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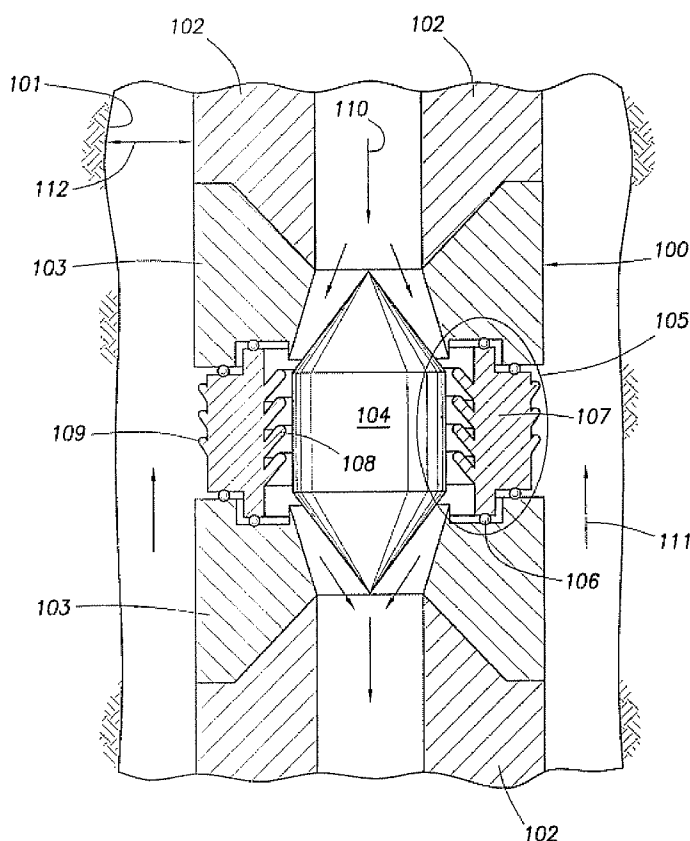
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(54) Title: CLEANING APPARATUS AND METHOD



(57) Abstract: A method for cleaning debris from a wellbore having a top and a bottom comprising inserting cleaning tool comprising a coaxial pipe in the wellbore, pumping fluid through the cleaning tool to create a fluid flow in a direction towards the bottom of the wellbore, converting the fluid flow into rotary mechanical power, agitating the debris by cavitation with at least one vortex spinner having a plurality of spinner blades, and allowing the debris to flow towards the top of the wellbore thereby cleaning the wellbore.

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CLEANING APPARATUS AND METHOD

Field of Invention

The present inventions relate to a cleaning apparatus and a method for cleaning
5 debris from a wellbore.

Background

Formation damage is defined as a reduction in permeability around a wellbore, which is the consequence of drilling, completion, injection, attempted stimulation or production of the well. The mechanism of formation damage varies from well to well; however the
10 transport of solids into and out of the wellbore is consistently an important factor. Drilling mud, drilling fluids drill-in fluids, fluid loss inhibitors, and other similar fluids can invade permeable formations, replacing native fluids adjacent to the wellbore. During replacement, solid particles invade the formation and reduce its permeability by blocking flow channels. This blockage in the flow channels causes formation damage, which can
15 result insignificant decreases in well productivity and resulting economic loss.

A variety of techniques have been developed to remove formation damage. Acidization is probably the most commonly applied technique; however this solution may often result in corrosion of the wellbore equipment and chemical incompatibilities. Additionally large volumes of acid are very expensive and can be problematic in horizontal completions.
20 Formation damage may also be limited somewhat by pretreating the fluids used in drilling, fracturing, and perforation; however this is not an option for correcting post-completion damage.

A recent development in the area of hole cleaning is the use of the principle of cavitation for removing debris such as cuttings, pieces of rock chips, gravel, fines, asphaltenes, solids deposited to reduce fluid loss, and other particles that may interfere
25 with the production or operation of a well. Cavitation generally refers to the formation and instantaneous collapse of innumerable tiny vapor bubbles within a fluid subjected to rapid and intense pressure changes. A liquid subjected to a low pressure (tensile stress) above a threshold ruptures and forms vaporous cavities. When the local ambient pressure at a point
30 in the liquid falls below the liquid's vapor pressure at the local ambient temperature, the liquid can undergo a phase change, creating largely empty voids termed cavitation bubbles.

