United States Patent

Baumstimler

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[54] COMBINATION WELL CLEAN-OUT TOOL AND JAR

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[52] **U.S. Cl.** **166/99,** 166/100, 166/224

[51] **Int. Cl.** **E21b 31/08**

[58] **Field of Search** 166/99, 100, 224

[56] **References Cited**

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[57] **ABSTRACT**

A well cleanout tool for retrieving junk or debris from the bottom of a borehole. The tool may be run into an oil well on the end of a wire line or sand line. Included within the tool are various chambers for retrieving or holding junk which flows thereinto when a valve is actuated. A combination valve actuator and jar mechanism is manipulated by the wire line and facilitates removal of the tool from the borehole when it becomes stuck therein. An improved releaf valve in the form of a resilient one-way check valve progressively reduces the internal pressure of the tool after it has been actuated and is traveling uphole. A second jar mechanism is optionally provided at the lower extremity of the tool.

9 Claims, 9 Drawing Figures

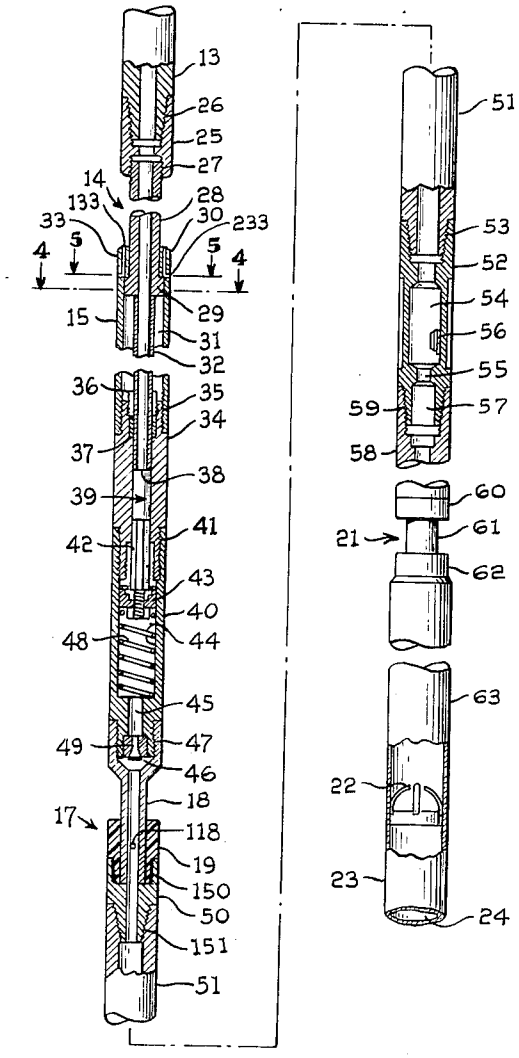


Fig. 1

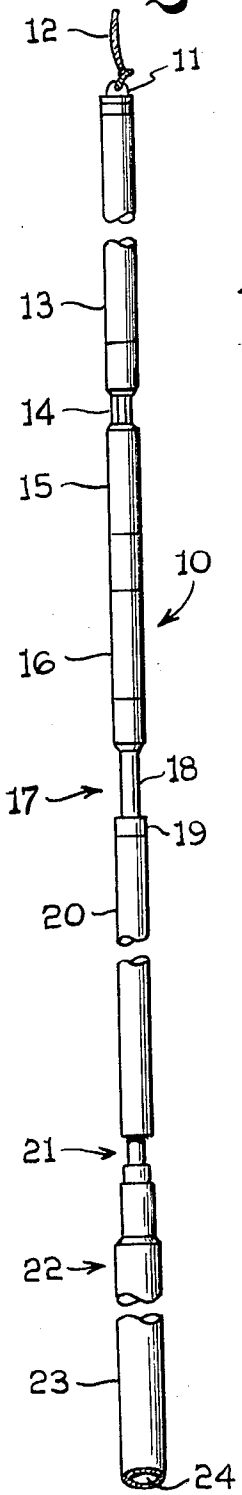


Fig. 3

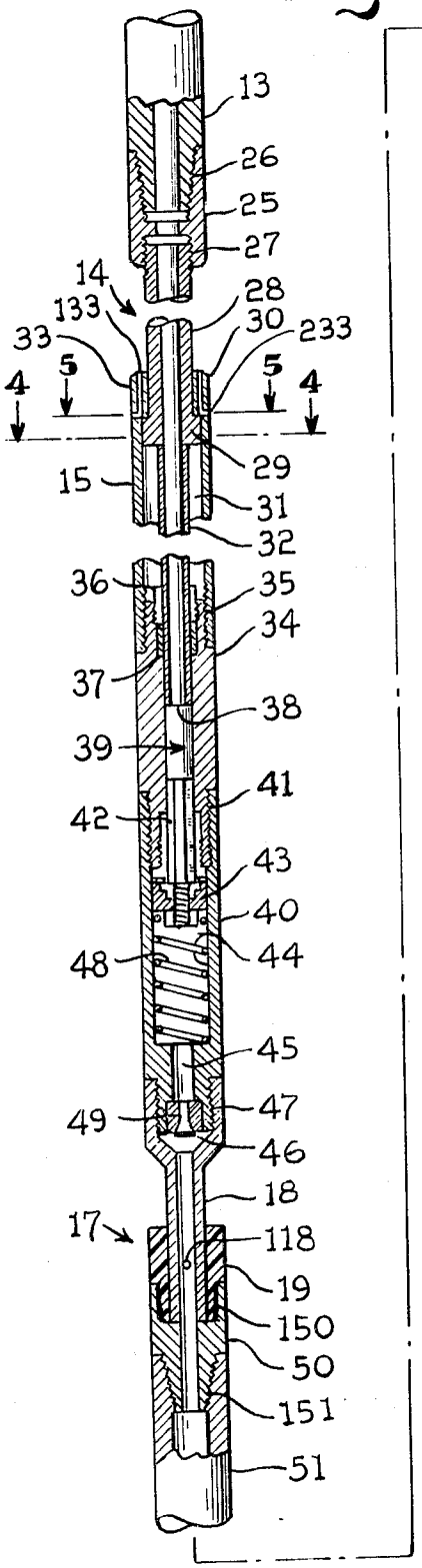
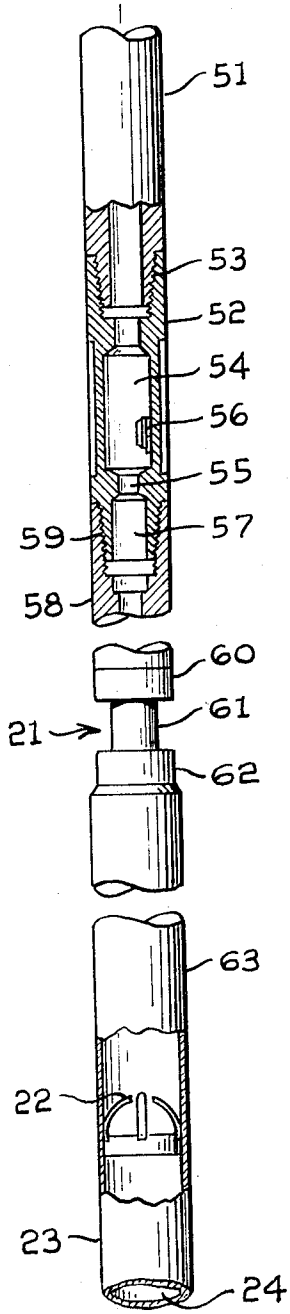


