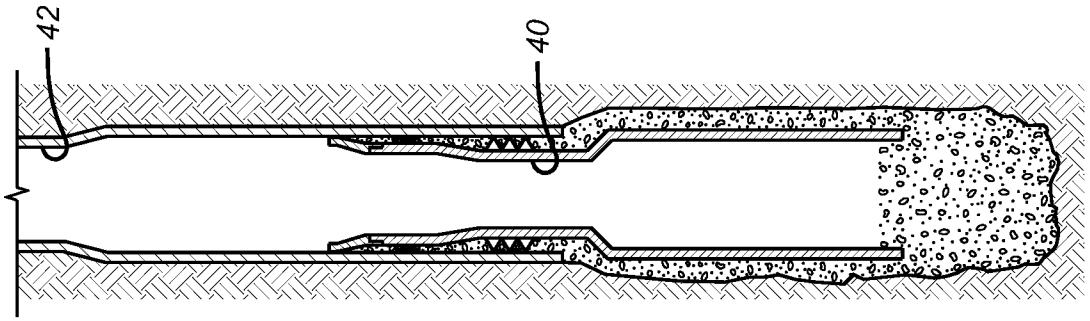

FIG. 7

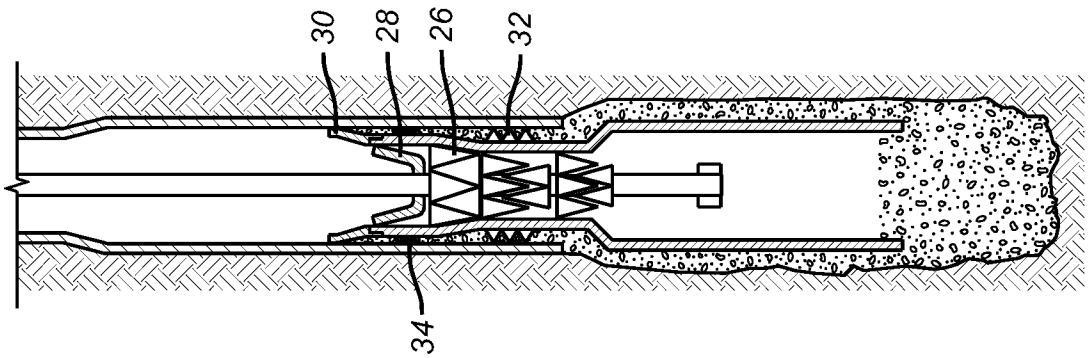

FIG. 6

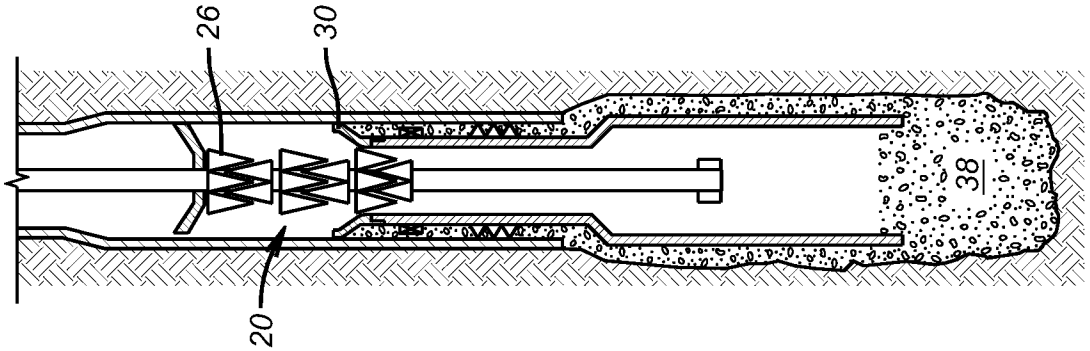

FIG. 5

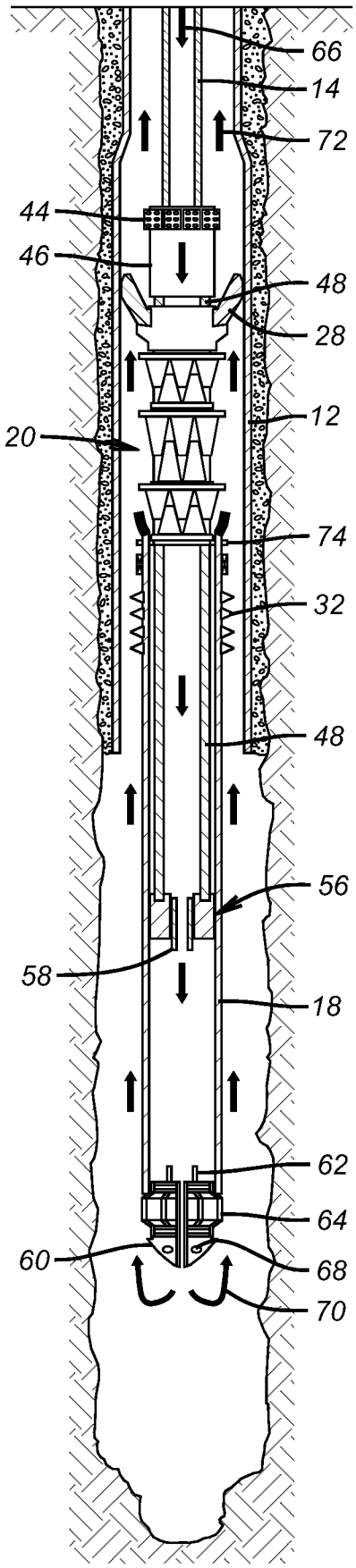

FIG. 8

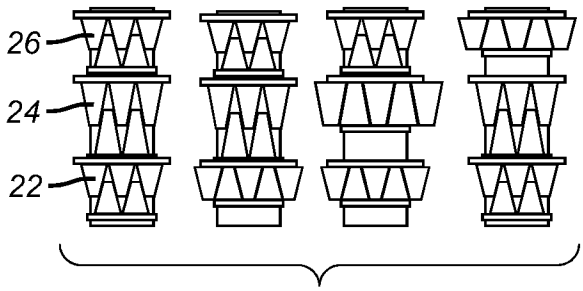

FIG. 8a

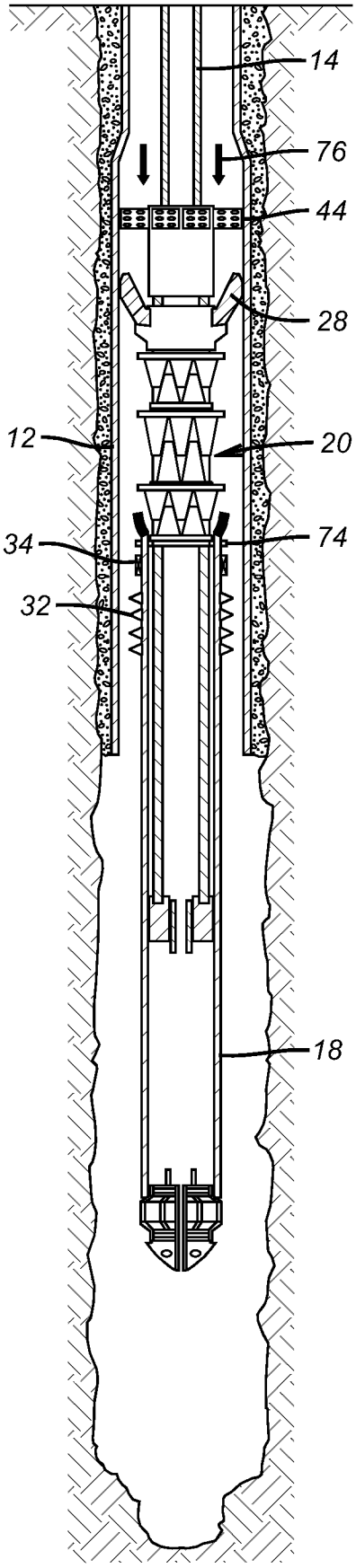

FIG. 9

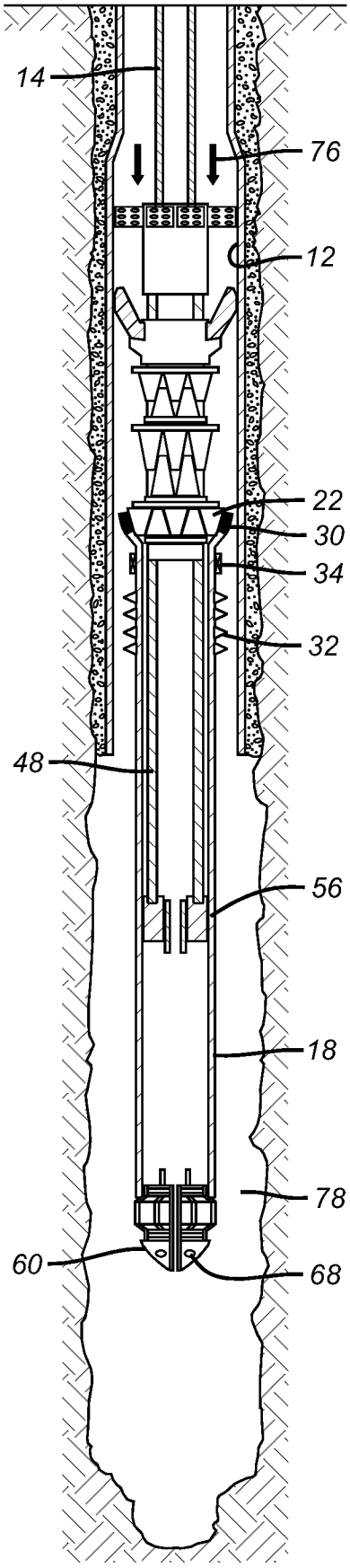

FIG. 10