Downhole cleaning via cavitation involves attaching a cavitation tool to the end of the coiled tubing, drill pipe or work string. To do so, the production or drilling must be stopped

while the cleaning apparatus is run into the hole. Fluid pumped through the tool drives a mechanical process that induces cavitation, and a flare of bubbles is released. The combined effects of the flow impact, the suction effects of the decaying bubble flare, and the implosion shock waves of the cavitation are effective to mobilize and remove debris that may be trapped in the wellbore.

Summary of the Invention

The present inventions include a method for cleaning debris from a wellbore having a top and a bottom comprising inserting cleaning tool comprising a coaxial pipe in the wellbore, pumping fluid through the cleaning tool to create a fluid flow in a direction towards the bottom of the wellbore, converting the fluid flow into rotary mechanical power, agitating the debris by cavitation with at least one vortex spinner having a plurality of spinner blades, and allowing the debris to flow towards the top of the wellbore thereby cleaning the wellbore.

The present inventions include an apparatus for cleaning a wellbore comprising a coaxial pipe with a first end and a second end, at least one vortex spinner operatively connectable to the coaxial pipe between the first end and the second end, and a fluid divider arranged inside the coaxial pipe.

Brief Description of the Drawings

The present invention is better understood by reading the following description of non-limitative embodiments with reference to the attached drawings, wherein like parts of each of the figures are identified by the same reference characters, and which are briefly described as follows:

Figure 1 illustrates a side view of one embodiment of a cleaning tool during production.

Figure 2 illustrates a close-up side view of the one embodiment of the downhole cleaning tool.

Figure 3 illustrates a side view of another embodiment of the cleaning tool.

Figure 4 illustrates a top view of the cleaning tool.

Figure 5 illustrates a top view of the cleaning tool with a ball dropped to deactivate one of the nozzles.

Figure 6 illustrates a side view of the cleaning tool with a ball dropped to deactivate one of the nozzles.

Figure 7 illustrates a side view of another embodiment of the cleaning tool during production.

Detailed Description

For the purpose of this application, the terms used shall be understood as follows. The
5 term “horizontal” or “deviated” well is used to describe an oil or gas well drilled at an angle at least 30 degrees from vertical. The term “debris” is used to mean cuttings, pieces of rock chips, gravel, fines, asphaltenes, solids deposited to reduce fluid loss, and other particles that may interfere with the production or operation of a well.

Referring to Figure 1, one embodiment of downhole cleaning tool 100 is shown
10 installed in wellbore 101 during production. Cleaning tool 100 is attached to a portion of tubing 102 and lowered into the well. In this embodiment, the cleaning tool is shown integrated with the production tubing. Alternatively the cleaning tool may be inserted into the well with a wireline, stinger, or another joint of tubing. In the embodiment shown, only one cleaning tool is depicted; however, multiple tools may be installed at various intervals
15 along the tubing to increase cleaning efficiency.

Cleaning tool 100 may be made up of coaxial pipe 103, fluid divider 104, and vortex
spinner 105 connectable around the circumference of the coaxial pipe. Connectors 106
hold the spinner in place, decrease friction of vortex spinner 105 while rotating, and seal
the fluid flow from interior pipe to outside. Figure 2 shows a close-up view of a portion of
20 the downhole cleaning tool from Figure 1 in which connectors 106 are roller bearings, or any similar connection apparatus. Vortex spinner 105 comprises spinner housing 107, interior spinner blades 108, and exterior spinner blades 109.

During operation, fluid is pumped down production tubing 102 through cleaning tool
100 towards the bottom of the wellbore as represented by arrow 110. When the fluid moves
25 through fluid divider 104, the pressure decrease causes the velocity of the fluid to increase. Alternatively fluid divider 104 may be removed from the design. The fluid hits interior spinner blades 108 and rotates vortex spinner 105 at a speed sufficient to induce cavitation. The interior and exterior spinner blades and may be connected to the vortex spinner in any arrangement; however, a spiral, helical, or slanted configuration is preferred. Vortex
30 spinner 105 and exterior spinner blades 109 agitates the fluid in annulus 112 and releases debris attached to the wall of the wellbore. The fluid then may pass through the rest of the assembly. Mobilized debris may be circulated along annulus 112 (according to arrow 111) to the surface.

