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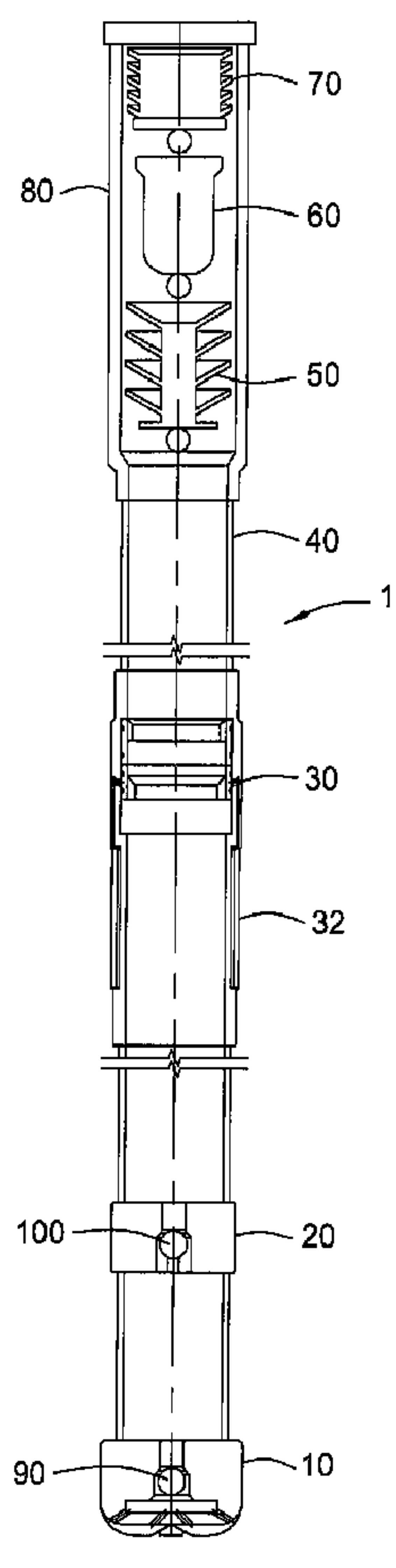

(57) **Abrégé/Abstract**:
Apparatus and methods are provided for a cementing operation for use with a drilling with casing application. In one embodiment, an apparatus (1) is provided for stage cementing using a full opening stage tool (30). In another embodiment, an apparatus is provided for reverse cementing of the casing.

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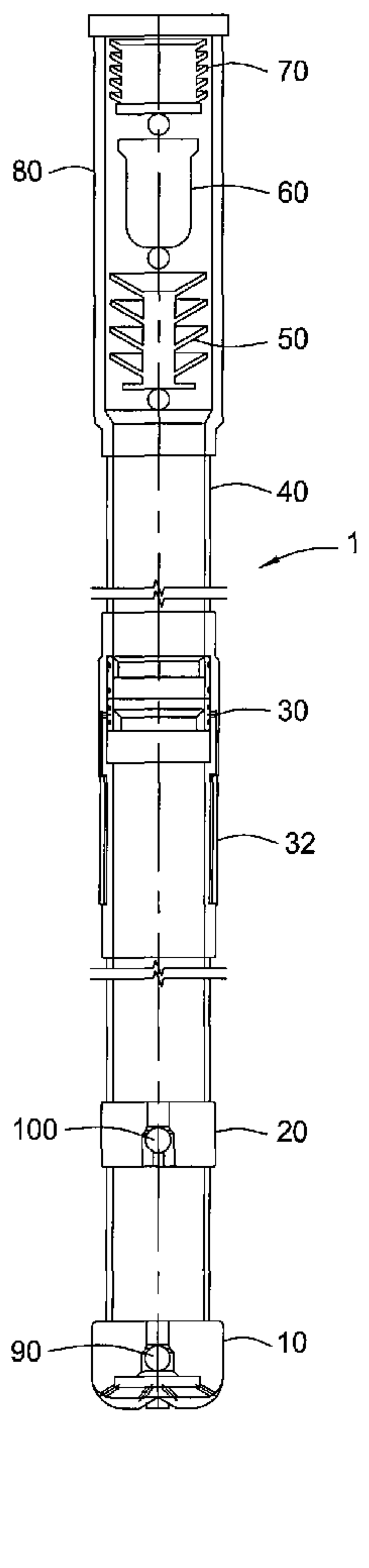
(54) Title: STAGE CEMENTING METHODS USED IN CASING WHILE DRILLING



(57) Abstract: Apparatus and methods are provided for a cementing operation for use with a drilling with casing application. In one embodiment, an apparatus (1) is provided for stage cementing using a full opening stage tool (30). In another embodiment, an apparatus is provided for reverse cementing of the casing.

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STAGE CEMENTING METHODS USED IN CASING WHILE DRILLING

BACKGROUND OF THE INVENTION

Field of the Invention

Embodiments of the present invention relate to apparatus and methods for forming a wellbore, lining a wellbore, and circulating fluids in the wellbore. Particularly, the present invention relates to apparatus and methods for cementing a wellbore formed by drilling with casing. More particularly, embodiments of the present invention also relate to apparatus and methods for stage cementing a wellbore.

Description of the Related Art

In the drilling of oil and gas wells, drilling with casing is a method of forming a borehole with a drill bit attached to the same string of casing that will line the borehole. In other words, rather than run a drill bit on smaller diameter drill string, the bit is run at the end of larger diameter casing that will remain in the wellbore and be cemented therein. Because the same string of casing transports the bit and lines the borehole, no separate trip out of or into the wellbore is necessary between the forming of the borehole and the lining of the borehole. Drilling with casing is especially useful in certain situations where an operator wants to drill and line a borehole as quickly as possible to minimize the time the borehole remains unlined and subject to collapse or the effects of pressure anomalies. For example, when forming a sub-sea borehole, the initial length of borehole extending from the sea floor is much more subject to cave in or collapse than the subsequent sections of borehole. Sections of a borehole that intersect areas of high pressure can lead to damage of the borehole between the time the borehole is formed and when it is lined. An area of exceptionally low pressure will drain expensive drilling fluid from the wellbore between the time it is intersected and when the borehole is lined. In each of these instances, the problems can be eliminated or their effects reduced by drilling with casing.

After drilling to a predetermined depth, a cementing operation is performed. The cementing operation fills the annular space between the outer diameter of a casing and the earth with cement. The cement will set the casing in the wellbore and facilitate the isolation of production zones and fluids at different depths within the wellbore. Currently, cement flows into the annulus from the bottom of the casing (e.g., cementing the long way) or the top of the casing (e.g., reverse cementing). Due to weak earth formations or long strings of casing, cementing from the top or bottom of the casing may be undesirable or ineffective. When circulating cement into the annulus from the bottom of the casing, problems may be encountered as the cement on the outside of the annulus rises. For example, if a weak earth formation exists, it will not support the cement. As a result, the cement will flow into the formation rather than up the casing annulus. When cementing from the top of the casing it is often difficult to ensure the entire annulus is cemented.

There is, therefore, a need for apparatus and methods of cementing the drilling casing of a drilling with casing operation. There is also a need for apparatus and methods of cementing a casing string at intermediate points. A need also exists for cementing a casing string at intermediate points using a full bore stage tool.

SUMMARY OF THE INVENTION

The present invention generally relates to methods and apparatus for cementing a wellbore. In one embodiment, the wellbore is formed by drilling a wellbore with a drilling member coupled to the end of a casing, opening a port in a wall of the casing, and circulating cement through the port.

In one embodiment, a method of cementing a wellbore includes drilling the wellbore using a drilling member coupled to a casing; performing a first cementing operation; opening a stage tool located in the casing string; and performing a second cementing operation through the stage tool. In another embodiment, a plurality of plugs are used to perform the first and second cementing operations. In yet another embodiment, the drilling member is removed prior to performing the first cementing operation. In another embodiment, the stage tool may be a full bore stage tool.

In another embodiment, an apparatus for forming a wellbore includes a casing string having a drilling member disposed at a lower end; a cementing stage tool disposed at an intermediate location on the casing string; a one way valve disposed at a lower portion of the casing string; and an operating tool for controlling the stage tool. In yet another embodiment, the stage tool includes a sliding sleeve for regulating flow through the stage tool. In yet another embodiment, the drilling member is retrievable from the casing string. In yet another embodiment, the drilling member is latched to a profile in the casing string.

In another embodiment, an apparatus for cementing a wellbore includes an outer string and an inner string adapted to engage an interior of the outer string, wherein fluid may be circulated down the inner string, out of a port in the outer string, back into the outer string, and up the inner string. The outer string includes a casing string; an annular packer; a selectively actuatable port for fluid communication with an exterior of the outer string; and a valve disposed at a lower portion of the outer string. The inner string includes a bypass port; a reverse port; and an outer string engagement member.

In another embodiment, a method of cementing a tubular in a wellbore includes providing the tubular with a port collar disposed above a valve; positioning an inner string in the tubular; opening a port in the port collar; opening the valve; circulating cement down the inner string and out of the port to an exterior of the tubular; and circulating cement in the exterior through the valve and up the inner string.

In another embodiment, a method of cementing a wellbore includes drilling the wellbore using a drilling member coupled to a casing; opening a stage tool positioned at an intermediate location in the casing string; and performing a cementing operation through the stage tool. In yet another embodiment, the method may include performing an optional cementation through the lower end of the casing.

In one or more of the embodiments described herein, the provision and inflation of the packer on the stage tool may be optional.

In one or more of the embodiments described herein, the stage tool may be used to cement an intermediation portion of the casing without cementing through a lower portion of the casing. In yet another embodiment, the stage tool cementation may be performed with or without the isolation packer.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Figure 1 is a schematic of a casing string and stage tool according to one embodiment of the present invention.

Figures 2A-2D shows a sequential operation of cementation of the casing string using the stage tool.

Figures 3A-3C is a schematic of an exemplary stage tool according to one embodiment of the present invention.

Figure 4 shows a casing string equipped with a retrievable drilling member.

Figure 5 shows the casing string of Figure 4 after the drilling member has been removed. An embodiment of a cementing assembly has been disposed in the casing string.

Figures 6A-6B shows a sequential operation of cementation of the casing string shown in Figure 5.

Figure 7 shows a casing string after the drilling member has been retrieved. The casing string is equipped with a stage tool. A packer valve is disposed in the casing string.

Figures 8A-8C shows a sequential operation of cementation of the casing string shown in Figure 7. As shown, the stage tool is operated by a tool conveyed on a work string.

Figures 9A-9C shows a sequential operation of cementation of the casing string shown in Figure 7. As shown, the stage tool is operated by a tool conveyed on a wire line.

Figure 10 illustrates an exemplary embodiment of a cementing assembly for a stage cement operation.

Figures 11 A-C show a sequential stage cementing operation using the cementing assembly of Figure 10.

Figures 12A-12F illustrate an embodiment of an apparatus and method for reverse cementing.

Figure 13 is a schematic of plugs used in cementing operations.

DETAILED DESCRIPTION

Embodiments of the present invention relates to cementing methods, techniques, and equipment that may be used with drilling with casing systems including multiple stage cementing. In one embodiment, a casing string is coupled to a drilling member at the lower end, and one or more stage cementing tools are positioned at predetermined locations in the casing string for cementing at intermediate locations of the casing. In operation, the drilling member drills a wellbore while attached to the casing either by rotating the casing or using a mud motor coupled to the drilling member or a combination of both. The casing can be rotated by any means known in the art, for example a top drive, a power tong or a rotary table. Once the casing is at a desired depth, a first cementing operation is performed through the lower end of the casing.

After the first cementing operation is completed, a second cementing operation is performed using the stage tool at a predetermined location above the bottom of the casing. The second cementing operation is performed by opening a port in the stage tool and circulating cement through the port. The port is closed after cementing has been completed. Any number of additional cementing operations may be performed at desired locations on the drill string.

Figure 1 shows a schematic drawing of an embodiment of the present invention. An assembly 1 is shown which includes a drilling member 10, a collar 20, a stage tool 30, all coupled to a casing string 40. The drilling member 10, the collar 20, and the stage tool 30 can be coupled to the casing at the wellbore or prior to being transported to the wellbore. Also shown in figure 1 is a first stage plug 50, an opening plug 60, and a closing plug 70. As shown, the plugs are positioned within a plug container 80 which is coupled to the casing 40, however, it should be appreciated that any method of delivering the plugs to the casing 40 may be used.

The drilling member 10, shown in Figure 1, is a drill shoe that does not have to be retrieved from the bottom of the casing prior to cementing. The drilling member 10 will typically include one or more valves 90. Further, the collar 20 will optionally include one or more valves 100. The valves 90 and 100 are typically one way valves.

The stage tool 30 may be a plug operated stage tool such as hydraulically opened stage tools. The stage tool may also include an optional packer 32, as shown in Figures 2A-D. In one embodiment, the stage tool may be a full bore (also referred to as "full opening") stage tool. Figure 3A shows an exemplary stage tool suitable for use with embodiments of the present invention. In operation, an opening plug 60 is launched into the inner diameter of the casing and lands in a seat 34 of the opening sleeve 33 in the stage tool 30, as shown in Figure 3B. Then, pressure is applied to the inner diameter of the casing to shear the shear screws 35 holding the opening sleeve 33 in place. In one embodiment, the shear screws 35 are double shear, e.g., they shear once to open and again to close. The sleeve 33 then shifts down, thereby aligning ports 36, 37 to open the stage tool 30 to allow fluid flow between the casing inner diameter and the annulus between the stage tool and the drilled hole or a previously run casing. Rotational alignment of the ports 36,37 is maintained by anti-rotation pin 38p and anti-rotation slot 38s. The sleeve 33 is stopped when the locking lug 39 reaches its lower limit of travel. An optional external packer 32 may be used on the outer diameter of the stage tool 30. The packer 32 may be mechanical compression set or inflatable. The packer 32 will set to isolate the lower annulus from the upper annulus. A secondary opening mechanism (not shown) such as a sleeve or a rupture disk will then open, thereby allowing fluid to flow into the annulus above the pack-off packer. Referring to Figure 3B, after opening the ports 36, 37, cement is supplied and the closing plug 70 is pumped behind the cement. The closing plug 70 lands in and sealingly engages the closing seat 42. Fluid pressure is supplied to shear the shear screws 35 for a second time and shift the locking lug 39, thereby allowing the closing plug 70 to shift the sleeve 33 downward to close the port 36, as shown in Figure 3C.