Fig. 2



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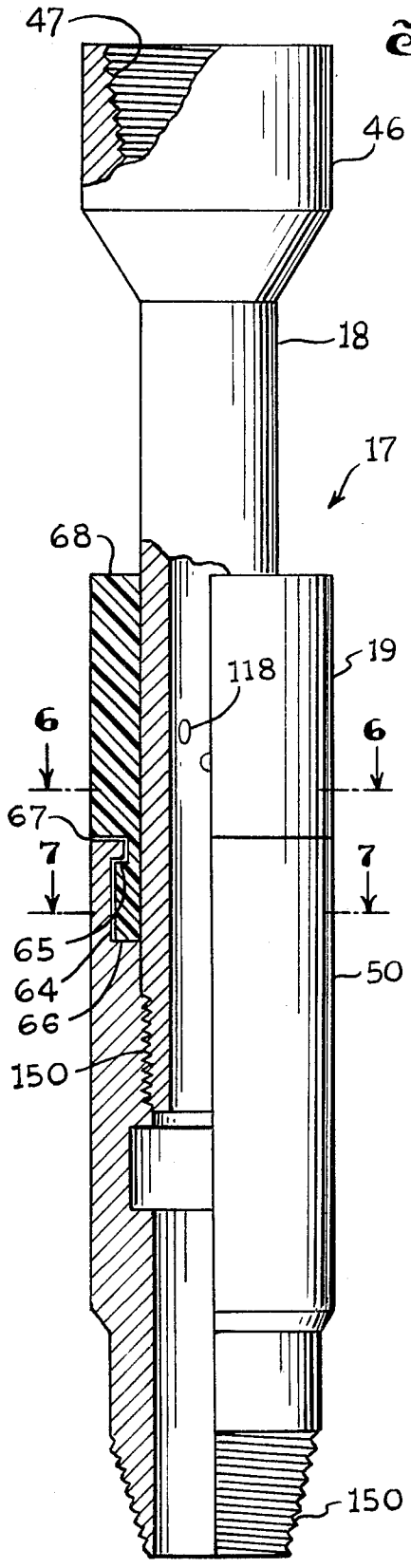


Fig. 8

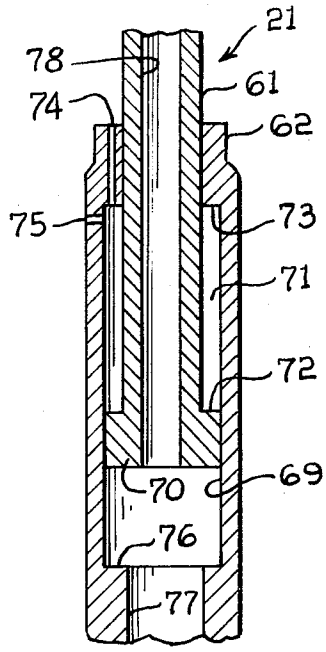


Fig. 9

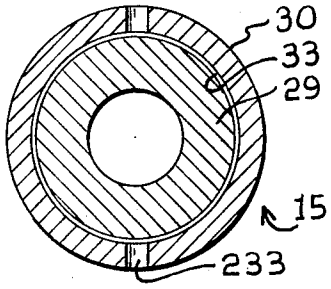


Fig. 4

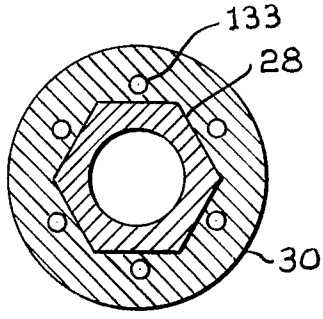


Fig. 5

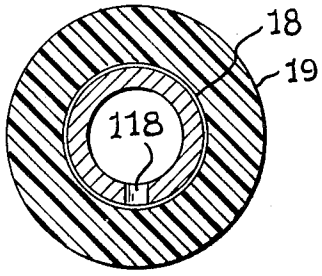


Fig. 6

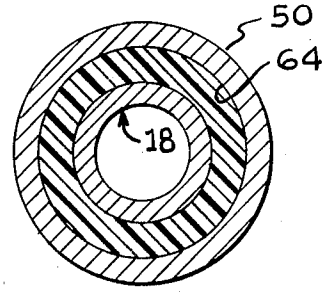


Fig. 7

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COMBINATION WELL CLEAN-OUT TOOL AND JAR

BACKGROUND OF THE INVENTION

Reference is made to my previous U.S. Pat. No. 3,406,757 issued Oct. 22, 1968, for additional background of the present invention. In running the tool of my previous invention into a borehole on a sand line, the pressure differential between the formation fluid and the tool interior causes a violent flow of debris into the tool when the valve is opened. This surge of fluid is of a sufficient magnitude to cause the tool to suck itself down into a layer of debris where it sometimes becomes stuck or caught. Heretofore it has been necessary to employ a jar which is incorporated into the tool string so as to enable removal of the tool from its stuck position. After the tool has been jarred loose from the bottom of the borehole and retrieved by the wire line, it has been found that the differential in internal pressure as the tool is brought out of the formation fluids creates a hazard to workmen when the tool is subsequently emptied of debris and made ready for the next trip into the hole.