Figure 3 shows an alternative embodiment of the downhole cleaning tool. In this embodiment, nozzles 301 may be attached to vortex spinner 105 to enhance the cleaning process. The number of nozzles and angles at which the nozzles are positioned may be adjusted based on well conditions. Optionally the nozzles may be equipped with nozzle heads (not shown) to direct fluid as it exists the nozzle. Optionally the nozzles may be threaded or otherwise manufactured to direct fluid flow. When fluid is pumped down along arrow 110, a portion may pass through nozzle 301 to agitate debris 302 and loosen it from the wellbore. The rest of the fluid continues through the tool to activate rotate the components to induce cavitation.

Figure 4 shows a top view of the embodiment of the downhole cleaning tool from Figure 3 in wellbore 101. Coaxial pipe 103 is shown encircled by vortex spinner 105. A plurality of nozzles 301 extend through vortex spinner 105. In this embodiment, four nozzles are shown; however more could be included in a variety of arrangements. Each nozzle may be equipped with a nozzle head 402 at its end, which can be adjusted to set the angle at which fluid exists the tool. Each nozzle may be connected to a hole in the inner wall of vortex spinner 105. Fluid breaker 403 encircles the inner wall of vortex spinner 105 beneath the holes leading to the nozzles.

During operation, fluid flows across fluid divider 104 and experiences an increase in velocity. Alternatively, the fluid divider could be omitted and the vortex spinner driven with the natural velocity of the fluid. A portion of the fluid hits interior spinner blades 108 and causes coaxial pipe 103 (or is it vortex spinner 105?) to rotate at a specified speed. A different portion of the fluid may enter nozzles 301 and is shot against the formation to loosen debris. The rest of the fluid may continue through the tool to activate the cavitation process via vortex spinners 105. One possible path of the fluid is shown by arrows 404; however, others paths are possible.

When the operator no longer requires the use of one of the nozzles, controllable passageways capable of stopping fluid communication in one or all of the nozzles may be used. In one embodiment, a ball 501 may be dropped to deactivate the nozzle. Figure 5 shows a top view of the tool with ball 501 resting on fluid breaker 403 and blocking the hole, which leads the leftmost nozzle. Figure 6 shows a side view of the same scenario. Alternatively another mechanism known in the industry to block flow such as a flapper valve. Alternatively, as shown in Figure 7, the vortex spinners may be removed and replaced with pipe 301 so that the tool is simplified to only include the nozzle cleaning

mechanism. Any other method that achieves the effect of the controllable passageways may be used.

Advantages of some embodiments of the invention may include one or more of the following:

- 5 • Allows the assembly of one or multiple fluid-driven rotary cleaning subs as needed anywhere in the completion eliminating the limitations of tools that may only be installed at the end of the tubing
- Eliminates additional trips required to disassemble and insert a cleaning assembly
- Reduces or eliminates backreaming
- 10 • Prevents settling of drill cuttings
- Increases lifetime of completion equipment and other downhole tools

Those of skill in the art will appreciate that many modifications and variations are possible in terms of the disclosed embodiments, configurations, materials, and methods without departing from their spirit and scope. Accordingly, the scope of the claims
15 appended hereafter and their functional equivalents should not be limited by particular embodiments described and illustrated herein, as these are merely exemplary in nature.

CLAIMS

1. A method for cleaning debris from a wellbore having a top and a bottom comprising:
5 inserting cleaning tool comprising a coaxial pipe in the wellbore;
 pumping fluid through the cleaning tool to create a fluid flow in a direction towards
 the bottom of the wellbore;
 converting the fluid flow into rotary mechanical power;
 agitating the debris by cavitation with at least one vortex spinner having a plurality
10 of spinner blades; and
 allowing the debris to flow towards the top of the wellbore thereby cleaning the
 wellbore.
2. The method of claim 1 wherein agitating is performed by allowing the fluid to hit the
15 plurality of spinner blades thereby rotating the coaxial pipe.
3. The method of claim 2 wherein converting is performed by pumping the fluid across a
fluid divider towards the bottom of the wellbore and allowing the fluid to hit the plurality
of spinner blades thereby turning the at least one vortex spinner.
20
4. The method of claim 3 wherein the coaxial pipe has a plurality of nozzles which create
fluid communication between the interior of the coaxial pipe and an annulus defined by
the area between the coaxial pipe and the wellbore.
- 25 5. The method of claim 4 further comprising allowing some of the fluid to pass through the
 plurality of nozzles to enhance cleaning.
6. The method of claim 5 further comprising controllable passageways capable of stopping
fluid communication in the plurality of nozzles when desired.
30
7. The method of claim 6 wherein a plurality of nozzle heads are attached to the plurality of
nozzles and adjusted to optimize cleaning.