Figures 2A-2D show a schematic of a two stage drilling operation according to one embodiment of the present invention. Figure 2A shows the first stage of the cementing operation almost complete. The drilling member 10 has been drilled to the desired depth. The first stage plug 50 has been dropped. The first stage plug 50 is pushed down the casing using fluid pressure. The first stage plug 50 follows the cement supplied during the first stage until the plug 50 lands the collar 20 (or optionally, the drilling member 10). In another embodiment, a plug with a by-pass feature may precede the first stage plug 50. Once the first stage plug 50 reaches its end point, the cementing of the lower end (i.e., first stage) of the casing is complete, as shown in Figure 2B.

With the first stage cementing operation complete, the opening plug 60 is dropped, as shown in Figure 2B. The opening plug 60 land in and sealingly engage the seat 200 of the stage tool 30. A port 37 in the stage tool 30 is then opened using fluid pressure above the opening plug 60, as described above. Although the stage tool 30 is shown operating with fluid pressure, it should be appreciated that any method of opening the stage tool may be used, as will be described in more detail below.

With the stage tool 30 open and the opening plug 60 sealing the casing below the stage tool 30, the second stage of cementing begins. Cement is pushed down the interior of the casing 40 and out the stage tool 30 ports 36, 37. The cement is followed by the closing plug 70, as shown in Figure 2C. When the closing plug 70 reaches the stage tool 30, fluid pressure is supplied behind the plug 70 to close the port 36 in the stage tool 30. At this time the second stage of cementing is complete, as shown in Figure 2D. If necessary, additional stage cementing operations may be performed above the second stage cementing operation. The plugs 50, 60, and 70 along with the drilling member 10 and the collar 20 may then be drilled out by the following drill string. The drill out diameter 39 is illustrated in Figure 3A.

Once the stage tool is opened, circulation is established between the casing inner diameter and the annulus between the outer diameter of the stage tool and drill casing outer diameter and the inner diameter of the drilled hole or the previously run casing inner diameter. Cement is then pumped down the casing inner diameter up the annulus. The cement is followed by the top closing plug. The plug is landed on the stage tool and closes it. The closing plug, the drillable portion of the closing and opening seats and the free fall opening plug along with the first stage top plug, float collar, and drill shoe are drilled out by the following drill string. (It should be noted that a third stage, two separate stage tools, may be run in this application if the operator deems it necessary.)

In another embodiment, prior to cementing, a ball may be released into the casing to operate a tool disposed below the stage tool. For example, a ball may be dropped to convert a drill shoe. After the ball lands in the drill shoe, pressure may be applied to displace the blades toward the annular area. In this respect, the next drill string may pass through the casing without drilling through the blades of the drill shoe. An exemplary convertible drill shoe is manufactured by Weatherford International. A suitable convertible drill shoe is disclosed in U.S. Patent No. 6,443,247.

Figure 4 shows another embodiment of a drilling with casing assembly. The assembly includes a retrievable drilling assembly 400 coupled to the casing 640. The retrievable drilling assembly includes a latch 410 adapted to couple to profile 415 in the casing 640. The drilling with casing assembly is shown supported by a spear 420. A mud saver valve 425 is connected to a lower portion of the spear. The latch 410 allows the drilling assembly 400 to be removed from the casing 640 and pulled out of the well prior to cementation. Examples of retrievable bottom hole drilling assembly are disclosed in Patent Application numbers: 2005/0000691, 2004/0245020, 2004/0221997, 2004/0216892.

Figure 5 shows an apparatus for cementing the casing 640 after the drilling assembly 400 is retrieved. A one way top plug 600 is suspended below the surface torque apparatus such as a drilling spear 420 or torque head, as shown in Figure 5. The mud saver valve 425 has been removed from the spear 420, as compared to Figure 4. The top plug 600 includes gripping members such as slips 650 that allow the top plug 600 to move in one direction, but are activated to prevent movement in the other direction. An exemplary one way top plug is described in U.S. Patent Application No. 2004/0251025. Disposed below the top plug 600 is an optional, releasable bottom plug 610. A cementing head 605 is connected above the spear 420 in order to drop a ball or dart into the casing 640.

Figures 6A and 6B show a schematic of a cementing operation according to an embodiment of the present invention. The bottom plug 610 is launched ahead of the cement followed by the one way top plug 600 behind the cement. The bottom plug 610 may be launched by dropping a first ball into the plug 610. The bottom plug 610 acts to separate the cement from a fluid ahead of the cement. When the bottom plug 610 reaches the casing shoe 620, it exits the casing 640 and falls to the bottom of the hole. The one way top plug 600 is launched by dropping a second ball into the plug 600. The top plug 600 is stopped after a specified amount of fluid has been displaced behind the one way top plug 600, as shown in Figure 6B. When the cement tries to U-tube, the slips 650 on the one way top plug 600 activate and keep the top plug 600 and the cement from moving back up the inner diameter of the casing 640. The top plug 600 remains in place while the cement cures. During the cementation, the spear 420 may remain attached to the casing 640 to support the casing 640 in the wellbore.

According to another embodiment, a stage cementing tool may be provided on the drilling casing to allow for stage cementing operations. Figure 7 shows a drilling casing after the drilling assembly has been retrieved. The drilling casing is equipped with a stage tool 500. The stage tool may be of a "full opening" type. Examples of stage tools are described in US patents numbers 3,768,572, 5,137,087, and 5,299,640. The stage tool 500 does not restrict the inner diameter of the casing and allows the drilling assembly 400 to be retrieved through the inner diameter of the stage tool. Therefore, an operator may set and retrieve the casing latch and the retrievable drilling assembly 400 through the stage tool 500. A restricted inner diameter such as with some stage tools may limit the choices of latch and drilling assemblies that could be used at the bottom of the casing. In Figure 7, drillable packer 510 is positioned in the casing 640 and a top and bottom plug system is positioned above the casing 640. A cementing operation may be performed by initially releasing the bottom plug 501 and supplying cement behind the bottom plug 501. After a predetermined amount of cement has been pumped, the top plug 502 is released to force the cement out through the bottom plug 501 and the packer 510 to fill the annulus. The top plug 502 continues to move down until it lands on the bottom plug 501 to complete the cementation. The cement is prevented from returning into the casing by the one way valve of the packer 510.

Figure 8A-8C shows a schematic of a work string cementing system for cementing a drilling casing. As shown, the casing latch and retrievable drilling assembly has already been removed. The cementing system includes a work string 800, an operating tool 810 for the stage tool 500 connected to the work string 800, and a drillable packer 510 actuatable by the work string 800. The operating tool 810 may include locking members such as dogs or keys for engaging the sliding sleeve of the stage tool 500. The cementing procedure begins with lowering the packer 510 on the work string 800 to the predetermined location in the casing 640. The packer 510 is then set in place by the work string, for example, by supplying pressure to activate the slips on the packer 510. Cement is pumped from the surface through the work string 800, through the packer 510, and into the annulus 840, as shown in Figure 8A. After a predetermined amount of cement has been pumped, the work sting 800 is disengaged from the packer 510, and a check valve within the packer 510 is closed, as shown in Figure 8B. Circulation through the work string 800 may then optionally be in the standard or reverse direction in order to remove any residual cement from the inner diameter of the work string 800. The operating tool 810 is then moved by work string 800 into position to engage the stage tool 500. The stage tool 500 may be a sliding sleeve, a rotational open-close sleeve, and/or an electronic, mechanical or hydraulic tool. After the locking members of the operating tool engage the stage tool 500, the sliding sleeve is moved to the open position. In situations where the stage tool 500 has an optional annular packer 815, it is typically set after the stage tool 500 is open, but before communication is established between the work sting and the annulus between the casing and the drilled hole or a previously run casing. After the packer 510 set, a secondary opening system, such as a sliding sleeve or a rupture disk (not shown), is opened to establish circulation between the work string and the annulus. Thereafter, the second stage of cement is pumped down the work string 800, through the stage tool 500, into the annulus 840, and circulated toward the top of the hole. When sufficient cement has been pumped, the operating tool 810 is manipulated to move the sleeve of stage tool 500 to the closed position. Then, the operating tool 810 is released from the sleeve. Circulation in the work string 800 may then optionally be in the standard or reverse direction in order to remove any residual cement from the inner diameter of the work string 800, as shown in Figure 8C. The work string 800 may then be moved to the next stage tool, if needed, for another stage or retrieved from the hole if the cementing has been completed.

In an alternative embodiment, stage cementing of the casing 640 using the stage tool 900 may be performed using an electric line, wire line, cable, coiled tubing, corod, or slick line run cementing system. Figures 9A, 9B, and 9C show a schematic of a wire line stage cementing operation using the stage tool 900. In one embodiment, the stage tool may be of the full opening type. In Figure 9A, the drillable packer 910 has already been set using a line 920 and/or plugs. A conventional plug container 930 with a top and bottom plug is shown on top of the casing 940. The top and bottom plugs may be used in conjunction with the packer 910 to complete the first stage of cementing. As shown, the bottom plug 931 has landed on the packer 910 and the top plug 932 is being pumped down to force the cement into the annulus 935. After the top plug lands on the bottom plug, the second stage cement begins by lowering an operating tool 950 for the stage tool 900 on a conveying member such as a wire line 920. Figure 9B shows the conveying member 920 with an operating tool 950 for opening and closing the stage tool 900 for the second and possible other stages of cementing. The operating tool 950 may include a locking member for engaging the sleeve of the stage tool 900. The operating tool 950 may also have sufficient weight so that it will drop to the bottom unless it is supported by the wire line 920 or other conveying member. To open the stage tool 900, the operating tool 950 is lowered so that the locking members engage the sleeve. The operating tool 950 is pulled up to move the sleeve to the open position. Then, the packer, if present, on the stage tool 900 is set and communication with the annulus is established. Cement is pumped down the casing 940 and exits through the stage tool 900 to fill the annulus above the packer 915. After the cement is supplied, the tension on the wire line 920 is relieved to allow the operating tool 920 to move downward. The motion moves the sleeve back to the closed position. Continued downward movement of the operating tool 950 causes the operating tool 950 to disengage from the stage tool 900. Thereafter, the operating tool 950 may be retrieved by the wire line 920. Figure 9C shows the cemented casing after the operating tool 950 has been retrieved. It must be noted that during the pumping of the cement, the operating tool 950 may remain in the casing 940 or be retrieved. If the wire line operating tool 950 is retrieved out of the casing during cementing operations, then pressure will be held on the casing inner diameter after the cement has been placed to allow the wire line tool to go back in the hole and close the stage tool 900.

A key system may be used to operate the stage tool in another embodiment of the present invention, as shown in Figure 10. Figure 10 shows a stage tool 1120 that may be opened and closed by pump down opening and closing plugs 1100 and 1110. In one embodiment, the stage tool 1120 may be of a full opening type. Each plug 1100, 1110 includes a key portion 1101, 1102 that will match a corresponding profile 1121, 1122 machined into the open and closing seats of the stage tool 1120. In one embodiment, the keys 1101, 1102 on the plugs 1100, 1110 may be different such that they have different matching profiles 1121, 1122 in the stage tool 1120. In another embodiment, the plugs 1100, 1110 may have the same key portion, which may suitable for sequential operations. The plugs 1100, 1110 are disposed below the spear 1115, which is used to support the casing 1140. A one way top plug 1130 equipped with a one way valve may be connected below the plugs 1100, 1110 for use in the first stage cementing.

Referring to Figure 11A, the first stage of cement is pumped followed by the one way top plug 1130. The one way top plug 1130 may be released by dropping a ball or dart from the cementing head 1145. Slips on the top plug 1130 prevent the top plug 1130 from moving back up the casing 1140, and the one way valve in the top plug 1130 prevents the cement from U-tubing. In another embodiment, the one way top plug 1130 may latch into a profile in the casing. Referring to Figure 11 B, after a specific amount of fluid has been pumped behind the top plug 1130, the opening plug 1100 is released and pumped toward the stage tool 1120. The volume of fluid pumped behind the one way top plug 1130 and in front of the second stage opening plug 1110, and/or the timing of release of the plugs, may be designed not to pump the one way top plug 1130 out of the casing 1140 before the second stage opening plug 1110 reaches the stage tool 1120 and opens it. The key portion 1101 of the opening plug 1100 engages the matching profiles 1121 on the opening sliding sleeve 1131 of the stage tool 1120. Pressure behind the opening plug 1100 causes the opening sleeve 1131 to shift down, thereby opening the port 1125 in the stage tool 1120. After the stage tool 1120 is opened, the optional annular pack-off element 1150 is set. A secondary opening system (not shown) is then opened to allow communication between the casing 1140 inner diameter and the annulus between the casing outer diameter and the drill hole inner diameter or the inner diameter of the previously run casing above the optional pack-off element 1150.

The second stage of cement is then pumped down the casing 1140 inner diameter, through the stage tool 1120, and into the annulus. The cement is followed by the keyed closing plug 1110 that will engage the matching profiles 1122 on the closing sleeve 1132 of the stage tool 1120. Figure 11C shows the casing after second stage cementing process has completed. The plugs 1100, 1110, 1130 and excess cement left in the inner diameter of the casing 1140 may be drilled out by the following drill string, not shown.

It should be noted that a free fall opening plug may also be used with the embodiment herein if desired.

Embodiments of the present invention provide apparatus and methods for a cementing application using a stage tool. It should be noted that any combination of the above methods may be used for multiple stage cement with or without a latch.

When the stage cementer is used in reverse cementing, it is typically used, but not limited to, near the bottom of the hole and requires a external pack-off to keep the cement from going up toward the surface of the wellbore instead of down to cover the annulus between the outer diameter of the casing and the inner diameter of the bore toward the bottom of the casing. This technique requires the use of an inner string 1200 to pump the cement down and to allow returns back through the inner diameter of the casing. (See Figures 12A-12F).

