A wellbore cleaning tool system includes a plurality of brushes and scrapers supported by or mounted to a casing body to clean an interior wall of a wellbore. The cleaning tool system includes selectively actuated high-velocity jet sprays to aid the cleaning of the interior wall of a wellbore by enhance the loosening and releasing of mud cake, oily residue, cement sheath, and pipe scale. The jet sprays also aid in the cleaning operation performed by and efficiency of the brushes and scrapers by spraying, loosening and releasing matter (mud cake, oily residue, cement sheath, and pipe scale) adhering to or sticking on the brushes and scrapers.
- Wash the Blow Out Preventer
- Wash the Wellhead Wear Bushing
- Wash the Liner Top
- Wash the Orifice Collar
- Wash the Casing I.D. Wall

FIG. 25
WELLBORE CLEANING TOOL SYSTEM AND METHOD OF USE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to tools for cleaning a wellbore and, more particularly, to a cleaning tool system that employs brushes, scrapers, and selectively actuated jets, with high-velocity jet sprays, matter from the interior wall of a wellbore.

[0003] 2. General Background

[0004] Cleaning a wellbore with scraping and brushing has been employed in the oil field drilling and exploration industry. The cleaning out of the wellbore is essential so, for example, the flow of drilling fluid to the annulus of the wellbore remains unobstructed between tool casings and the interior wall of the wellbore.

[0005] Drilling operations use drilling fluid (sometimes referred to as drilling fluid mud) that cakes onto the wellbore. The mud is very thick and may mix with any oil residue in the wellbore annulus. Pipe scale and cement sheath can also be found adhering to the wellbore casing or liner. When cleaning the unwanted mud cake from the wellbore, the scraped or brushed mud cake (having a natural tendency to stick and adhere to surfaces) can stick, adhere, and glob on surfaces of the scrapers and brushes. The scraping and brushing is performed by metal blades and steel bristles, respectively. The mud cake may coat the blades and steel bristles and build-up thereon such that the efficiency of the scraping and brushing is diminished.

[0006] Another of the disadvantages of known wellbore cleaning devices is the accumulation of round trip delays to journal the cleaning device down hole and to remove the cleaning device, such as each time the device needs cleaning, replacing broken parts, or before, during, and after drilling operations. The round-trip delay time extends the time to complete drilling operations which increases the cost of operations.

[0007] Furthermore, known wellbore cleaning devices require repeated cleaning of the brushes and scraper, thus adding additional round trip delays.

[0008] In view of the above, there is a continuing need for a wellbore cleaning tool system that employs wellbore cleaning devices and a convenient and cost-effective means for cleaning said devices and the interior wall surface of the wellbore while said devices remain in the wellbore.

[0009] In view of the above, there is a continuing need for a wellbore cleaning tool system that employs brushes, scrapers and a convenient and cost-effective means for cleaning the brushes, the scrapers and the interior wall surface of the wellbore while said brushes, scrapers remain in the wellbore.

[0010] In view of the above, there is a continuing need for a wellbore cleaning tool system that employs brushes, scrapers and selectively actuated high-velocity jet sprays wherein the jet sprays clean the brushes, the scrapers and the interior wall surface of the wellbore while said wellbore cleaning tool remains in the wellbore.

[0011] Another continuing need is for a wellbore cleaning tool system that can selectively actuate jet sprays without interrupting drilling operations.

[0012] A still further need is for a wellbore cleaning tool system that can selectively actuate jet sprays during drilling operations or while allowing a continuous flow of fluid to the bottom of the wellbore and/or drill string.

[0013] A still further need is to provide a wellbore cleaning tool and cleaning tool system that permits fewer trips in and out of the wellbore.

[0014] A still further need is to provide a wellbore cleaning tool and cleaning tool system that can, without removing the drill string from the wellbore, select between wellbore cleaning operations and wellbore drilling operations.

[0015] As will be seen more fully below, the present invention is substantially different in structure, methodology and approach from that of other cleaning tools.

SUMMARY OF THE PRESENT INVENTION

[0016] The preferred embodiment of wellbore cleaning tool apparatus of the present invention solves the aforementioned problems in a straightforward and simple manner.

[0017] The present invention contemplates a wellbore cleaning tool system for cleaning an interior surface of the wellbore comprising: a wellbore cleaning tool apparatus operable to clean a section in a wellbore with brushes, scrapers and selectively actuated high-velocity jet sprays and operable to continuously communicate fluid through a hollow center; and, a jet spray triggering tool apparatus having a jet spray triggering mechanism which is selectively operable to restrict a flow of the fluid in the jet spray triggering tool apparatus at a location below the wellbore cleaning tool apparatus wherein the restriction causes the fluid to take a path of least resistance to selectively turn on the high-velocity jet sprays while simultaneously permitting a limited amount of fluid to flow below the jet spray triggering tool apparatus.