Accordingly, it is desirable to be able to progressively relieve the pressure differential existent between the tool interior and the borehole annulus as the tool is brought uphole in a manner which is fool-proof and reliable. Furthermore it is desirable to be able to incorporate a jar into the tool without suffering the weight penalty occasioned by adding additional tools in series with the basic tool string.

SUMMARY OF THE INVENTION

The present invention comprehends a well clean-out tool having a valve unit at the upper extremity thereof which can be directly actuated by reciprocatory motion of the wire line to which the tool is attached. The reciprocatory motion of the wire line also actuates a jar apparatus which enables the tool to be removed from a borehole when it becomes stuck therein. The internal pressure of the tool is controlled by a novel relief check valve which cooperates with the valve unit in a manner which equalizes the pressure differential between the interior of the tool and the ambient.

The novel features of the present invention lies in the combination of a valve unit which is actuated by a valve stem, wherein the valve stem forms part of a jar mechanism, whereby reciprocation of the wire line from the surface enables the valve to be moved to the opened position so as to fill the tool with debris, and wherein further manipulative action of the wire line actuates the jar mechanism to thereby provide impact force which drives the tool in an upward direction. Another novel feature of the tool lies in a relief check valve which permits outward flow or equalization of internal tool pressure, but which precludes inward flow therethrough. The relief check valve cooperates with the valve unit in a manner to maintain the pressure differential across the tool substantially equal as the tool is brought out of the hole.

It is therefore a primary object of the present invention to provide a well clean-out tool which is actuated in response to movement of a wire line or a drill string to which the tool may be attached.

Another object of the present invention is the provision of an improved relief check valve assembly for a well clean-out tool.

A further object of the present invention is the provision of a well clean-out tool which is fabricated into a number of subcomponents which enables rapid assembly and disassembly thereof to expedite cleaning the tool after it has been used in removing debris from a well.

A still further object of the present invention is the provision of a well clean-out tool having means associated therewith which functions in a manner to improve the operation of the tool as well as to protect the various components of the tool from the high pressures associated with a deep well.

Another object of the present invention is the provision of a well clean-out tool having a combination jar and valve assembly associated therewith which can be actuated by a wire line.

A still further object of the present invention is the provision of a lost motion coupling which enables reciprocatory or longitudinal motion of a supporting means to upset a valve means, while at the same time it permits the supporting means to impart a jarring action into the tool.

The above objects are attained in accordance with the present invention by the provision of a well clean-out tool which is fabricated from a number of subcomponents to provide a junk catching section, a smaller section having a check valve interposed between the junk section and the main valve section, and a main valve section having a valve element therein which is upset to the open or closed position by the action of the wire line. The internal pressure of the tool is determined by a relief check valve element. The valve unit includes a lost-motion coupling located between the valve assembly and support means which enables a jarring action to be imparted into the tool by the wire line.

These and other objects of the invention are made possible by the provision of a well cleanout tool made in accordance with the above summary. Various other objects and advantages of this invention will become readily apparent to those skilled in the art upon reading the following detailed description and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general view of a well clean-out tool made in accordance with the present invention, with some parts thereof being broken away and removed in order to better illustrate in a general manner the entire device;

FIG. 2 is an enlarged, fragmentary, more detailed representation of a portion of the device seen in FIG. 1, with some parts thereof being broken away and removed so as to better disclose various details of the device, and other parts being broken away and shown in section in order to better describe the details thereof;

FIG. 3 is also an enlarged fragmentary representation of part of the device seen in FIG. 1, with some parts being broken away and shown in section in order to better illustrate the details thereof;

FIGS. 4 and 5, respectively, are enlarged cross-sectional views taken along lines 4—4 and 5—5, respectively, of FIG. 3;

FIGS. 6 and 7, respectively, are enlarged cross-sectional views taken along lines 6—6 and 7—7, respectively, of FIG. 8;

FIG. 8 is an enlarged part cross-sectional view of a part of the apparatus seen in FIG. 3; and