Figures 12A-B show an embodiment of a cementing apparatus for a reversing cementing operation. Figure 12A shows a casing assembly 1210 having a packer 1220, a port collar 1215, and a cement valve 1250. Figure 12B shows an inner string 1200 adapted to be inserted into the casing assembly 1210 to regulate fluid flow. The inner string 1200 includes a fluid crossover tool 1205, a port collar operating tool 1270, and a stinger 1275. The fluid crossover tool 1205 includes one or more bypass ports 1230 and a reverse flow port 1260. Figure 12C shows the inner string 1200 inserted into the casing assembly 1210. As shown, the port collar operating tool 1270 has engaged the sliding sleeve 1216 in the port collar 1215. In Figure 12D, the inner string 1200 has moved axially to shift the sliding sleeve 1216 down to open the port 1235 in the port collar 1215. The downward shift also causes the stinger 1275 to open the cement valve 1250. Initially, the fluid such as cement is pumped down to inflate the packer 1220. After inflation, a second opening sleeve shifts up to open a port to the annulus between the casing 1240 and the wellbore. Then, cement flows down the interior of the inner string 1200 and into the bypass port(s) 1230 and exits to the interior of the casing 1240 adjacent the port 1235 of the port collar 1215. Figure 12E shows the flow route of the cement. The cement then flows through the port 1235 and down the annulus between the casing and the wellbore until it reaches the lower end of the casing 1240. The fluid that was behind the casing in front of the cement then flows into the stinger 1275 and the cement valve 1250, up the reverse flow port 1260, and up the annular area between the inner string 1200 and the casing 1240. Once a pre-determined amount of cement has been pumped, the cementing operation is complete. The inner string 1200 is removed from the casing 1240 and the cement valve 1250 is closed. As the inner string 1200 is pulled, it also pulls the sleeve 1216 to close the port 1235. In another embodiment, the cement valve 1250 may be opened by any suitable method known in the art. In yet another embodiment, the cement may flow into the casing through an opening in the casing other than the cement valve 1250.

In another embodiment, a method of cementing a wellbore includes drilling the wellbore using a drilling member coupled to a casing; opening a stage tool positioned at an intermediate location in the casing string; and performing a cementing operation through the stage tool. In yet another embodiment, the method may include performing an optional cementation through the lower end of the casing.

In one or more of the embodiments described herein, the provision and inflation of the packer on the stage tool may be optional.

In one or more of the embodiments described herein, the stage tool may be used to cement an intermediation portion of the casing and first stage cementing through the lower portion of the casing may be omitted. In yet another embodiment, the stage tool cementation may be performed with or without the isolation packer.

Exemplary plugs used for the multiple stage cementing operations include but are not limited to the plugs shown in Figure 13.

While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

Allowed Claims:

1. A method of cementing a wellbore, comprising:

drilling the wellbore using an assembly comprising: a casing, a drilling member coupled to the casing, a float collar coupled to the casing, and a stage tool coupled to the casing;

opening ports in the drilling member;

performing a first cementing operation using the float collar and the open ports, wherein the float collar comprises a one way valve allowing flow of cement through the casing and into an annulus formed between the casing and the wellbore and preventing backflow of the cement into the casing;

opening the stage tool located in the casing string;

performing a second cementing operation through the open stage tool; and

drilling out the drilling member and the float collar.

2. The method of claim 1, wherein the stage tool is opened using a plug.

3. The method of claim 1, further comprising closing the stage tool.

4. The method of claim 3, wherein the stage tool is closed using a plug.

5. The method of claim 1, further comprising setting a packer prior to the second cementing operation.

6. The method of claim 1, wherein the ports in the drilling member are opened by releasing a ball into the casing, landing the ball in the drilling member, and applying pressure to the drilling member.

7. The method of claim 6, wherein landing the ball in the drilling member and applying pressure to the drilling member also displaces blades of the drilling member.

8. A method of cementing a wellbore, comprising:

drilling the wellbore using a drilling member coupled to a casing;

retrieving the drilling member from the casing;

pumping cement into the casing and through a one way plug;

launching the one way plug behind the cement;

pumping fluid behind the plug, thereby propelling the cement through the casing and into an annulus formed between the casing and the wellbore, wherein:

pumping is stopped to retain the plug within the casing, and

the plug anchors to the casing in response to the pumping stoppage, thereby retaining the cement in the annulus and preventing backflow of the cement into the casing.

9. The method of claim 8, further comprising launching a bottom plug into the casing ahead of the cement, wherein the bottom plug is pumped through the casing and into the wellbore.

10. The method of claim 8, wherein:

a stage tool is located in the casing,

the method further comprises launching an opening plug into the casing, and

the opening plug lands in the stage tool and opens the stage tool.

11. The method of claim 10, wherein the opening plug is launched after pumping a predetermined volume of fluid so that the opening plug lands in and opens the stage tool while the top plug is still in the casing.

12. The method of claim 10, wherein the opening plug free-falls to the stage tool.

13. The method of claim 10, further comprising pumping cement through the open stage tool and into the annulus, wherein a closing plug is pumped behind the cement, lands in the stage tool, and closes the stage tool.

14. The method of claim 10, wherein the opening and closing plugs are keyed to match respective profiles in the stage tool.

15. A method of cementing a wellbore, comprising:

drilling the wellbore using a drilling member coupled to a casing;

retrieving the drilling member from the casing;

deploying an electric, wire or slick line into the casing;

setting a packer in the casing using the line, wherein the packer has a one-way valve;

pumping cement through the casing and one-way valve and into an annulus formed between the casing and the wellbore, wherein the one-way valve retains the cement in the annulus and prevents backflow of the cement into the casing;

opening a stage tool located in the casing string using the line;

pumping cement through the casing and open stage tool and into the annulus; and

closing the stage tool using the line.

16. The method of claim 15, further comprising drilling out the packer.

17. A method of cementing a wellbore, comprising:

drilling the wellbore using a drilling member coupled to a casing;

performing a first cementing operation;

opening a stage tool located in the casing, wherein:

the stage tool comprises a housing, a sleeve, an opening seat, and a closing seat,

a housing port is aligned with a sleeve port in the open position, and

a wall of the sleeve covers the housing port in a closed position;

performing a second cementing operation through the open stage tool; and

drilling out the seats, wherein the sleeve remains after drill out.