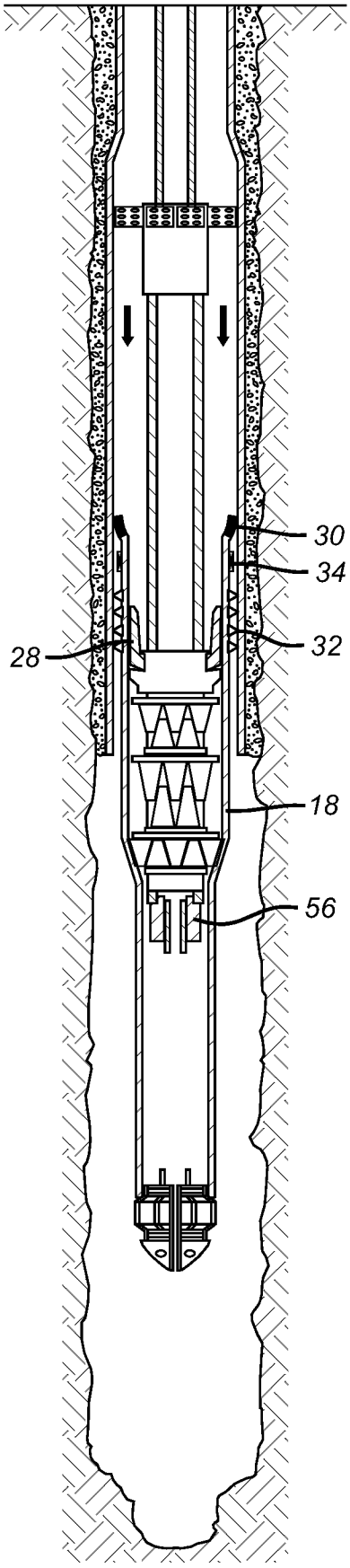

FIG. 11

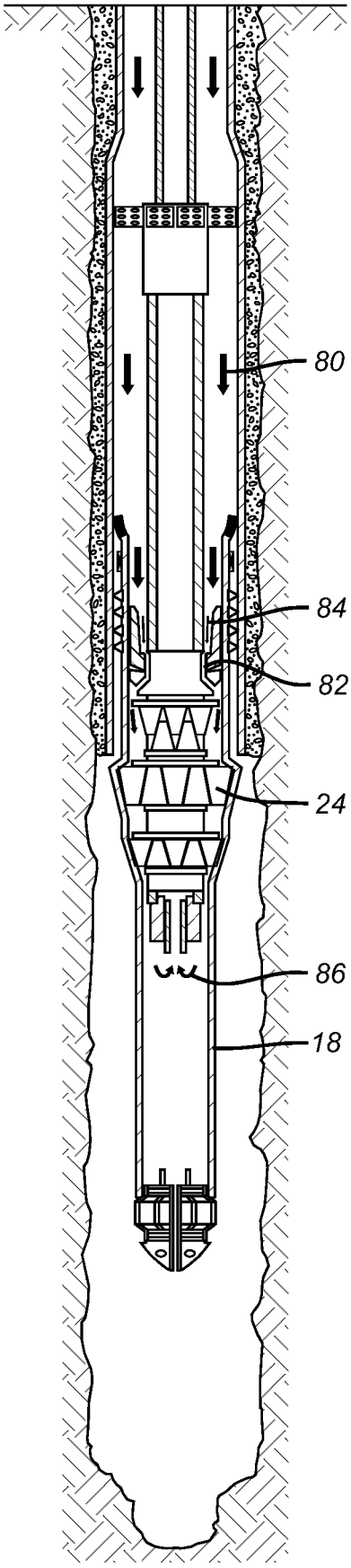

FIG. 12

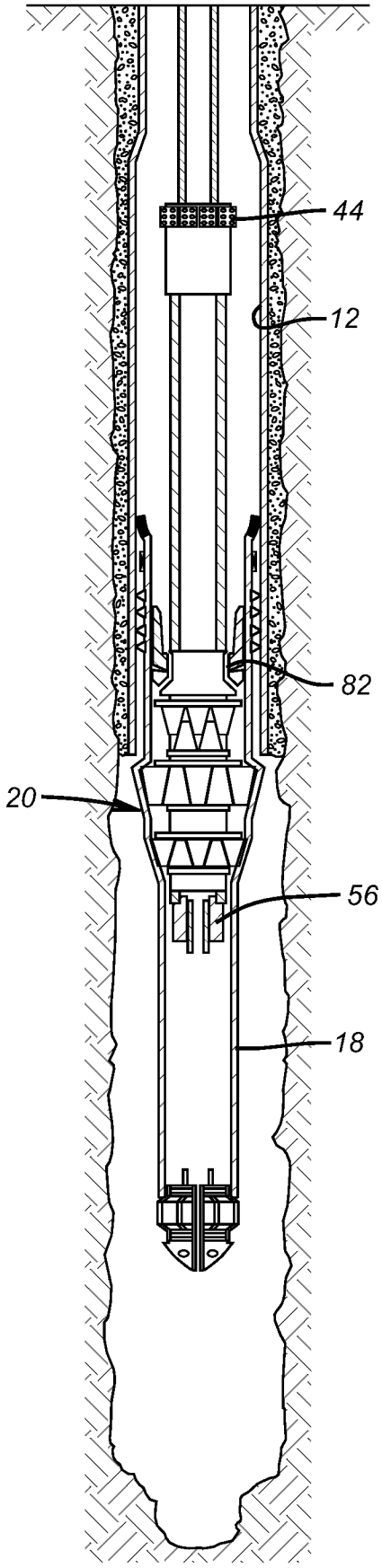

FIG. 13

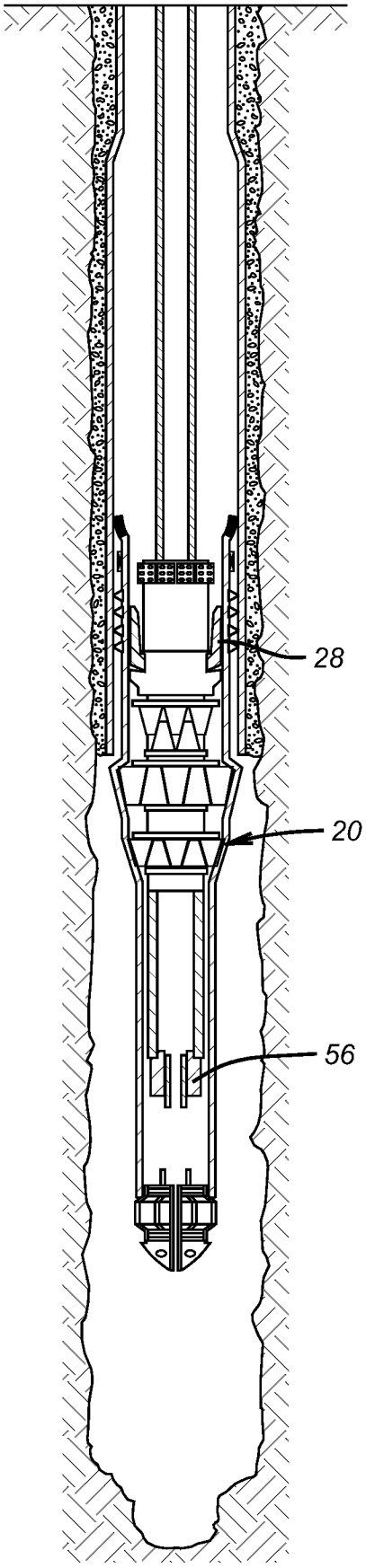

FIG. 14

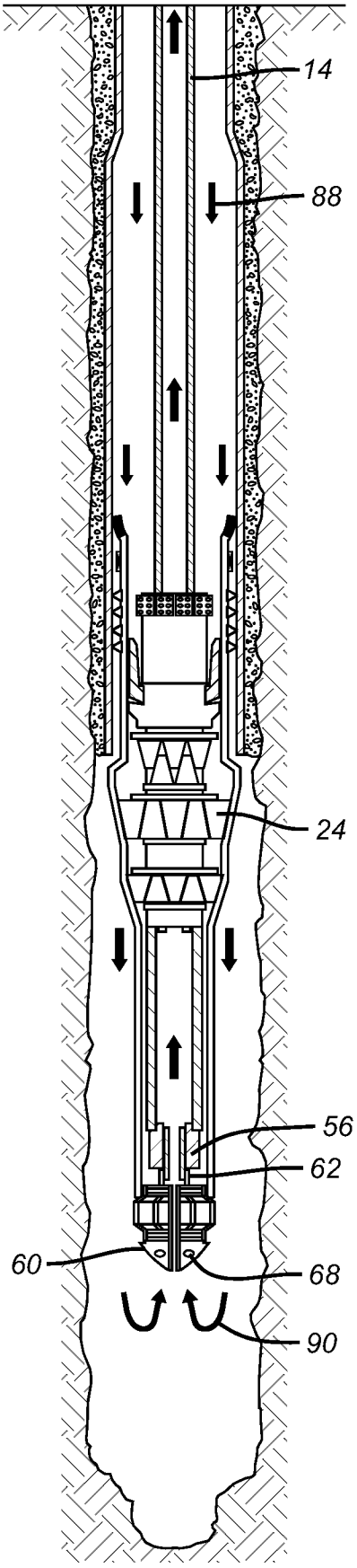

FIG. 15

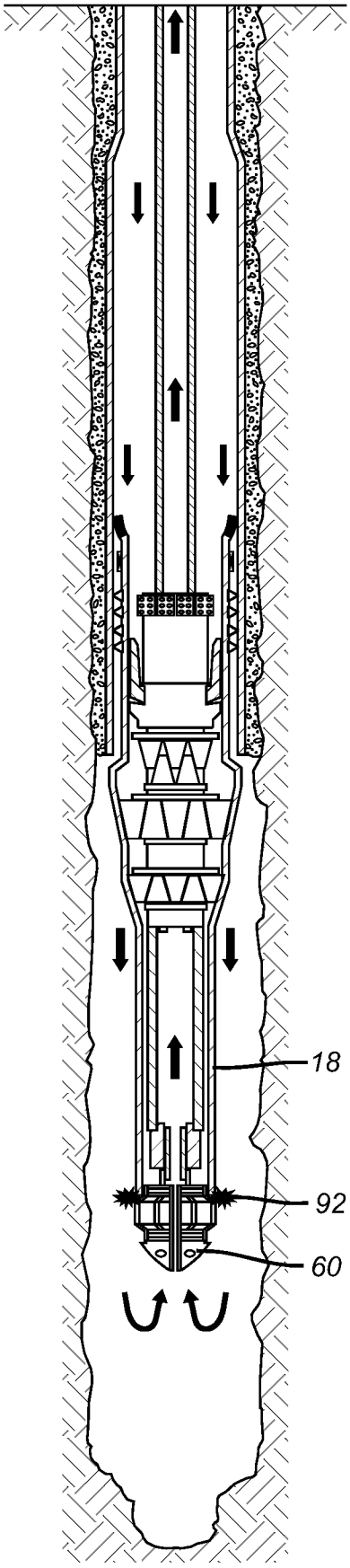

FIG. 16

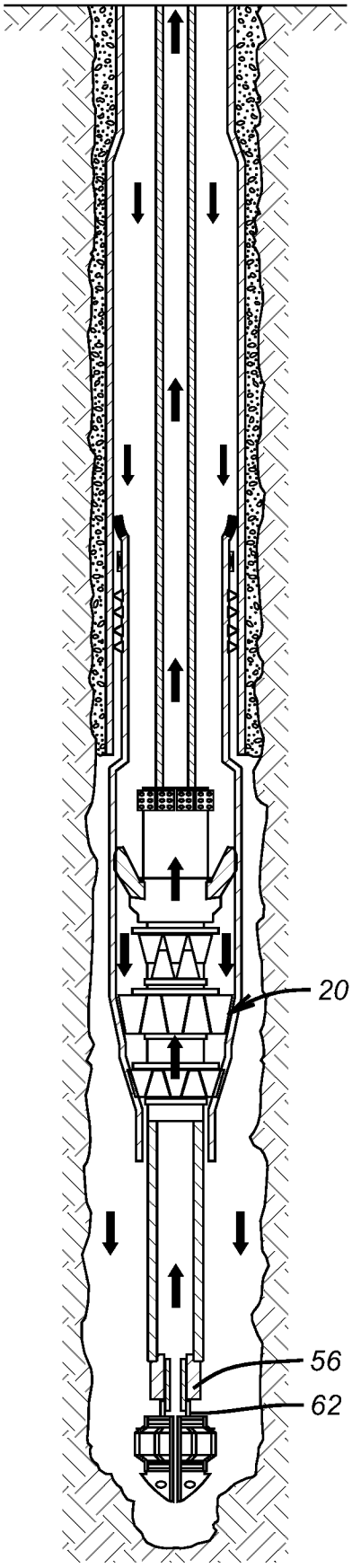