FIG. 9 is a fragmentary part cross-sectional view of part of the apparatus disclosed in FIGS 1 and 2.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 the arrow at numeral 10 generally illustrates an oil well tool made in accordance with the present invention. A swivel 11 attached at the upper extremity of the tool is connected to a wire rope, such as a sand line 12. Tubing can be substituted for the sand line if desired. The swivel supports several joints of tubing 13. Connected to the lower extremity of the tubing is a combination jar and valve section 14. Tubing 15, which can be of any length, can be interposed between the valve section and an orifice section 16. A relief check valve 17, which includes a reduced diameter tubing 18 having a resilient valve element 19 disposed thereabout, is arranged above tubing 20 which forms one of several chambers. A second jar 21 is optionally connected between chamber 20 and a junk section 22. As seen in FIG. 2, the junk section can take on several different forms but preferably is comprised of an enlarged tubing having a junk catcher 22' therein. The lower terminal end 24 forms an inlet into the tool.

Looking now to the details of FIGS. 2 and 3 in conjunction with all of the remaining figures, sub 25 is seen to be connected to the lower end of tubing 13 by means of threads 26. This sub includes threads 27 which engages a shaft 28 of the combination jar and valve actuator. The shaft is preferably of a length which will provide six to 18 inches in effective travel, with 12 inches being considered an optimum value.

Piston 29 is received within jar housing 30 and reciprocates within chamber 31. Downwardly depending from and forming an integral portion of the piston there is disposed a hollow valve actuating member 32.

The upper extremity of the jar section is provided with several radially spaced apart vertically disposed passageways 133. The side wall of cylinder 30 is provided with a multiplicity of radially spaced apart holes 233.

A sub assembly 34 has a stop member 36 and packing gland 37 associated therewith, and includes a central bore 39 for reciprocatingly receiving the lower depending end 38 of the hollow valve actuator.

Housing 40 is connected to the sub by means of threads 41. Valve stem 42 forms a Maltese Cross when viewed in cross-section, and has an end portion which actuates valve element 43. The valve element is free to reciprocate within chamber 44 and against spring 48. The reduced passageway 45 provides a shoulder against which the spring is compressed. Sub 46 reduces in diameter at 18 to form the before mentioned relief check valve, the details of which will be discussed later on.

Orifice 49 enables a controlled flow of fluid to occur into chamber 44. The details of the orifice and the valve unit are set forth in greater detail in my before mentioned issued patent.

Sub 50 is connected to tubing 51 and tubing 51 is connected to sub 52 by means of threads 53. Sub 52 has a chamber 54 therein which inwardly and downwardly converges to form a valve seat 55 which receives check valve element 56 thereon. The check valve is shown in the opened position, but it should be understood that the valve is normally closed. Chamber 57 is formed interiorally of member 58 with the last named member being threadedly connected to the lowermost jar by means of sub 60.

Sub 60 has a shaft rigidly affixed thereto which is reduced in diameter as seen at 61. The shaft is slidably received within member 62. Member 62 is connected to junk chamber 63.

Looking in detail now to FIGS. 4 and 5, the upper extremity of the jar is seen to be provided with radially spaced apart vertically disposed apertures 133 and radially spaced apart apertures 233 which communicate the internal upper portion of cylinder chamber 31 above piston 29 with the exterior of the tool. The valve actuator 28 is seen to be in a hexagon form, although other types of splined and unsplined connections could be substituted for this particular geometrical configuration.

Looking now to FIGS. 6, 7, and 8, the resilient check valve 17 is seen to be comprised of the before mentioned reduced diameter portion 18 which threadedly engages member 50 by means of the threaded connection at numeral 150. Member 50 is provided with a groove 64 which forms an inwardly directed boss at 65 and a lower shoulder 66 all of which cooperate with the resilient valve member 19 so as to effectively anchor the lower marginal end portion of the element to the inside peripheral wall surface of member 50. The element 19 terminates at 68 at a location which is spaced apart from apertures 118 so as to place the inside peripheral wall surface of the member in intimate contact with the apertures.

As seen in FIG. 9, in conjunction with FIG. 2, the lower jar 21 has the before mentioned shaft 61 which is slidably received within member 62. The shaft terminates in an enlargement 70 having an upper face 72, which abuts stop means 73. Apertures 74, 75, similar to the apertures of FIGS. 4 and 5, exhaust fluid from annulus 71 when the jar is actuated. Counterbore 69 reduces in diameter to form lower stop member 76 and flow communicates with passageway 77 and 78.