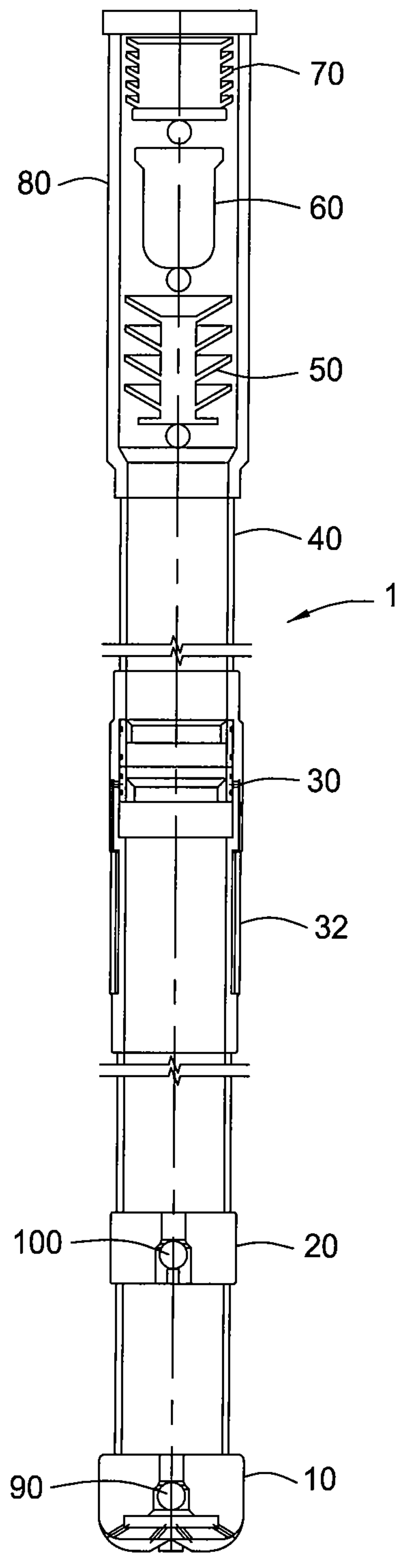


FIG. 1

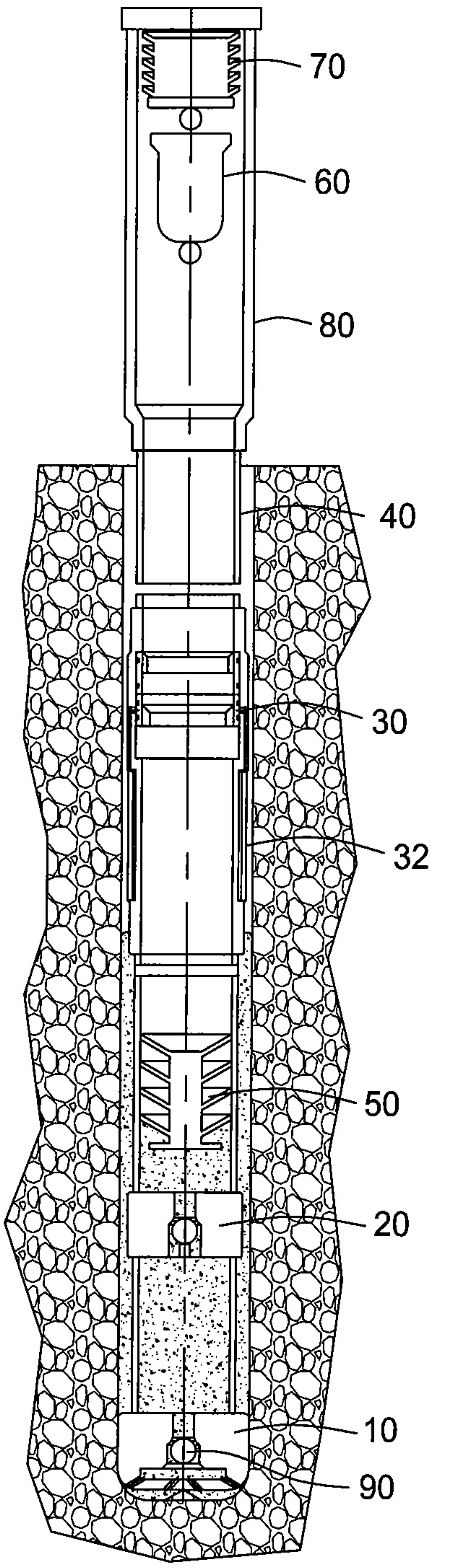


FIG. 2A

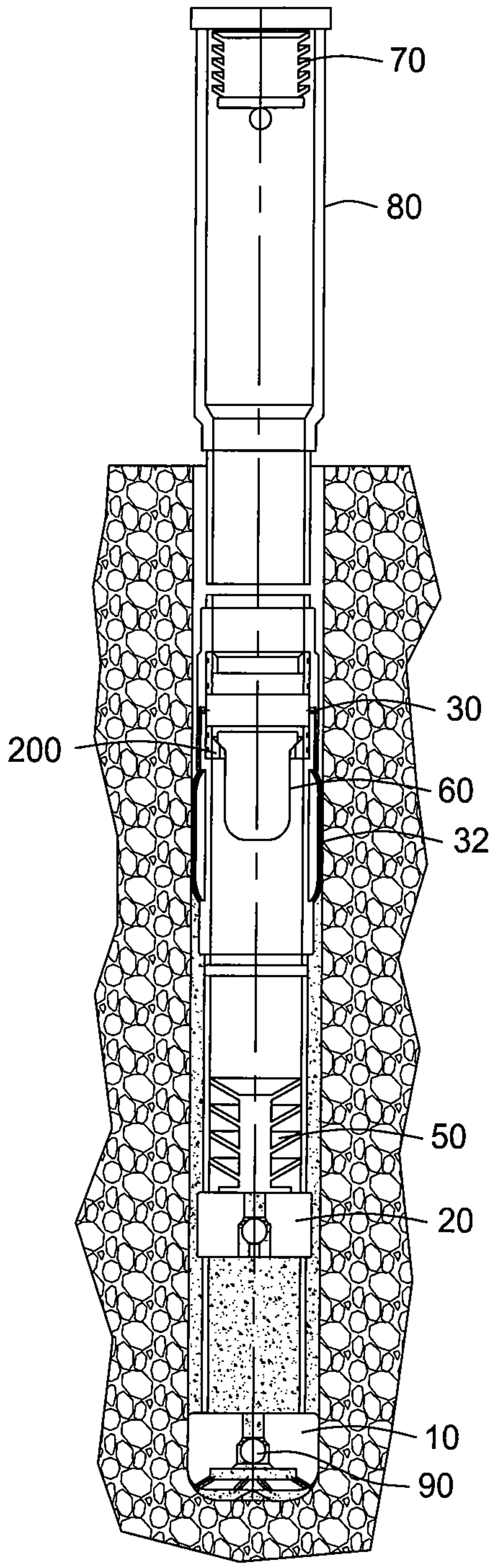


FIG. 2B

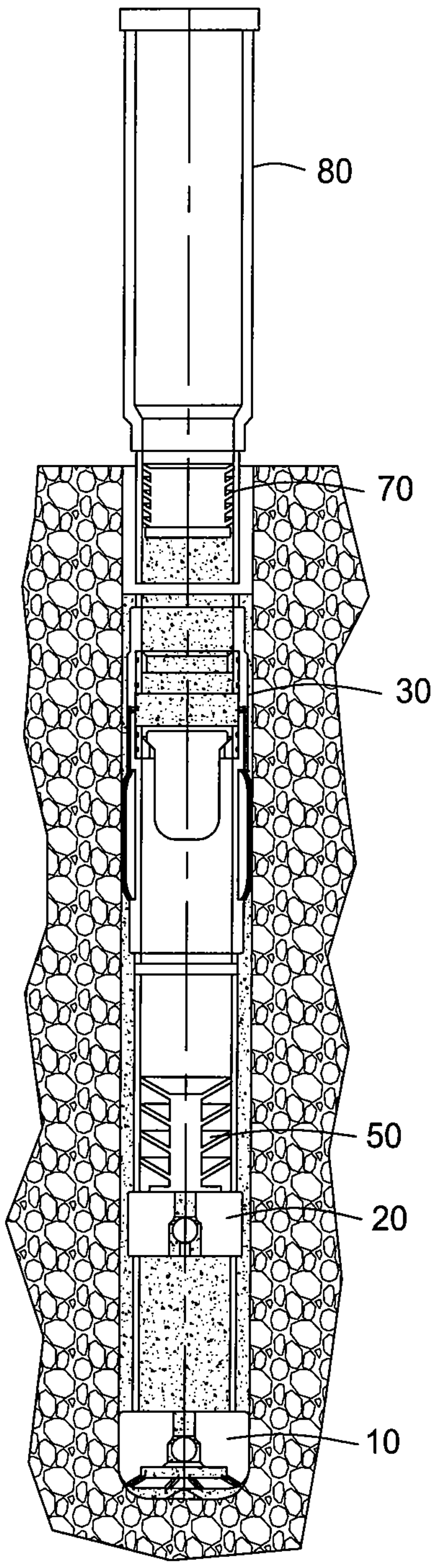


FIG. 2C

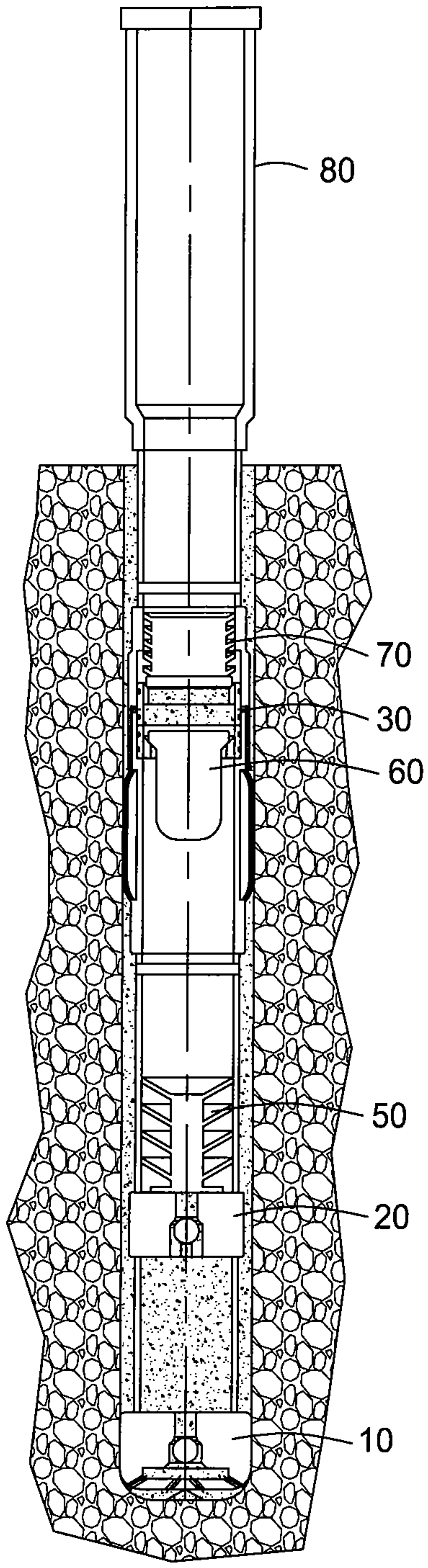


FIG. 2D

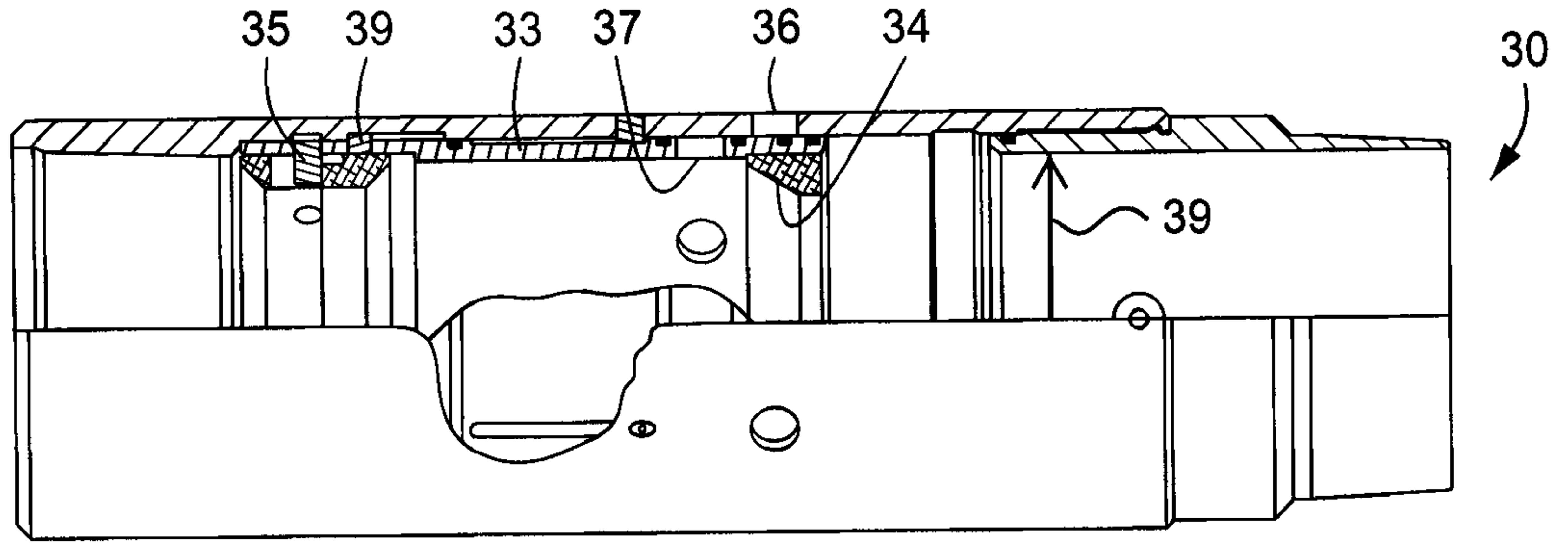


FIG. 3A

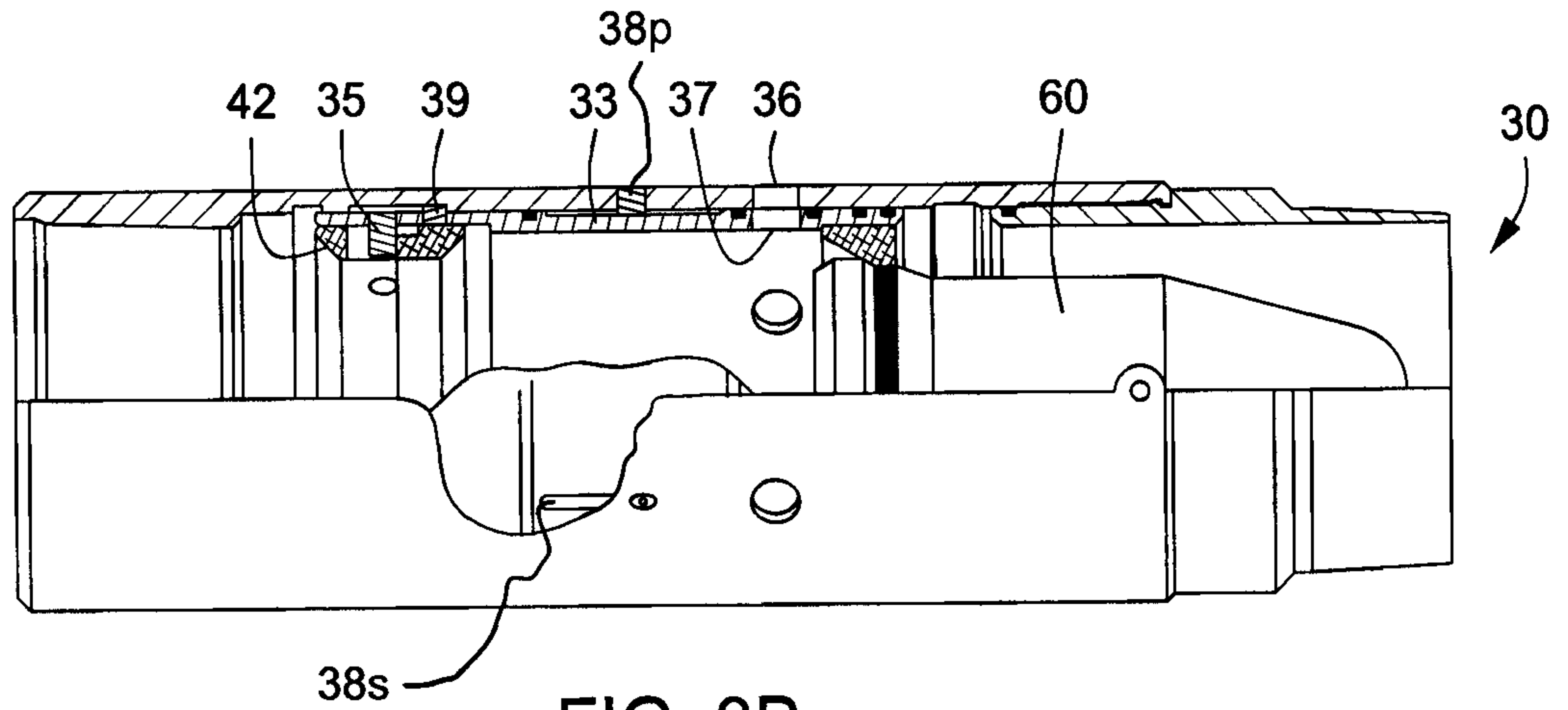