8. The method of claim 7 wherein the debris is cuttings, pieces of rock chips, gravel, fines, and other particles located on the wellbore, inside perforations shot into the wellbore, or on tools installed in the wellbore.
- 5 9. The method of claim 8 wherein the inserting is performed by integrating the cleaning tool with the production tubing.
10. The method of claim 8 wherein the inserting is performed by lowering the cleaning tool into the well with a wireline, stinger, or other tubing.
- 10 11. An apparatus for cleaning a wellbore comprising:
- a coaxial pipe with a first end and a second end;
 - at least one vortex spinner operatively connectable to the coaxial pipe between the first end and the second end; and
 - 15 a fluid divider arranged inside the coaxial pipe.
12. The apparatus of claim 1 wherein the at least one vortex spinner comprises a spinner housing, a set of interior spinner blades, and a set of exterior spinner blades.
- 20 13. The apparatus of claim 12 wherein the at least one vortex spinner is connectable to the coaxial pipe with rollers or bearings whereby the spinner housing is rotatable around an axis substantially parallel to the wellbore.
14. The apparatus of claim 13 wherein the first end of the coaxial pipe is connected to a first tubular; wherein the first tubular is selected from the group consisting of production tubing, wireline, workstrings, stingers, and other tubing.
- 25 15. The apparatus of claim 14 wherein the second end of the coaxial pipe is connected to a second tubular wherein the first tubular is selected from the group consisting of production tubing, wireline, workstrings, stingers, and other tubing.
- 30 16. The apparatus of claim 11 further comprising a plurality of nozzles located on the coaxial pipe; wherein the plurality of nozzles create fluid communication between the

interior of the coaxial pipe and an annulus defined by the area between the coaxial pipe and the wellbore.

17. The apparatus of claim 16 further comprising a plurality of nozzle heads attached to the
5 plurality of nozzles.

18. The apparatus of claim 17 further comprising controllable passageways capable of stopping fluid communication in the plurality of nozzles when desired.

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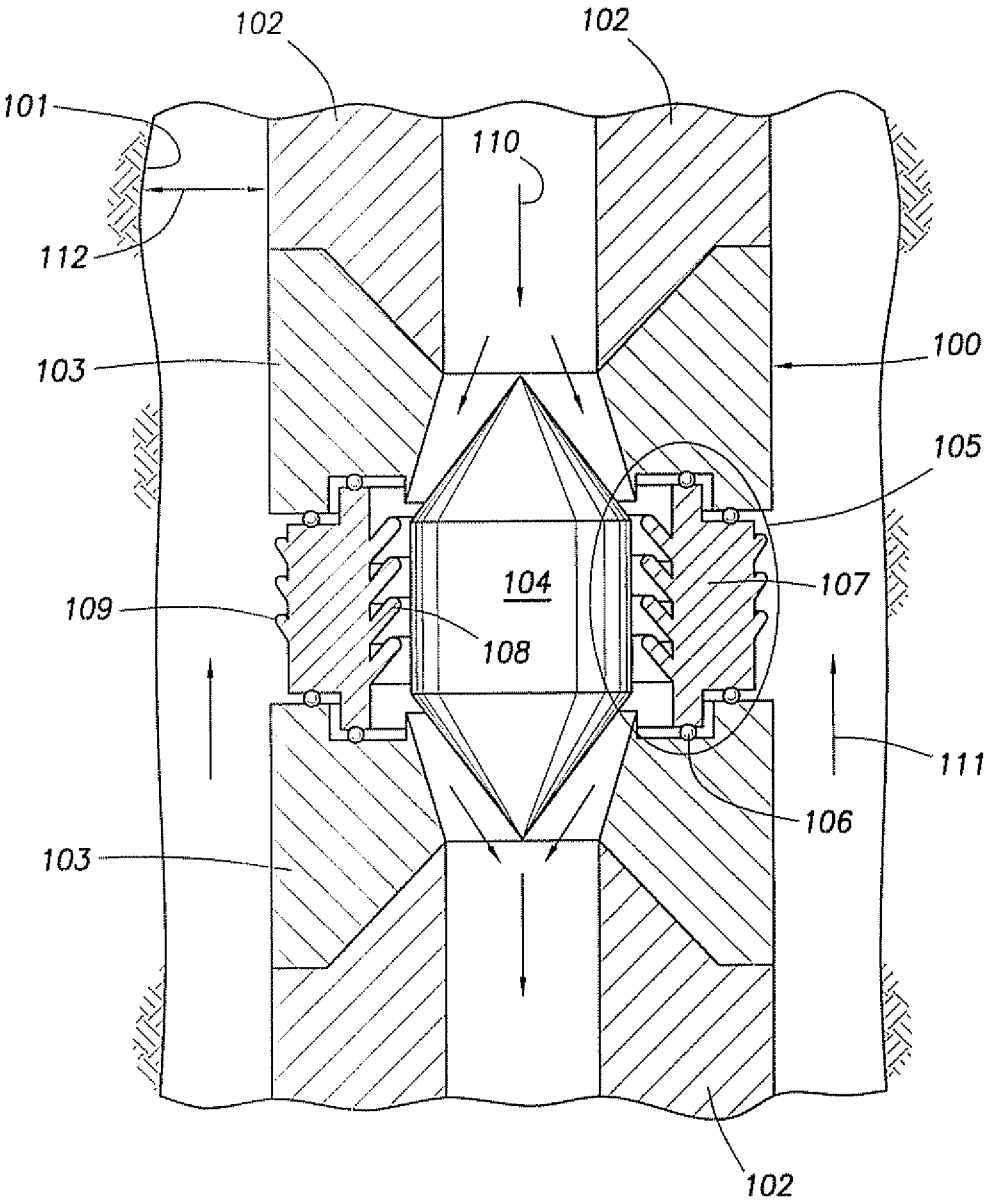