OPERATION

The well clean-out tool, when attached to support means such as the illustrated sand line of FIG. 1, can be run into a borehole when assembled in the manner of FIG. 1. For proper operation of the tool, it is necessary to have an appreciable hydrostatic head in the bottom of the well bore and for this reason it is sometime necessary to flow several barrels of water into the well prior to traveling downhole and actuating the tool in order to remove debris therefrom.

As the tool is submerged below the well fluid, a pressure differential occurs therebetween with fluid flow occurring inwardly of the tool. As the hydrostatic head of the tool increases, the liquid flows into the inlet 24, through passageway 78 of the lower jar, through the lower check valve 56, and into tubing 51 as the air within the tool is compressed. Fluid cannot flow past valve element 43 for the reason that the pressure differential across the valve maintains the face of the valve tightly adjacent to its seat. However, flow can occur from the interior of tubing 51 and through the resilient check valve 17 for the reason that fluid pressure effected at passageway 118 presses or urges the resilient member 19 outwardly away from the outer peripheral wall surface of member 18 so as to permit escape of compressed fluid from the interface near numeral 68.

The above described action fills the tool with clean well fluid as the tool descends through the liquid column toward the debris located on the bottom of the borehole. As inlet 24 strikes the bottom of the borehole, or a packer, the valve actuator 36 will telescope into chamber 39 and continue in a downward direction until the terminal end 38 abuts the upper terminal end of valve stem 42. This action causes the valve stem to move in a downward direction against valve spring 48 which unseats valve element 43 from the seat face thereby permitting fluid to flow into tubing 13, as is explained in my previously issued patent. The pressure differential between the bottom hole and the pipe forming chamber enables a surge of fluid along with debris contained therein to enter the inlet at 24 and flow past junk basket 22.

The well fluid and some of the junk flows through the check valve 56 and into the passageway provided within member 51. Junk consisting of large debris is caught and retained in the junk section or basket 22. The reduced diameter at 55 increases the velocity of fluid flow to cause smaller debris which failed to separate from the fluid to continue to flow along with the fluid into member 51 where some of the debris remains due to the presence of check valve 56, depending upon the size and density of the junk.

The still further reduced diameter passageway between members 40 and 51 impart additional velocity into the flow of fluid, with the fluid pressure differential being primarily regulated by the size of orifice 49.

The resilient relief check valve precludes flow of fluid from the innerface near 68 towards apertures 118 for the reason that the pressure differential thereacross now tends to firmly maintain the resilient member urged against the outside peripheral surface of member 18.

The fluid flowing into the chamber forming tubing 13 is the clean well fluid which heretofore was located below valve unit 43. As equilibrium is established across the unit, compressible fluid located at the upper extremity of the tool, that is adjacent the swivel, will be approximately equivalent to the hydrostatic head. As the fluid surges into tubing 13 a partial reversal in its travel will occur as a result of its momentum. This action causes check valve 56 to be moved to the closed position while valve element 43 of the valve unit is seated because of the presence of spring 48.

The rubber cylinder 19 of the resilient relief check valve is seated against apertures 118 with a force which is proportional to the tolerance given the respective surfaces as well as the inherent resilience of the rubber or rubber-like material. Accordingly, the maximum allowable pressure within chamber 54 is controlled by the relief check valve, and is proportional to the pressure differential across the tool. The primary purpose of the relief valve is to relieve the internal pressure of the tool as the tool is removed from the borehole and to fill the lower portion of the tool with clean well fluid. This is especially important in high pressure or deep wells. It should be noted that fluid trapped within tubing 51 cannot flow back past the lower check valve 56. However, fluid trapped within tubing 13 will upset valve element 43 and flow through the

resilient check valve 17 when the pressure differential across the valve 17 becomes great enough.

As the tool is removed from the borehole, the hydrostatic head of the well fluid continually decreases. This action causes the clean fluid from tubing 13 to flow past valve element 43, past the orifice and out of the tool by means of passageway 118. Accordingly, when the tool reaches the surface the internal pressure of the entire tool interior is essentially ambient and therefore the tool can be safely disassembled and serviced with no danger of injury from a high pressure fluid source.