FIG. 3B

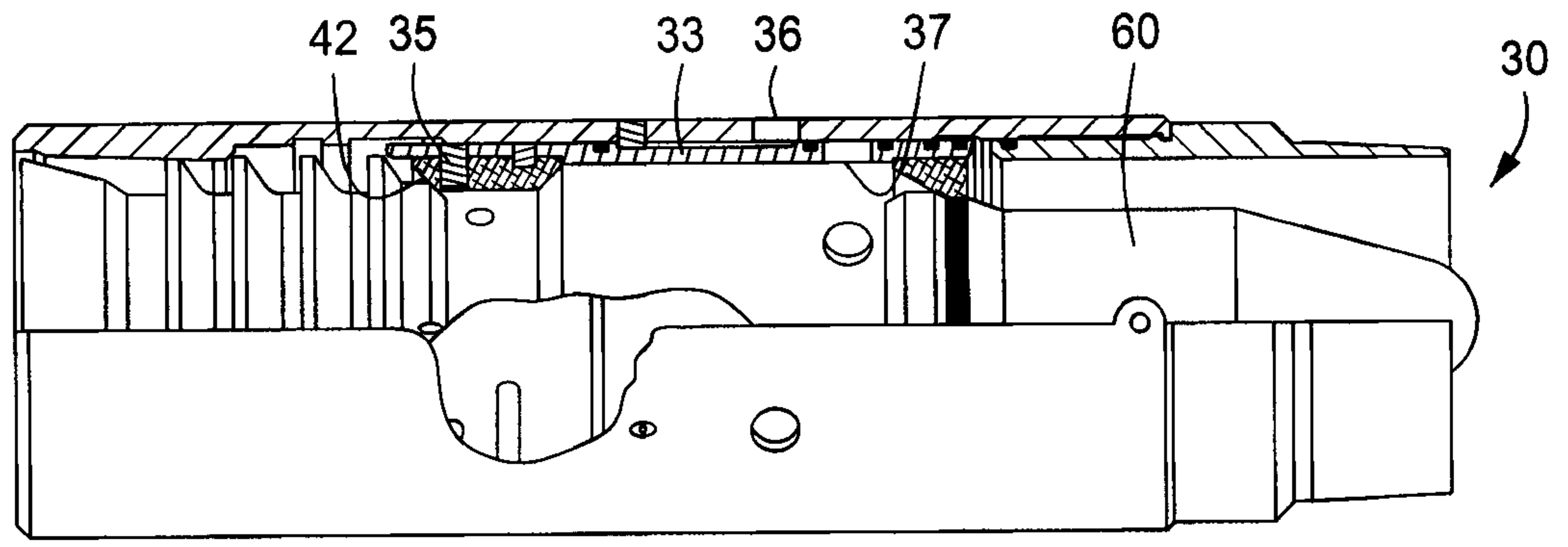


FIG. 3C

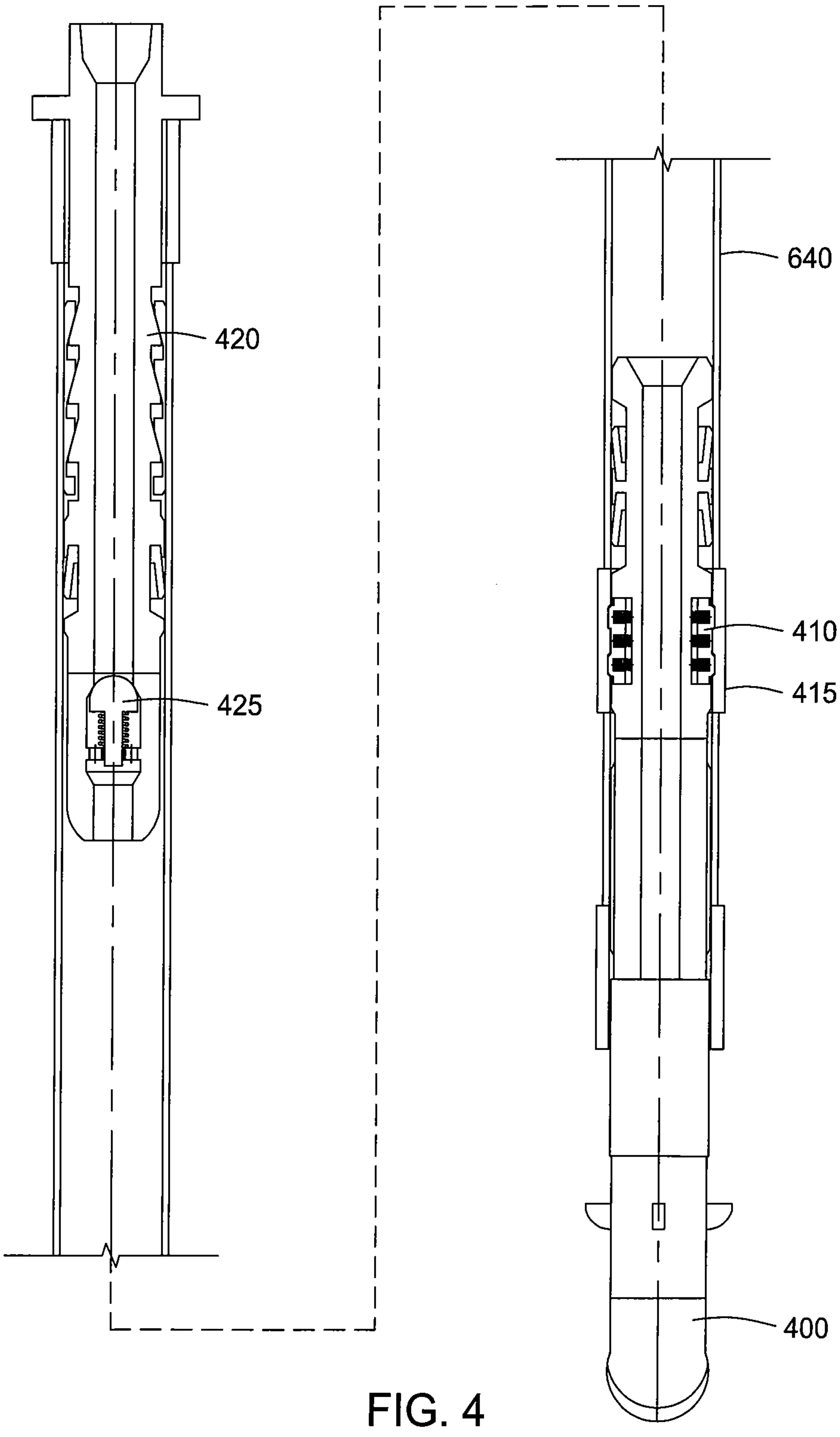


FIG. 4

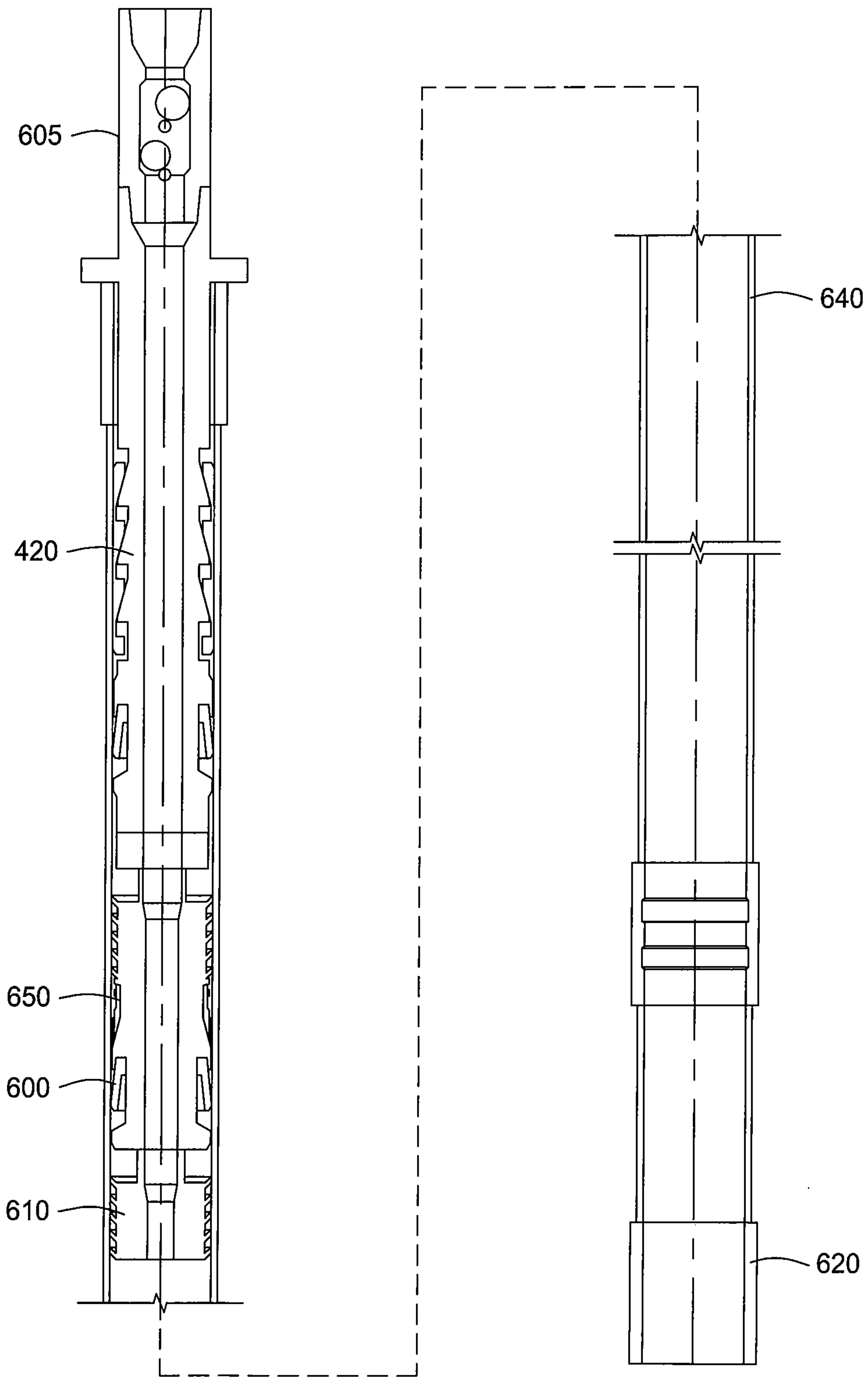


FIG. 5

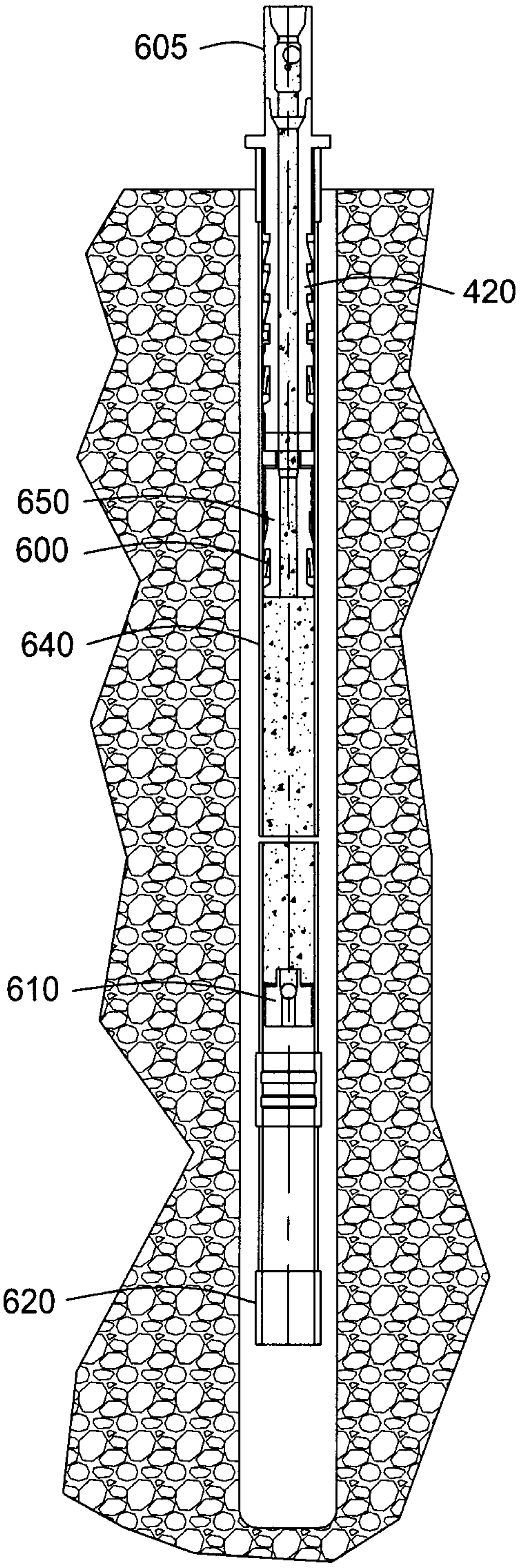


FIG. 6A

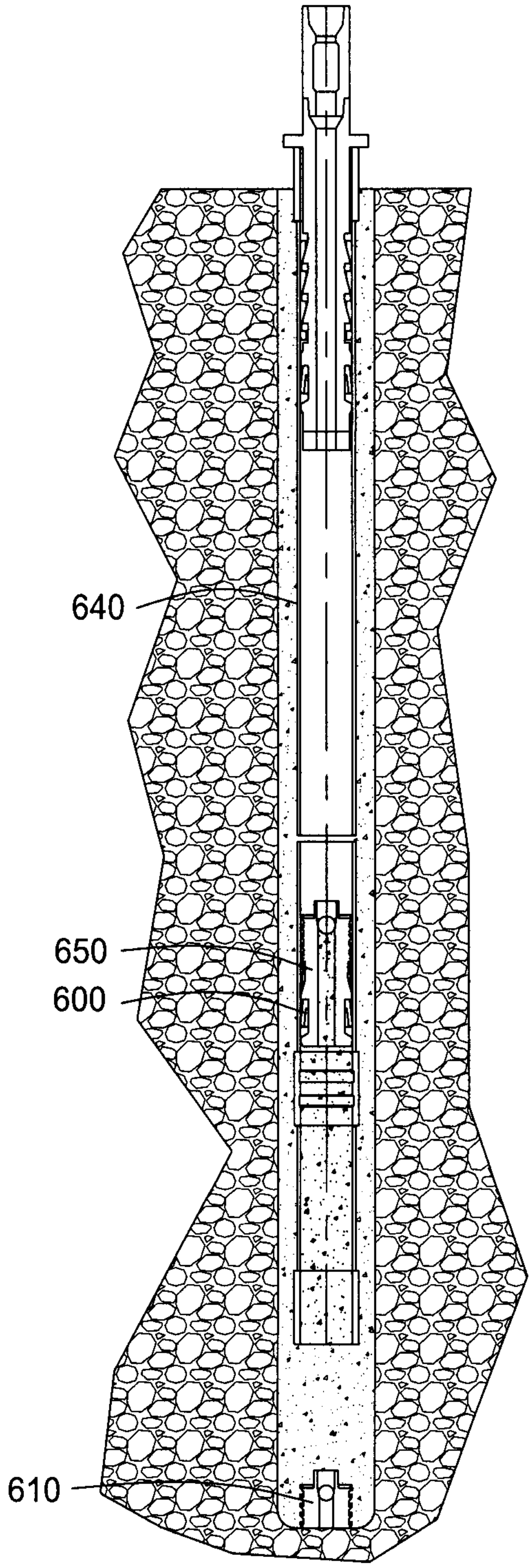


FIG. 6B

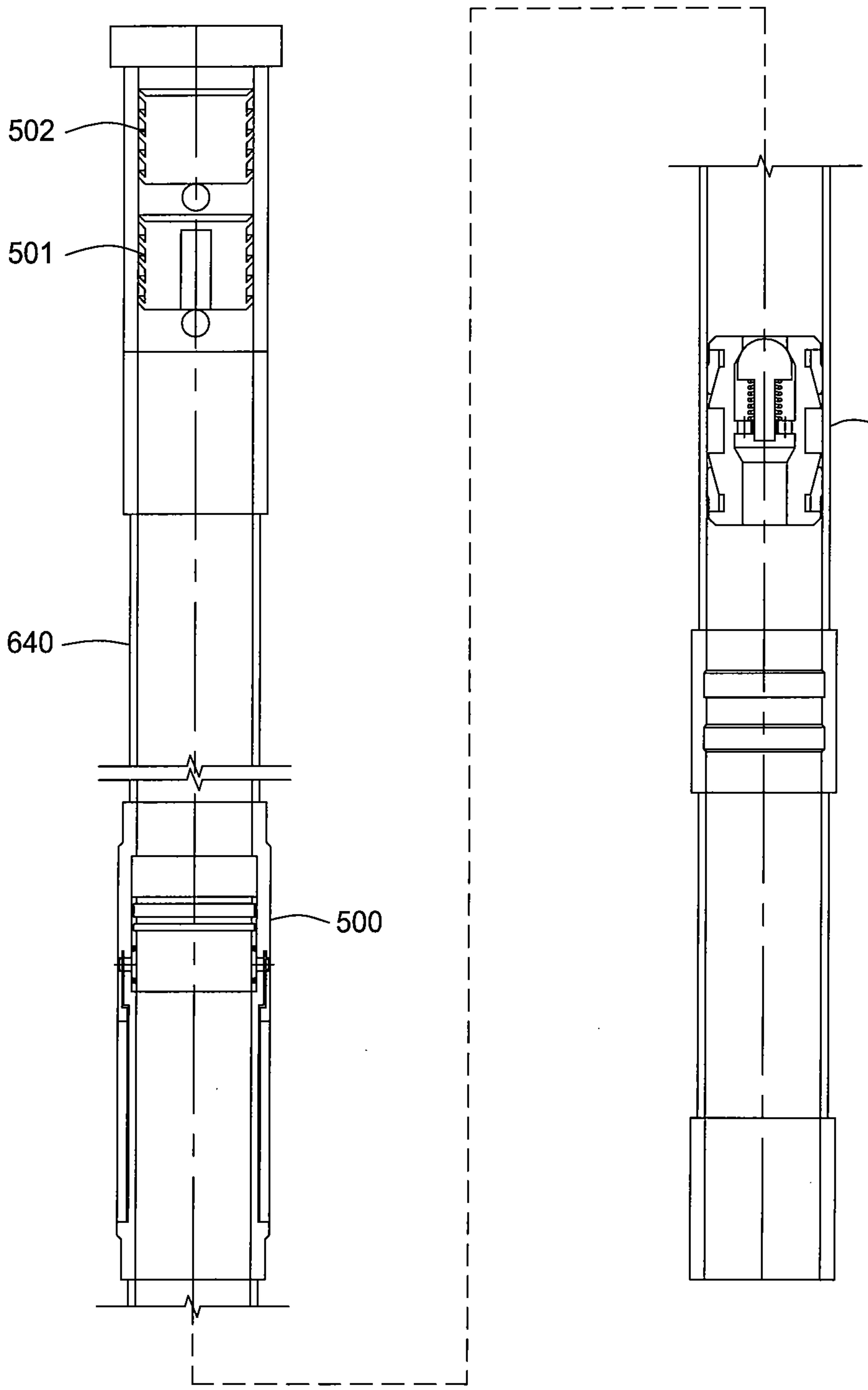