[0018] An object of the present invention is to provide a wellbore cleaning tool system with high velocity jet sprays arranged in close proximity to the brushes and the scraper and being operable to clean off and release matter built-on or accumulated on any one brush or any one scraper wherein a limited amount of the fluid is operable to flow to a drill bit (whether or not said drill bit is drilling) in the wellbore when the high velocity jet sprays are on.

[0019] A further object of the present invention is to provide a wellbore cleaning tool system wherein the section being cleaned comprises one of many sections of a wellbore (for example, but not limited to, a blow-out preventer section, a wellhead wear bushing section, a liner top section, an orifice collar section or a wellbore casing wall section).

[0020] A still further object of the present invention is to provide a wellbore cleaning tool system with a jet spray triggering tool apparatus that comprises a casing body having a cradle therein; and, a ported bull seat operable to be cradled in said cradle and having a cylindrical structure with a hollow center, a seat area and a plurality of through holes formed in a wall of said cylindrical structure to permit said limited amount of the fluid to flow therethrough.
A still further object of the present invention is to provide a wellbore cleaning tool system wherein the jet spray triggering mechanism comprises a ball operable to be circulated through the wellbore cleaning tool apparatus to said seat area to restrict the flow of the fluid.

A still further object of the present invention is to provide a wellbore cleaning tool system wherein each of the high-velocity jet sprays comprise a spray head with at least one jet spray orifice; and, an internal check valve subassembly having a spring biased plunger to automatically seal close a fluid inlet port to said jet spray orifice wherein said restriction causes the fluid to take the path of least resistance which pushes said plunger from said fluid inlet port to selectively turn on the high-velocity jet spray through said at least one jet spray orifice.

A still further object of the present invention is to provide a wellbore cleaning tool system wherein the internal check valve subassembly is operable to shut off automatically said fluid inlet port when pressure in said wellbore exceeds pressure of the restricted fluid.

The present invention further contemplates a method of cleaning an interior surface of the wellbore comprising the steps of: communicating fluid down hole in a drill string in the wellbore; brushing matter from said interior surface while continuously communicating the fluid down hole in the wellbore; scraping said matter from said interior surface while continuously communicating the fluid down hole in the wellbore; and, selectively spraying via jet sprays said interior surface to clean, loosen and release said matter from the interior wall of the wellbore while continuously communicating the fluid down hole in the wellbore.

An object of the present invention is to provide a method for wellbore cleaning which, simultaneously, sprays brushes during the brushing step and sprays scrapers during the scraping step to loosen and release matter sticking on or adhering to or otherwise accumulating on said brushes and said scrapers.

An object of the present invention is to provide a method for wellbore cleaning which further comprises the step of: drilling in said wellbore during the communicating, brushing, scraping and spraying.

A still further object of the present invention is to provide a method for wellbore cleaning which floats in said wellbore, during the communicating, brushing, scraping and spraying steps, debris from a bottom of said wellbore.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that is centralized in a wellbore with top and bottom non-rotating stabilizers and is adapted to be fully rotational enabling long hours of rotating and reciprocation typically associated with drilling fluid exchange operations.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that provides a means for automatically cleaning the brushes and scrapers of any build-up or matter sticking or adhering to or otherwise accumulating on such brushes and scrapers.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that includes a safety shut-off for shutting off the jet sprays.

A still further object of the present invention is to provide a wellbore cleaning tool system that can stay in the wellbore longer.

A still further object of the present invention is to provide a wellbore cleaning tool system that requires less round-trips into and out of the wellbore during drilling operations.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that minimizes the number of moving parts.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that includes easily replaceable brushes and scrapers.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus designed for multi-use washing applications including, without limitation, washing the blowout preventer, washing the wellhead, washing the liner top, washing the orifice collar, washing the casing's inner diameter wall.

A still further object of the present invention is to provide a wellbore cleaning tool apparatus that employs an internal check valve subassembly and creates pressure differentials in the casing body of the tool apparatus to trigger the valve plunger to turn on the jets, such jets being essentially biased to a closed mode of operation.

In view of the above objects, it is a feature of the present invention to provide a wellbore cleaning tool system that is relatively simple structurally and easy to use.

Another feature of the present invention is to provide a wellbore cleaning tool system that is easy to install and that is selectively activated in a wellbore.

Another feature of the present invention is to provide a wellbore cleaning tool system that is selectively activated in a wellbore and permits drilling operations without removing the drill string or wellbore cleaning tool from the wellbore.