When the tool is run into the hole on a sand line and actuated control of the tool depth is difficult because the line elongates sufficiently to permit the tool to decend into the debris where it becomes stuck in the well. When this occurs, the jar at 14 is cycled or reciprocated by cyclicly actuating the wire line drum above the ground. The impact of piston 29 against the massive upper stop member causes the tool to be driven out of the layer of debris, whereby the tool can then be returned to the surface and serviced.

It is important that the weight of the tool above jar 14 be approximately equal to the weight of the tool below the jar so as to advantageously take advantage of the relationship MV^2, that is, to provide sufficient force of impact by dividing the weight between the movable and the stuck portions of the tool. The use of tandem jars 14 and 21 have obvious advantages over a single jar when the weight distribution of the tool is considered.

I claim:

1. A well clean out tool having an inlet and an outlet; with the outlet being connected to a pipe forming chamber which is adapted to be supported by means such as a wire rope, comprising, in combination:

means forming a passageway through said tool with said passageway connecting the inlet to the outlet;

a combination jar and valve unit, a relief check valve, and a trap means, each spaced apart from one another and in communication with said passageway;

said jar and valve unit including a valve element and a valve stem, means by which said stem is connected to move said valve element; a valve seat assembly having a face thereon which cooperates with said element to permit fluid flow through said passageway when moved to a flow permitting position, and to normally prevent fluid flow when moved to a flow preventing position; said valve unit being disposed within said tool and near the outlet; said valve seat forming a portion of said passageway;

a valve actuator means, said actuator means adapted to move the valve stem to cause the valve element to move from the closed to the opened position, and vice versa, in accordance with the relative position of the support means with respect to the tool; said actuator having means forming a flow path therethrough which is a continuation of said passageway;

a jar means connected to said valve actuator means, said jar being in the form of a piston; a connecting rod, said piston being connected to said actuator and to said connecting rod; said connecting rod being affixed to said pipe forming chamber;

means forming a cylinder between said valve unit and said outlet, stop means defining the length of said cylinder, said piston being reciprocatingly received within said cylinder and adapted to be reciprocated between the limits of said stop means to thereby provide a jarring action; whereby:

the clean out tool can be set on bottom, thereby causing said valve unit to be moved to the opened position, and the clean out tool can be lifted to thereby cause a jarring action to occur.

2. The combination of claim 1 wherein said relief check valve is disposed between said jar and said trap means, said relief check valve includes a cylindrical rubber member, apertures formed in said tool and communicating the interior of the tool so as to enable outward flow therefrom, said rubber cylinder being slidably received about said apertures to thereby form the recited relief check valve.

3. The combination of claim 1 wherein said relief check valve includes a portion of the passageway which is disposed in underlying relationship with respect to said valve element;

said relief check valve being in the form of a sub-assembly which interconnects said valve assembly to said trap means;

said sub-assembly having a circumferentially extending bore defined by two spaced apart shoulders, means forming apertures through said sub-assembly for enabling flow of fluid from the interior of the tool with said apertures being spaced apart from said bore, said rubber cylinder having an inside peripheral wall surface which is slidably received over the apertured portion of said sub-assembly and further including an outwardly directed enlargement which is received within said bore.

4. The combination defined in claim 1 wherein said trap means includes a check valve located within said passageway and spaced apart from and below said relief check valve so as to enable flow of fluid and debris from said inlet toward said outlet while precluding flow of fluid in an opposite direction.

5. The combination of claim 4 and further including a junk basket spaced apart from said trap means to thereby provide a junk containing chamber between said junk basket and said trap means, a second debris containing chamber between said trap and said relief check valve, a third chamber between said relief check valve and the valve unit, and another chamber located in the upper extremity of the tool; each recited chamber forming a portion of said passageway.

6. The combination of claim 1 wherein said cylinder and said connecting rod are of a length which provides a range of between 6 to 18 inches of piston travel.

7. The combination of claim 1 and further including means forming a second jar which is interposed between said trap and said inlet.

8. The combination of claim 1 wherein said relief check valve is an elongated cylinder of rubber having means by which it is attached to a marginal length of the outside peripheral surface of the tool, means forming an aperture through a wall of the tool; said aperture being aligned with the inside peripheral surface of said cylinder of rubber.

9. The combination of claim 1, and further including means forming a passageway through a side wall of said tool near the upper stop means to enable fluid to flow outwardly from said cylinder as said piston is reciprocated in an upward direction.

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