FIG.1

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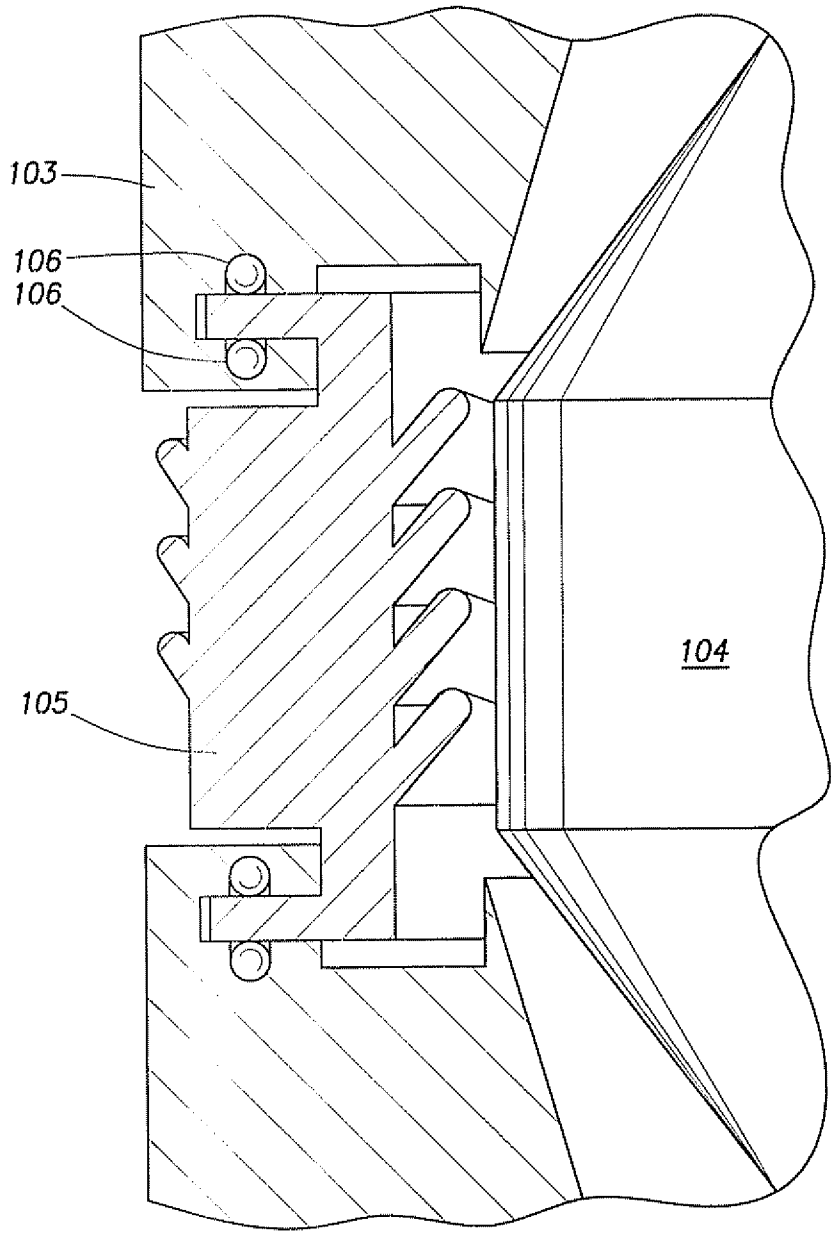