FIG. 7

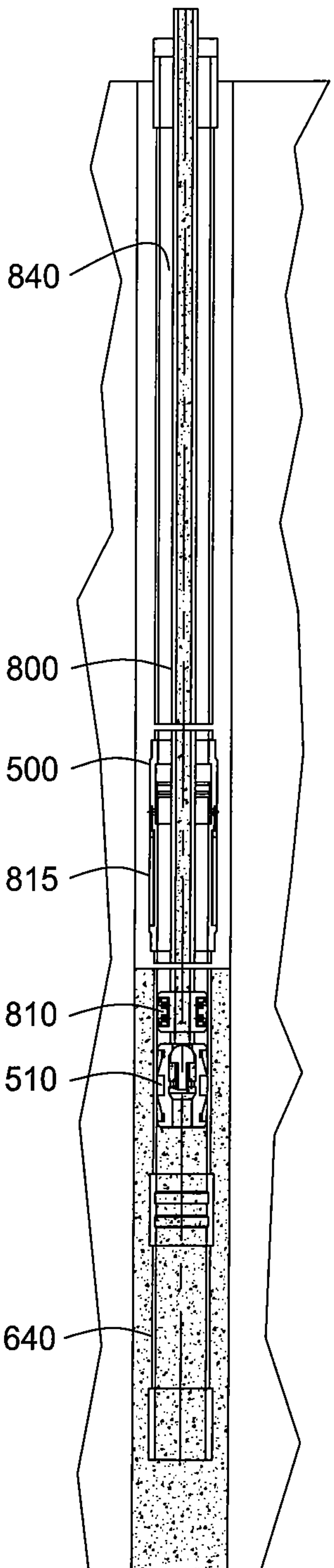


FIG. 8A

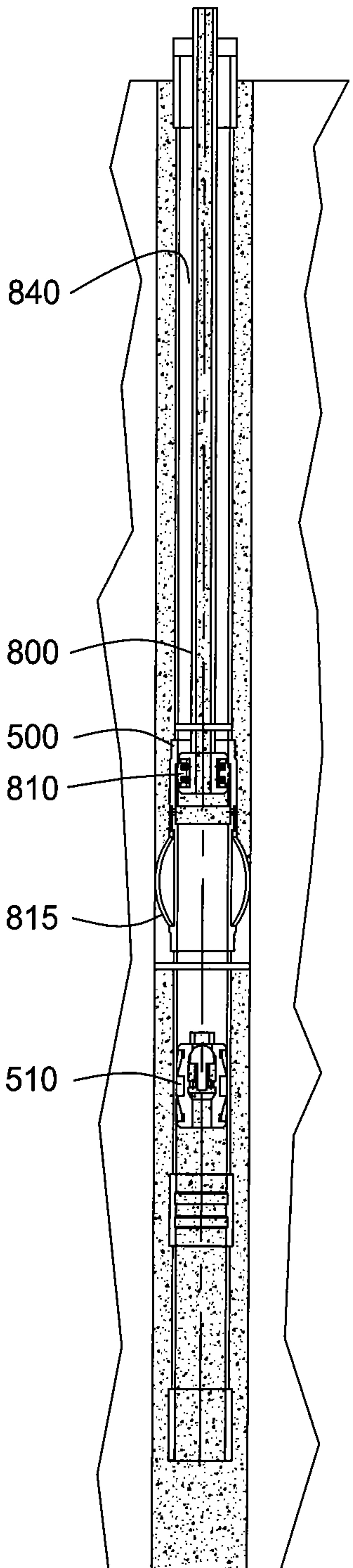


FIG. 8B

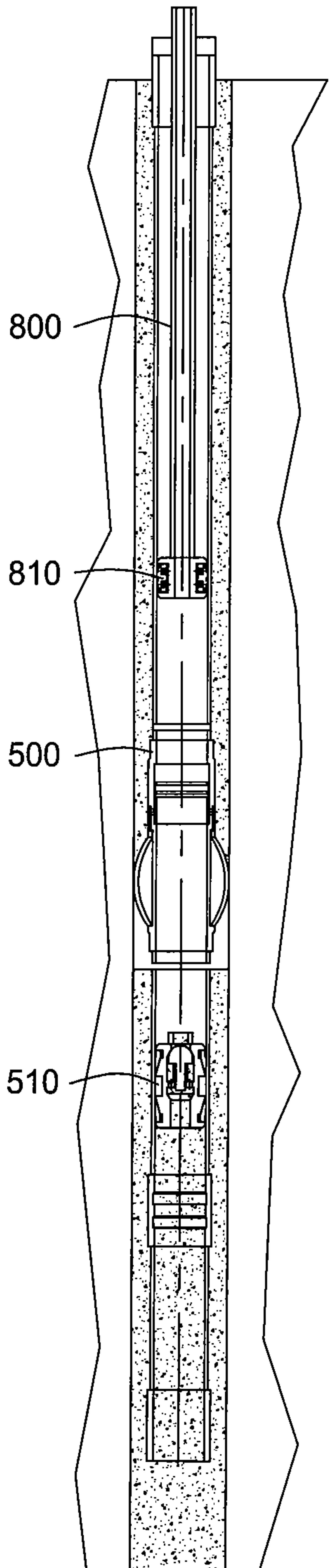


FIG. 8C

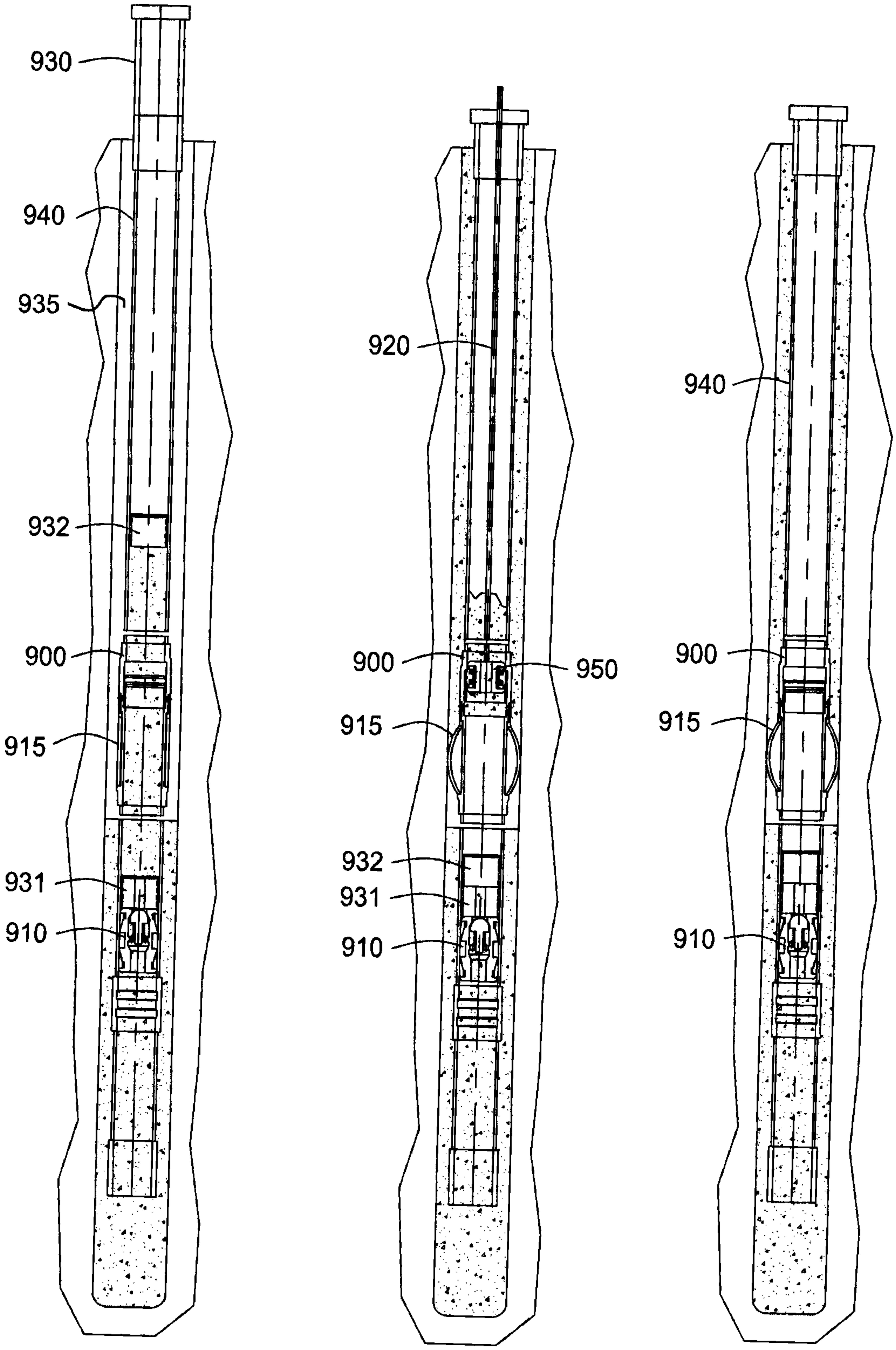
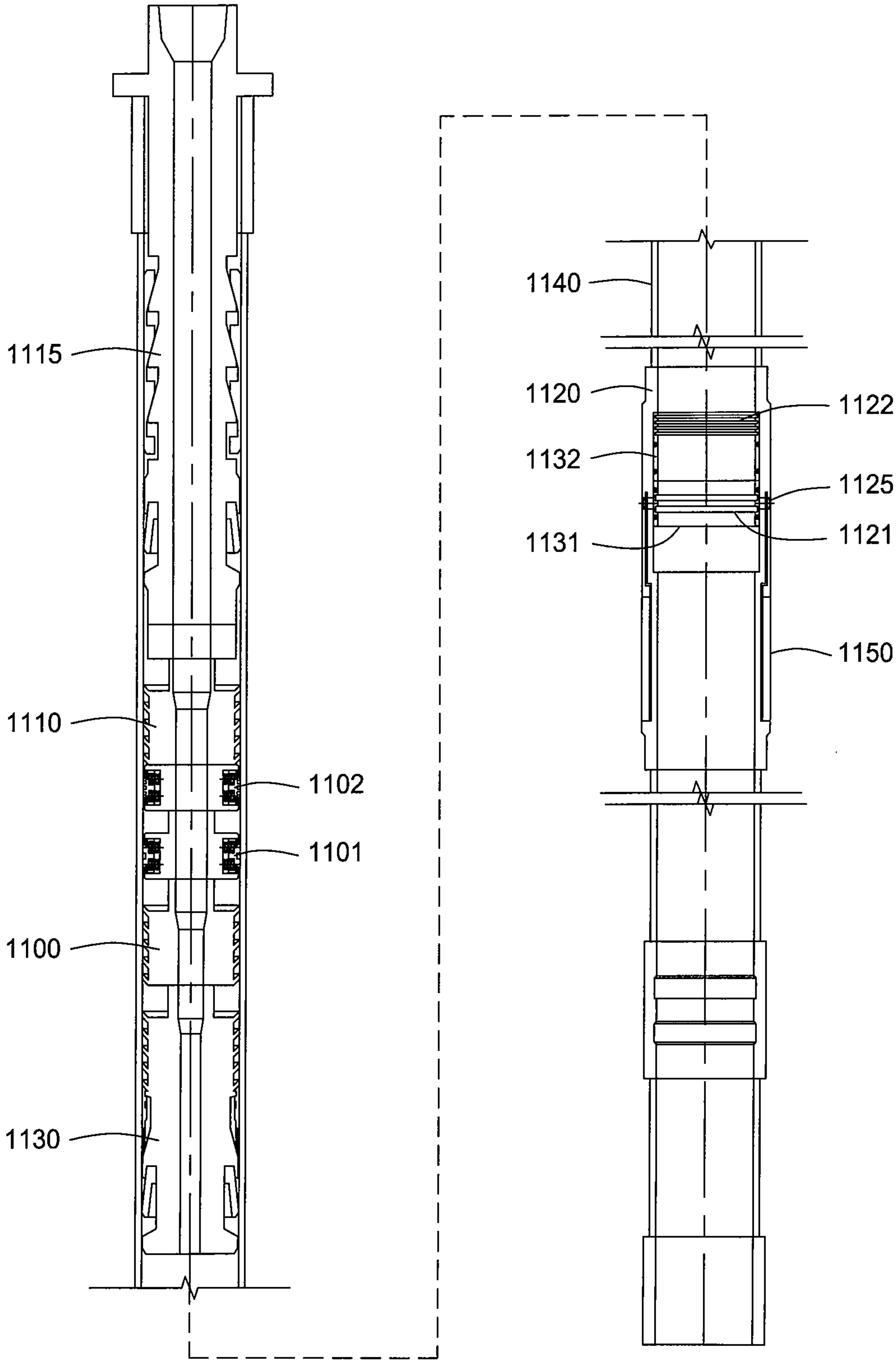


FIG. 9A FIG. 9B FIG. 9C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1121
1150