FIG. 17

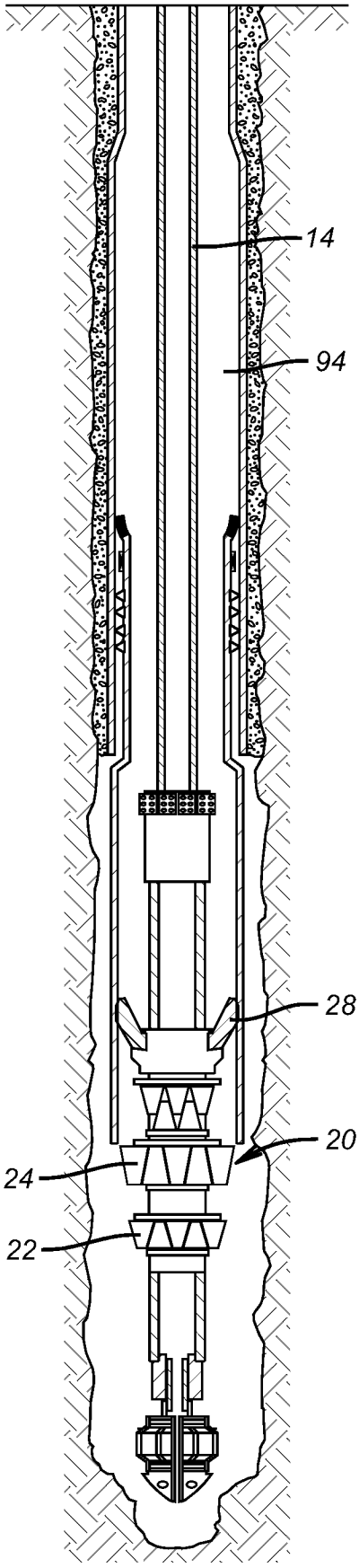

FIG. 18

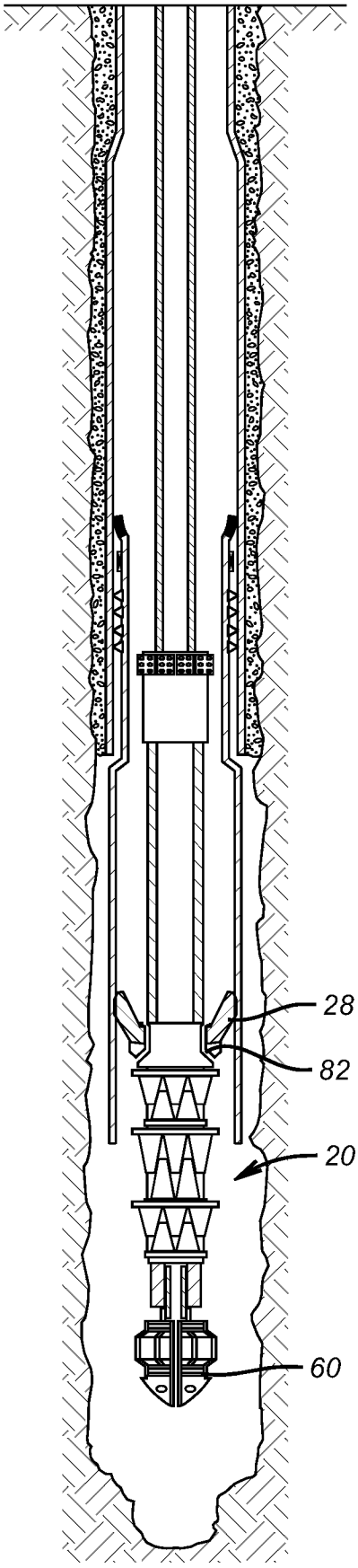

FIG. 19

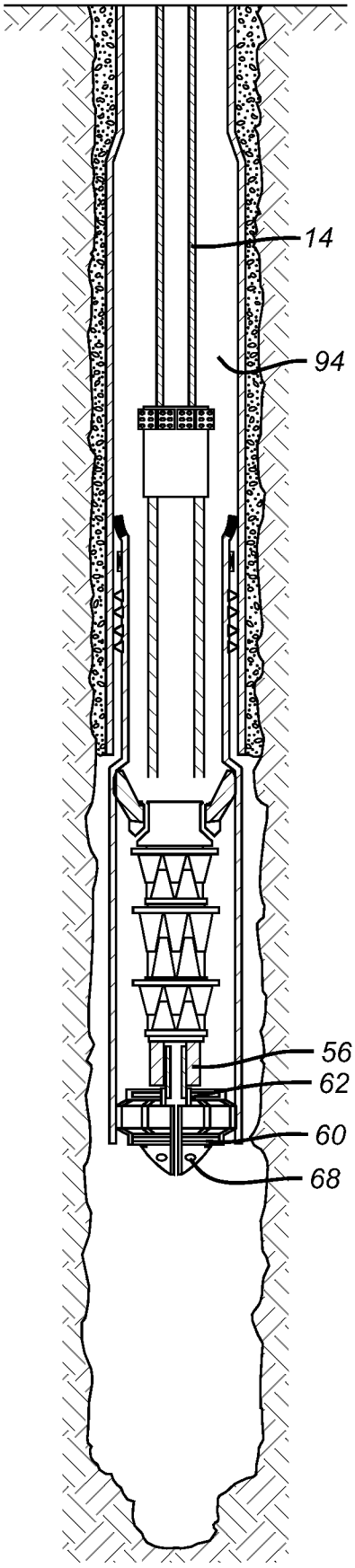

FIG. 20

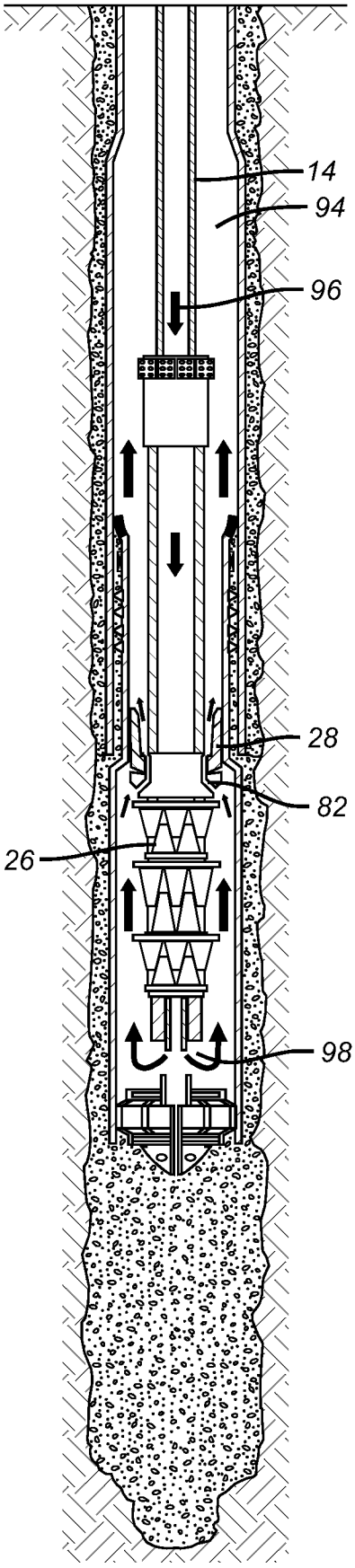

FIG. 21

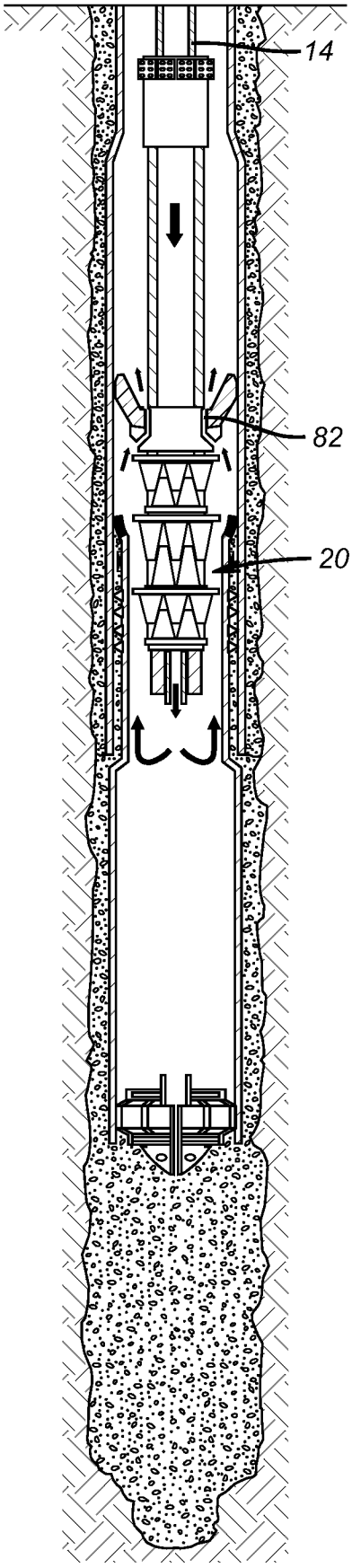

FIG. 22

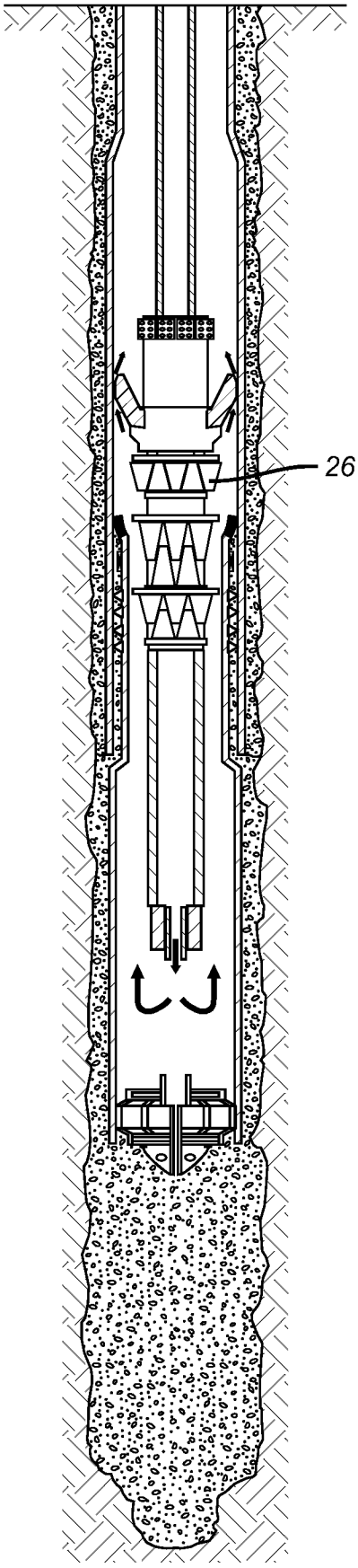

FIG. 23

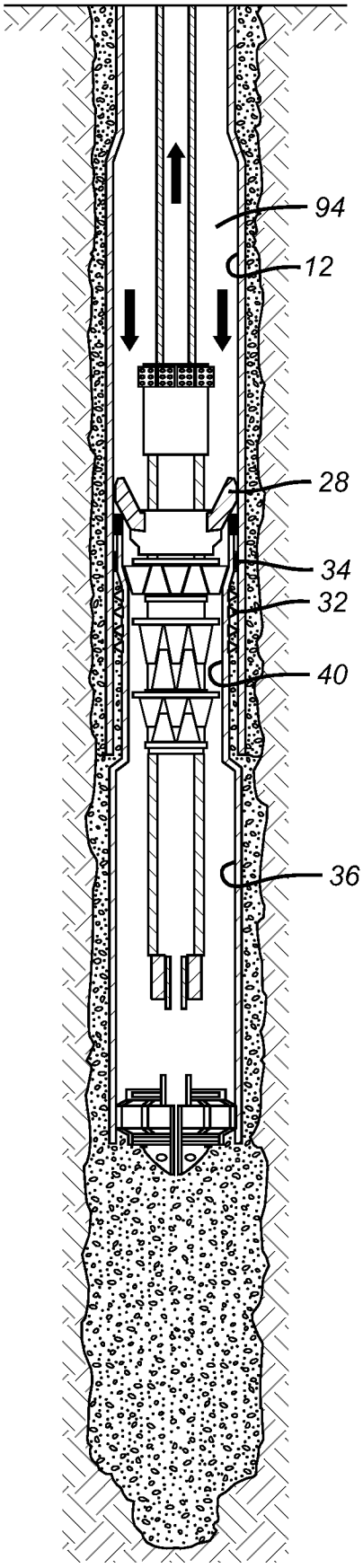