FIG. 2

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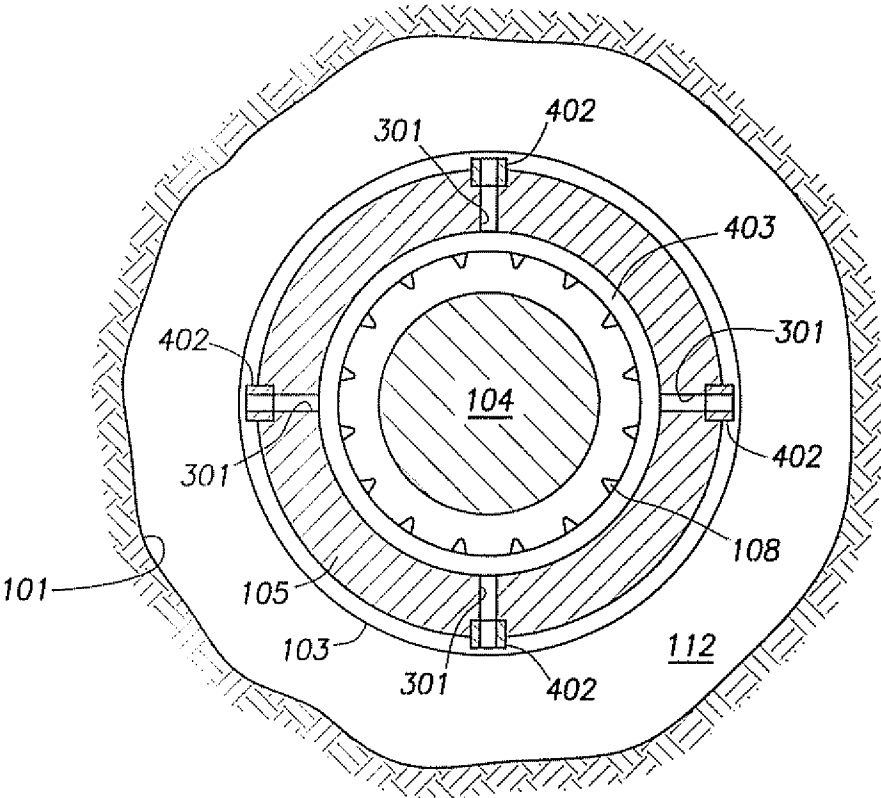


FIG.4

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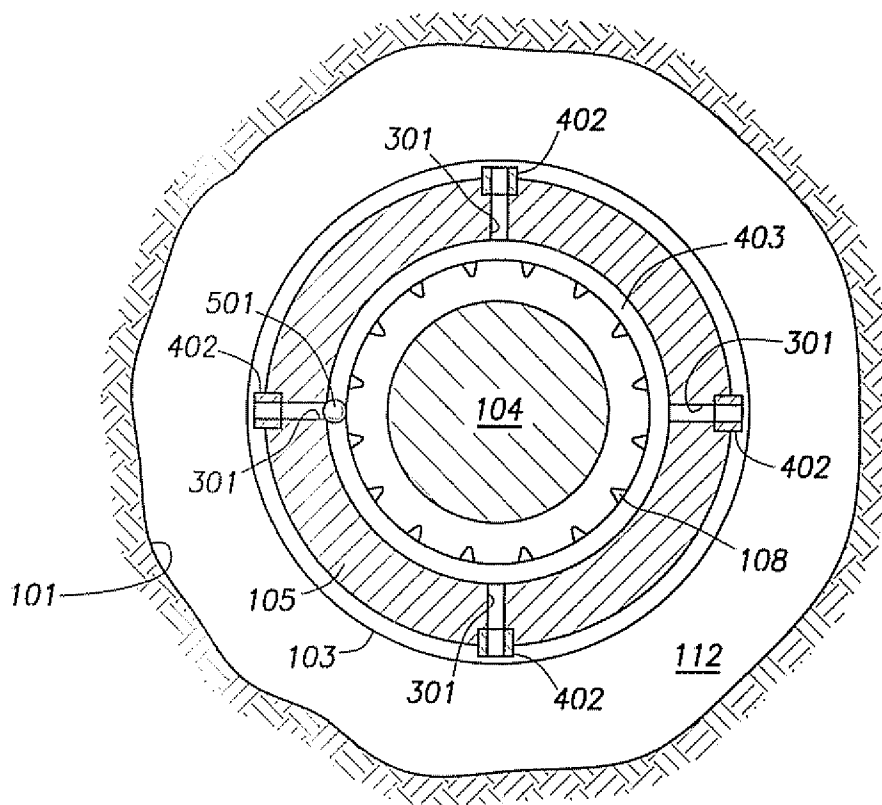