FIG. 10

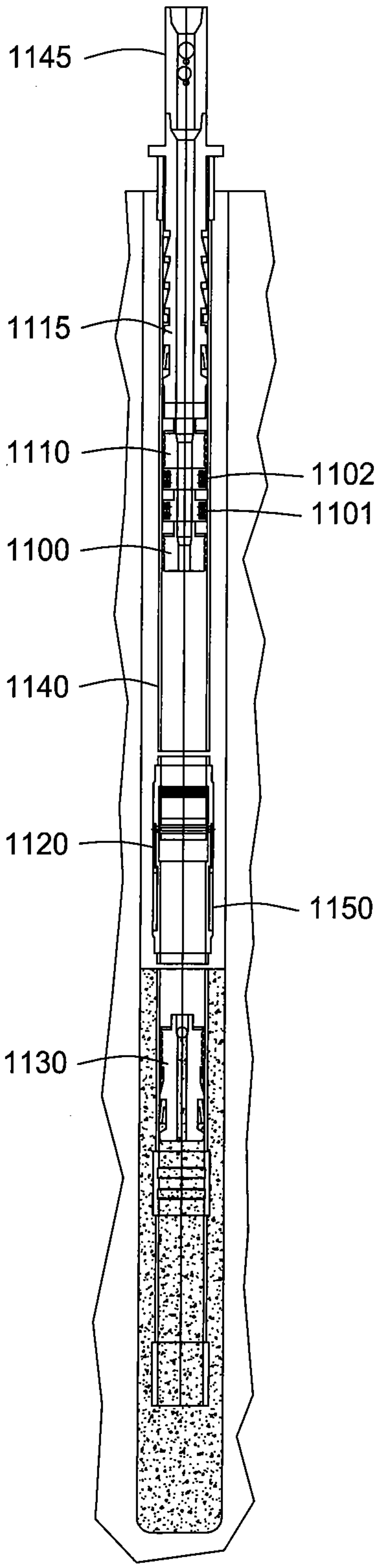

FIG. 11A

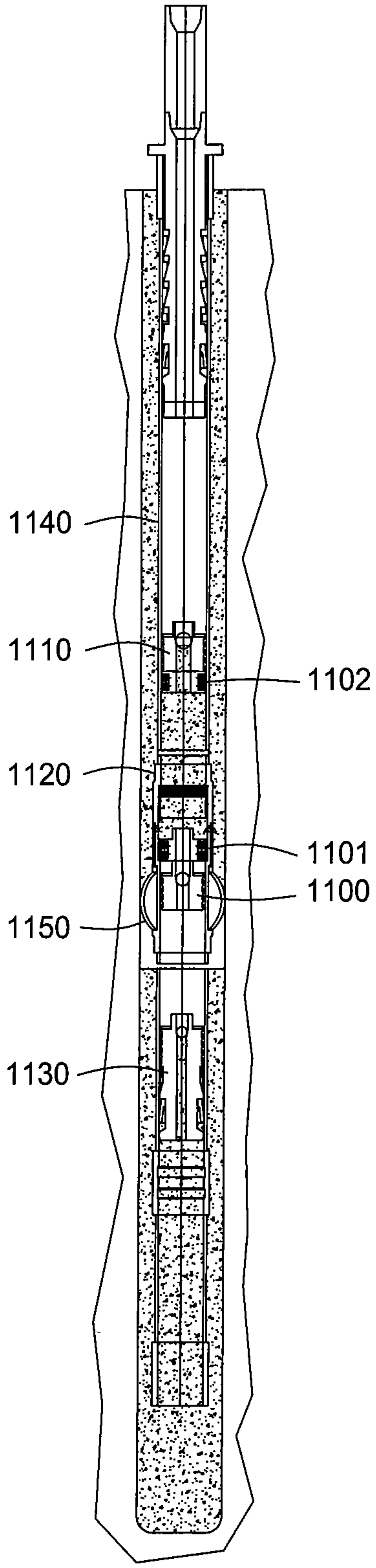

FIG. 11B

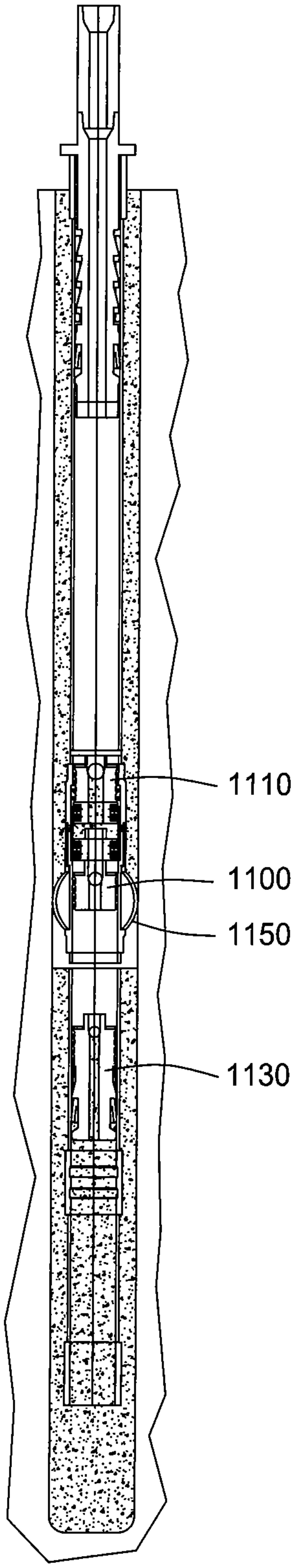

FIG. 11C

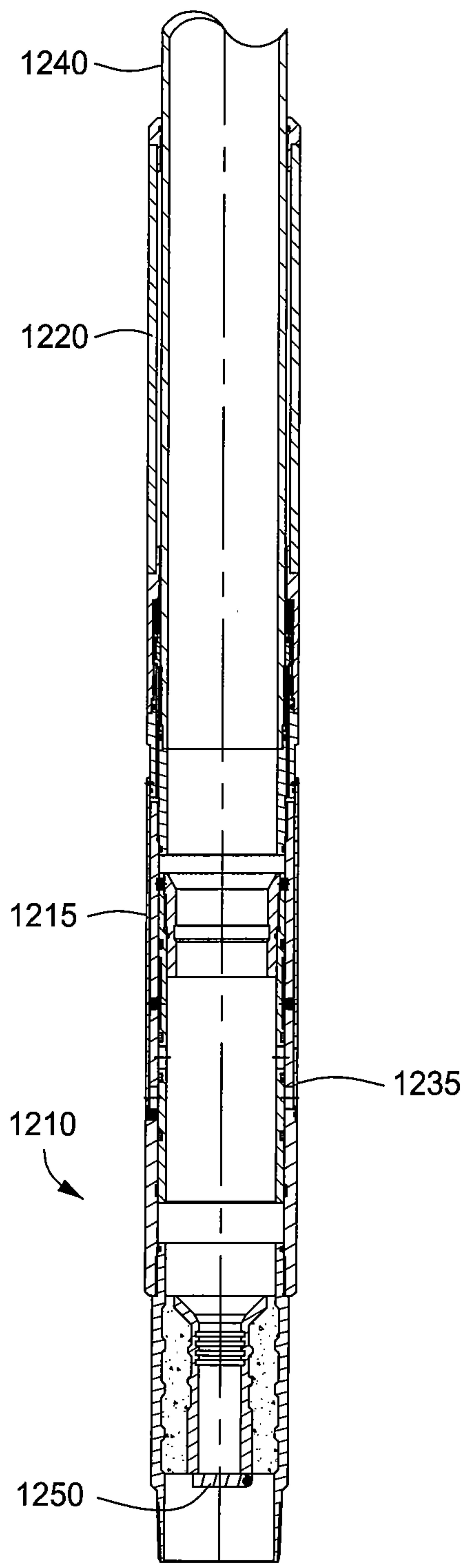

FIG. 12A

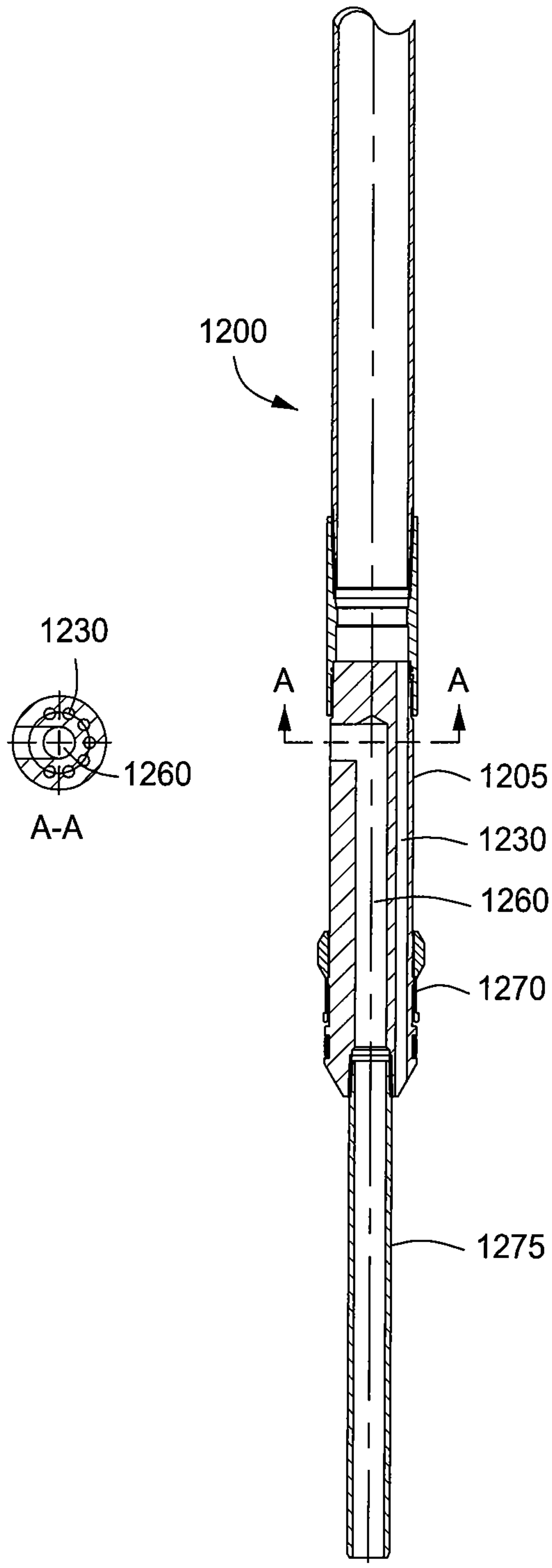

FIG. 12B

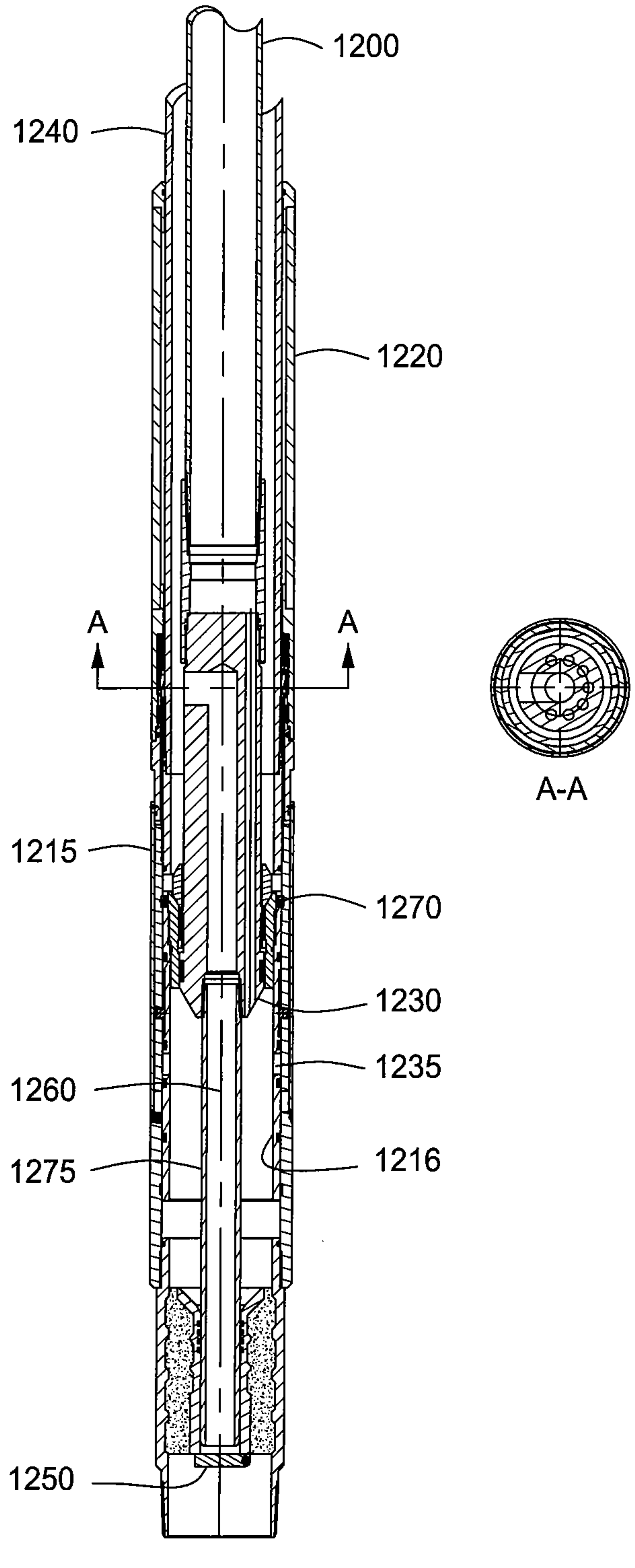

FIG. 12C

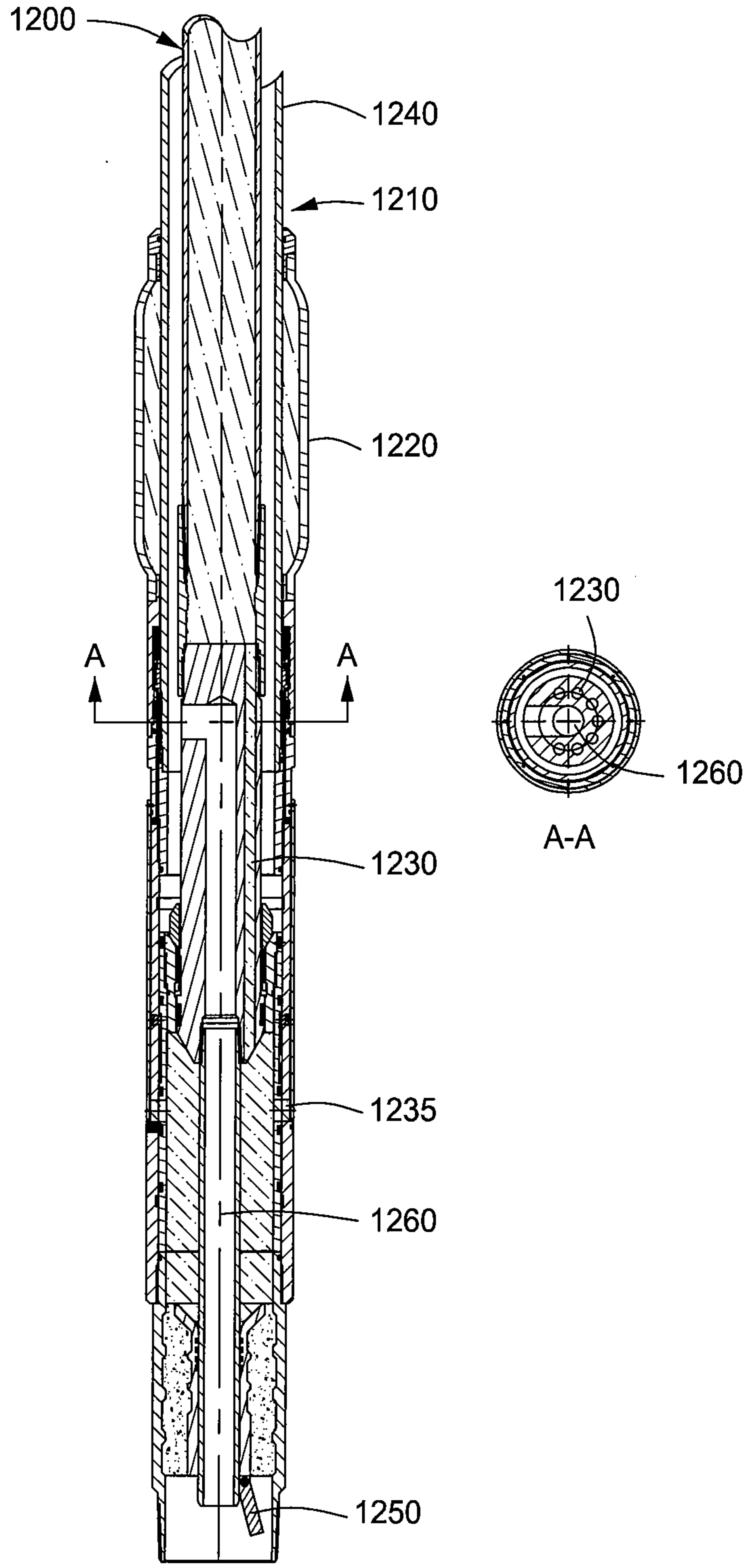

FIG. 12D

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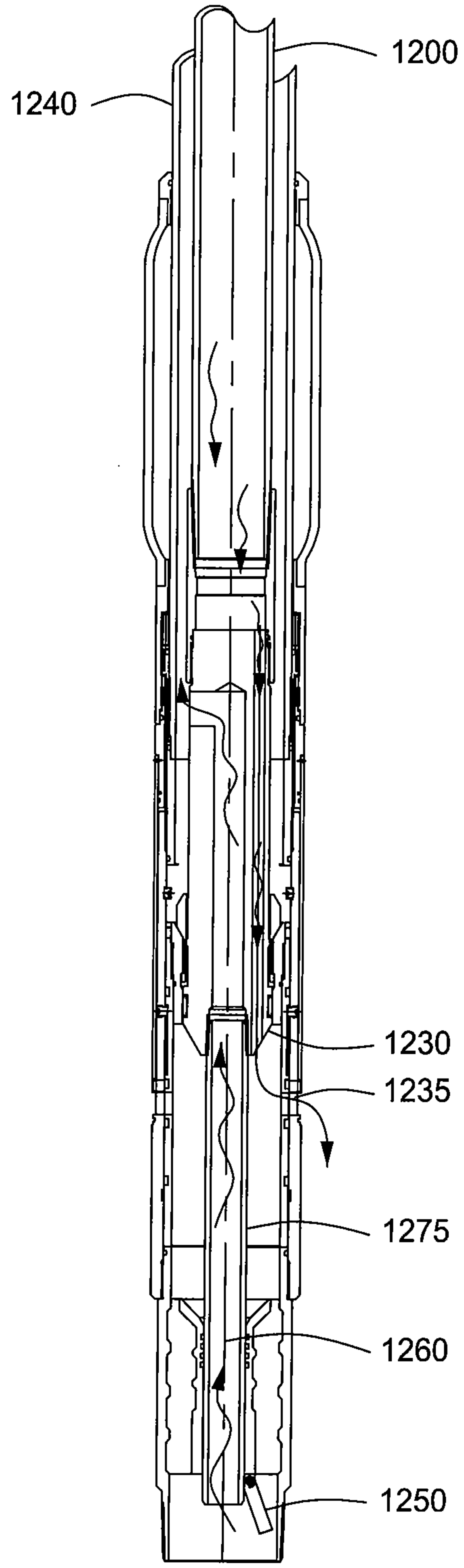