FIG. 24

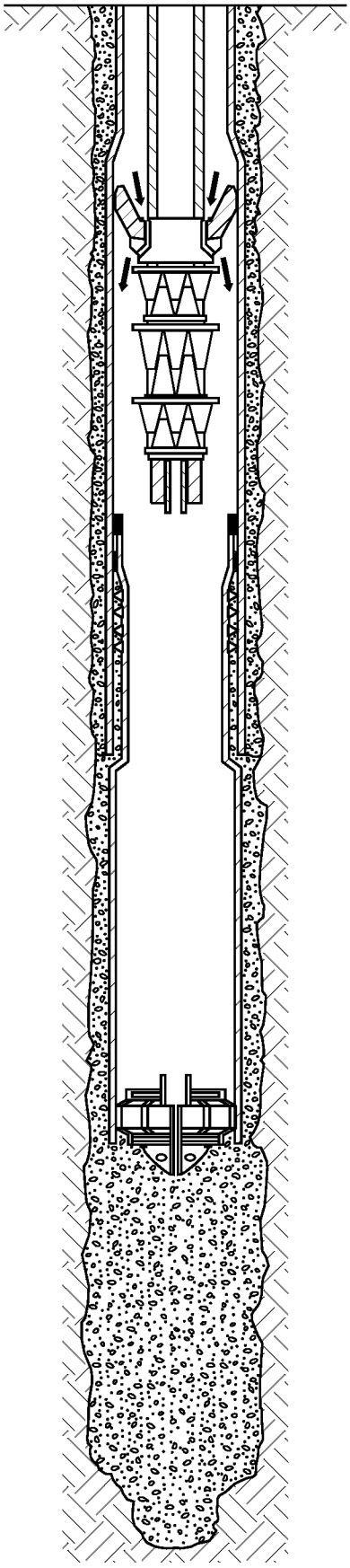

FIG. 25

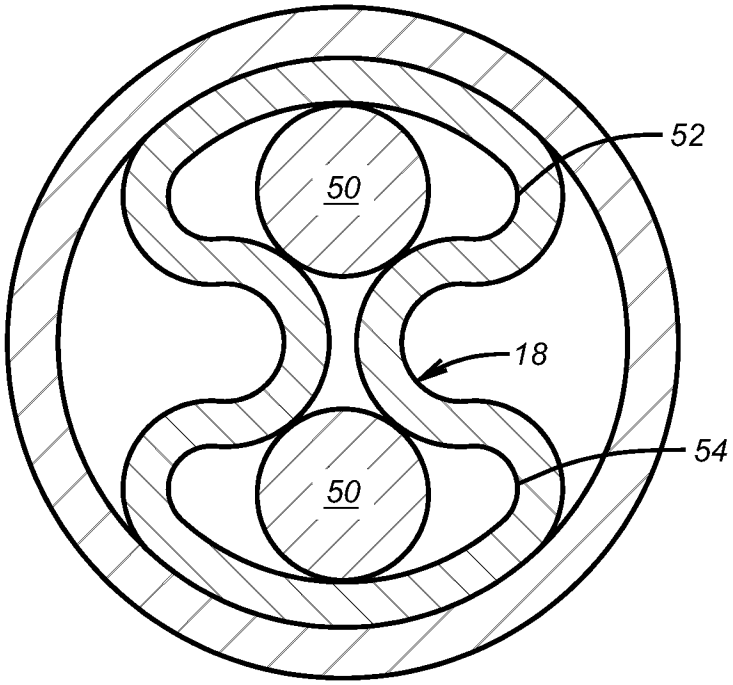

FIG. 26

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/053348

A. CLASSIFICATION OF SUBJECT MATTER

E21B 43/10(2006.01)i, E21B 29/10(2006.01)i, E21B 23/02(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 43/10; E21B 23/02; E21B 2300; E21B 29/00

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: expanding tubular, swage assembly and monobore.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 7370699 B2 (ADAM MARK K. et al.) 13 May 2008 See the abstract, column 5, line 22 - column 6, line 16, figures 7-14 and claims 1-4.	1-3,7,12-13,16,22 4-6,8-11,14-15,17-21,23
A	US 2008-0156499 A1 (GIROUX RICHARD LEE et al.) 03 July 2008 See the abstract, paragraphs [0044]-[0045], figures 4-5 and claim 1, 14.	1-23
A	US 2009-0266560 A1 (RING LEV et al.) 29 October 2009 See the abstract, paragraphs [0022]-[0035], figures 1-7 and claims 1, 7.	1-23
A	US 6843322 B2 (BURTNER JAMES C. et al.) 18 January 2005 See the abstract, column 2, line 9 - column 2, line 55, figures 1-3 and claim 1.	1-23

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

☒ See patent family annex.

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"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

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"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	Date of mailing of the international search report
16 FEBRUARY 2012 (16.02.2012)	**17 FEBRUARY 2012 (17.02.2012)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Kwak Joong Hwan

Telephone No. 82-42-481-8279

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/053348

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