FIG. 5

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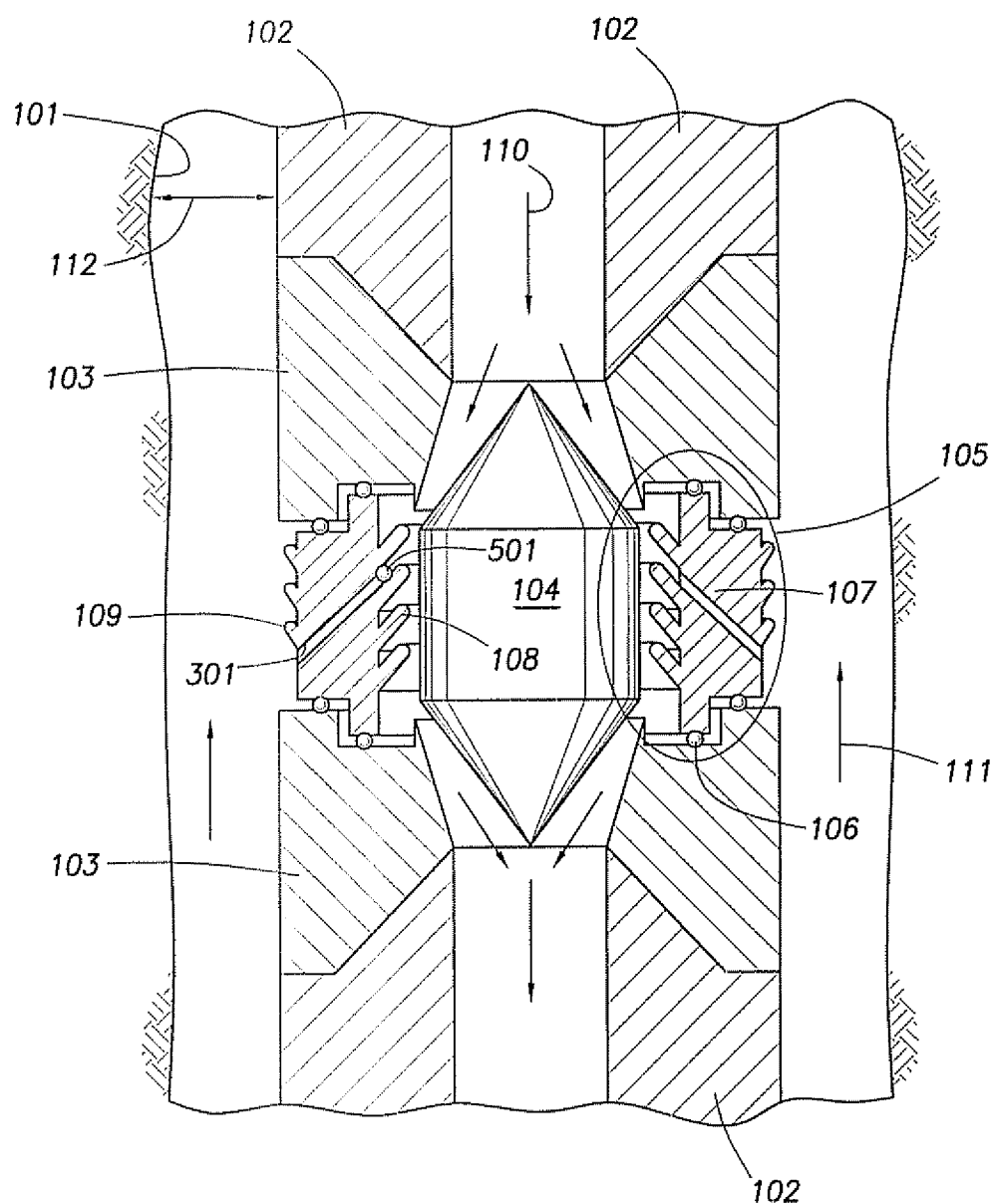