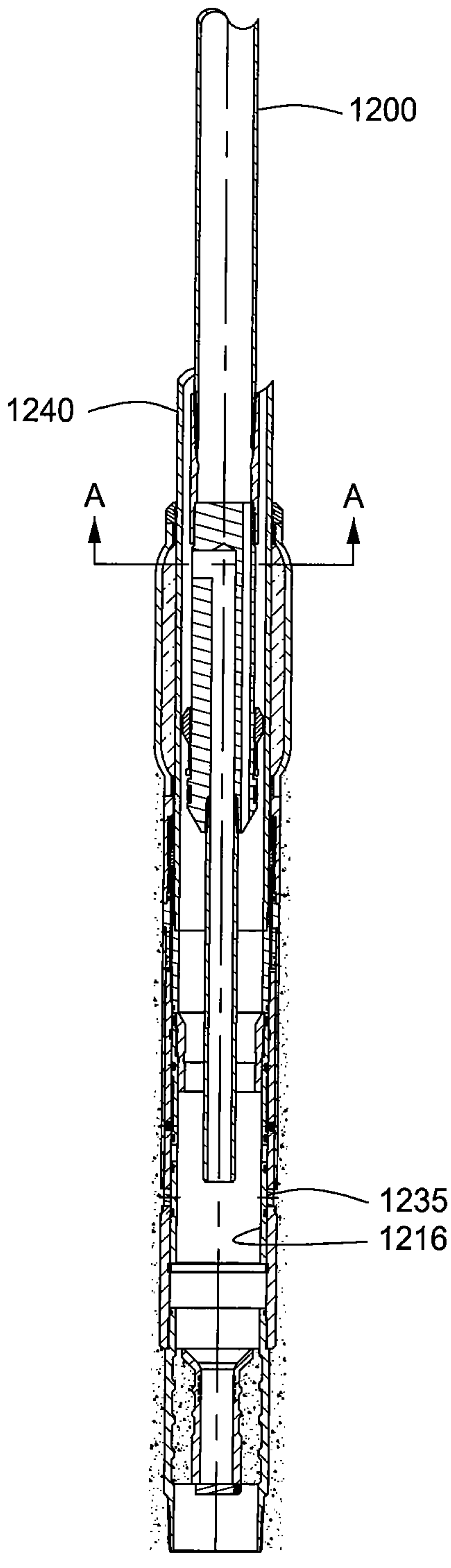
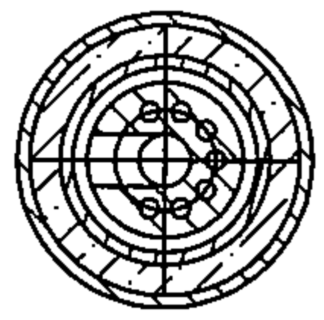


FIG. 12E





A-A

FIG. 12F

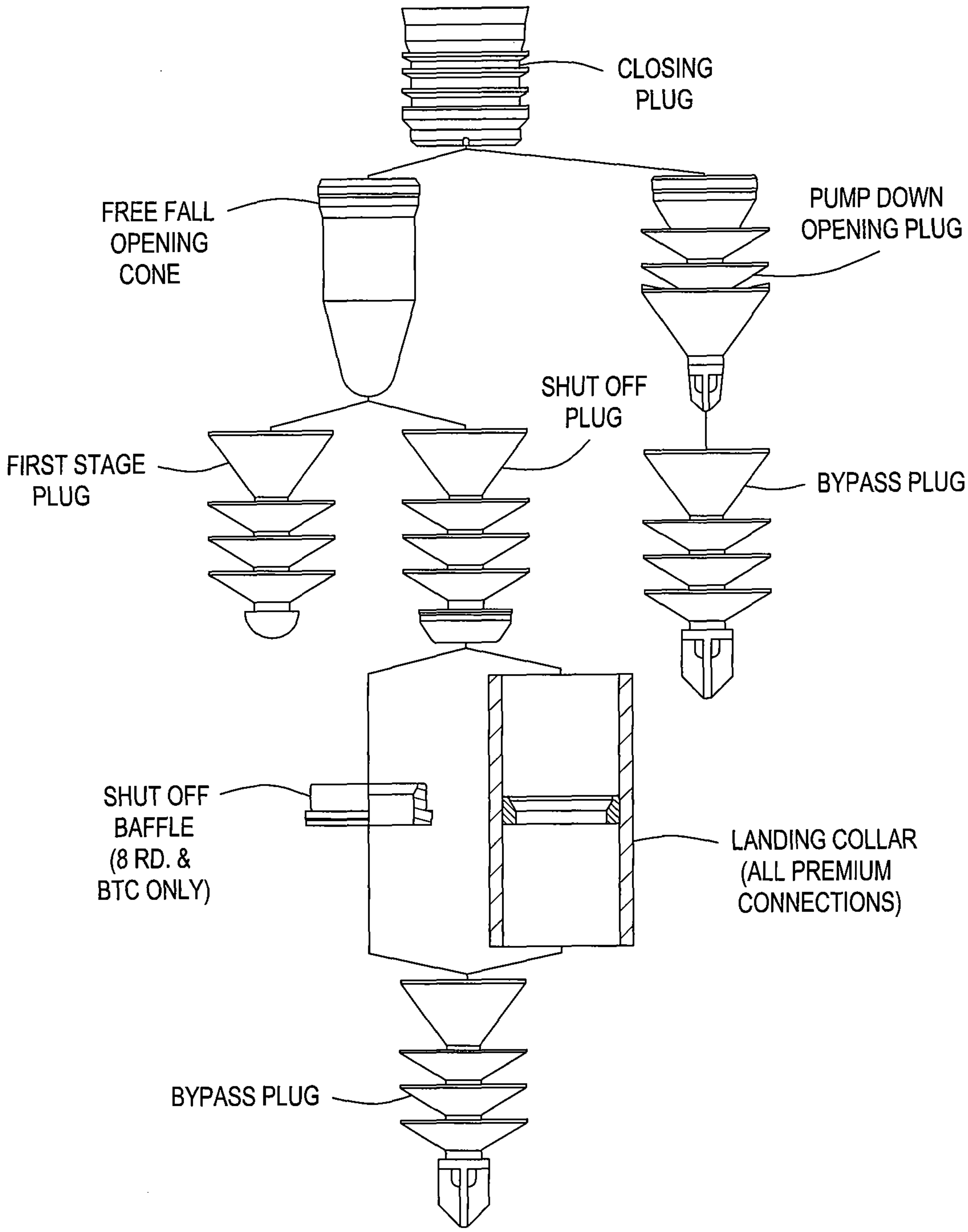
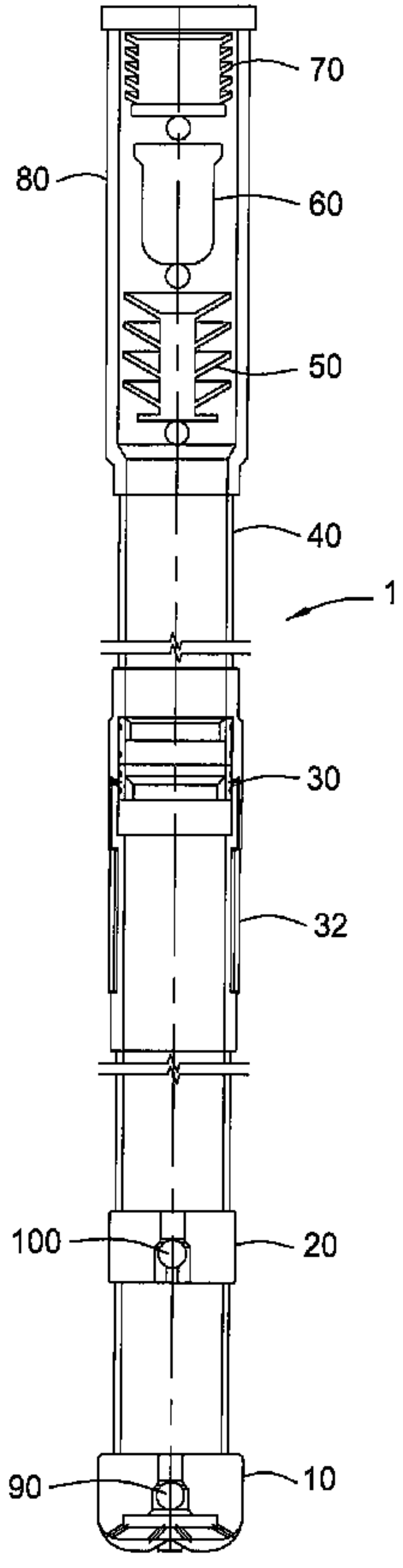

CLOSING
PLUG
FREE FALL
OPENING
CONE
PUMP DOWN
OPENING PLUG
SHUT OFF
PLUG
FIRST STAGE
PLUG
BYPASS PLUG
SHUT OFF
BAFFLE
(8 RD. &
BTC ONLY)
LANDING COLLAR
(ALL PREMIUM
CONNECTIONS)
BYPASS PLUG

FIG. 13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