FIG. 6

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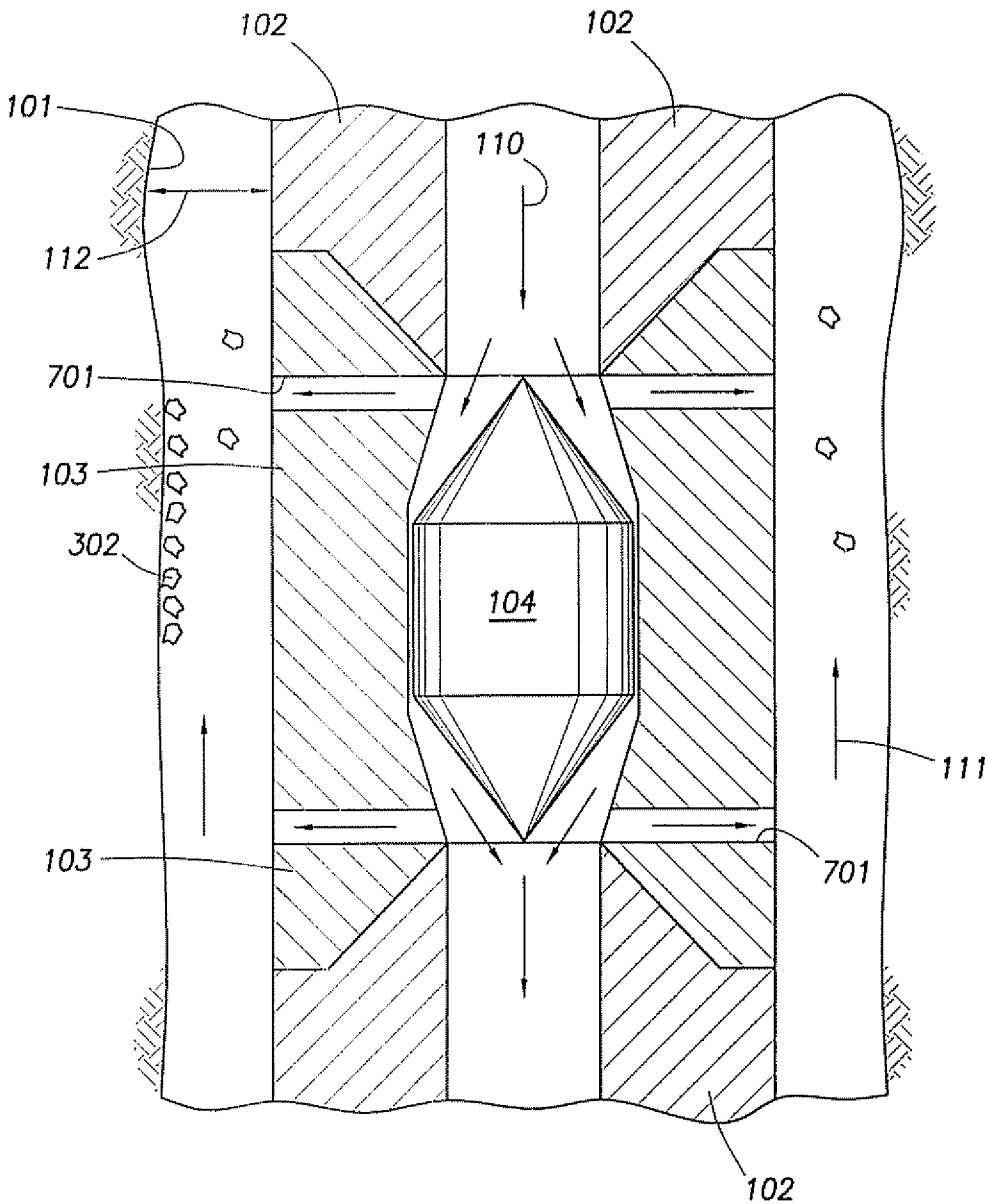


FIG. 7

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INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER
 INV. E21B37/04 E21B21/10

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

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

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

EPO-Internal

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Y	column 5, line 44 - column 6, line 1; figures 1-3	1-10, 12-14
Y	US 5 158 140 A (FERRY JEAN-CLAUDE [FR]) 27 October 1992 (1992-10-27) column 5, lines 9-11 column 5, lines 24,25	1-10
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A	column 5, line 37 - column 6, line 29; figure 6	1
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/074954

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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