Another feature of the present invention is to provide a wellbore cleaning tool and wellbore cleaning system that is self-cleaning.

Another feature of the present invention is to provide a wellbore cleaning tool and wellbore cleaning system that cleans during drilling operations.

The above and other objects and features of the present invention will become apparent from the drawings, the description given herein, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

For a further understanding of the nature and objects of the present invention, reference should be had to the following description taken in conjunction with the accompanying drawings in which like parts are given like reference numerals and, wherein:

FIG. 1 illustrates a partially exploded view of the wellbore cleaning tool apparatus in accordance with the present invention;

FIG. 2 illustrates a cross-sectional view along the plane 2-2 of FIG. 1;
FIG. 3 illustrates a side view of the jet spray head of the wellbore cleaning tool apparatus of FIG. 1;

FIG. 4 illustrates a front view along the plane 4-4 of FIG. 3;

FIG. 5 illustrates a rear view along the plane 5-5 of FIG. 3;

FIG. 6 illustrates an end view along the plane 6-6 of FIG. 4;

FIG. 7 illustrates a perspective view of the jet spray head of FIG. 3;

FIG. 8 illustrates a side view of a valve seat;

FIG. 9 illustrates a front view of the valve seat of FIG. 8;

FIG. 10 illustrates a cross-sectional view along the plane 10-10 of FIG. 9;

FIG. 11 illustrates an exploded view of the jet spray assembly of the wellbore cleaning tool apparatus of FIG. 1;

FIG. 12 illustrates a cross-sectional view along the plane 12-12 of FIG. 1;

FIG. 13 illustrates an exploded view of a set of brushes and a set of scrapers;

FIG. 14 illustrates an exploded view of the wellbore cleaning tool system;

FIG. 15 illustrates a side view of the ported ball seat of the wellbore cleaning tool system of FIG. 14;

FIG. 16 illustrates a cross-sectional view along the plane 16-16 of FIG. 15;

FIG. 17 illustrates a top view of the ported ball seat along the plane 17-17 of FIG. 15;

FIG. 18 illustrates a ball for use with the ported ball seat;

FIG. 19 illustrates a perspective view of the ported ball seat of the wellbore cleaning tool system;

FIG. 20 illustrates a cross-sectional view of the jet triggering tool apparatus of the wellbore cleaning tool system of FIG. 14;

FIG. 21 illustrates a cross-sectional view along the plane 2-2 of FIG. 1 with the valve plunger in a closed position;

FIG. 22 illustrates a cross-sectional view of the jet triggering tool apparatus of FIG. 20 with the ball seated to trigger the jet spray assembly and with intermediate positions of the ball shown in phantom;

FIG. 23 illustrates a cross-sectional view along the plane 2-2 of FIG. 1 with the valve plunger in an open position as a result of the ball being seated as shown in FIG. 22;

FIG. 24 illustrates a diagram of a wellbore, drilling fluid pumping system, fluid flow and wellbore cleaning tool system outline for performing the method of cleaning in accordance with the present invention; and,

FIG. 25 illustrates a diagram of a wellbore.

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[0069] Referring now to the drawings and in particular FIGS. 1 and 14, the wellbore cleaning tool apparatus of the present invention will generally be referenced by the numeral 10 with the wellbore cleaning tool system being referenced by the numeral 100. The wellbore cleaning tool apparatus 10 includes, in general, a casing body 20 adapted to be centralized in the wellbore 5 (FIG. 24) via top and bottom stabilizers (NOT SHOWN), a plurality of sets of brushes 30a and 30b, a plurality of sets of scrapers 40a and 40b and a plurality of sets of jet spray assemblies 50a and 50b for high-velocity jet spraying of the interior wall of the wellbore 5 for an added cleanout effect. As will be seen from the description provided below, the high-velocity jet sprays also aid in cleaning the plurality of sets of brushes 30a and 30b and the plurality of sets of scrapers 40a and 40b during cleaning operations so that any build-up of the mud cake, cement sheath, etc., when being brushed or scraped from the interior wall, on the a plurality of sets of brushes 30a and 30b and the plurality of sets of scrapers 40a and 40b can be continuously sprayed or cleaned off and released to the fluid in the annulus of the wellbore 5.

[0070] The casing body 20 includes top and bottom ends 15a and 15b for connecting the apparatus 10 in the drill string 7 to other tools, devices, such as the stabilizers (NOT SHOWN) or more drill string 7. The top and bottom ends 15a and 15b, in the exemplary embodiment are shown as threaded. Thus, apparatus 10 may be directly connected to jet triggering assembly 80 (with apparatus 10 directly on top of jet triggering assembly 80 as shown in FIG. 14, in which case 207 does not represent drill string or any other element but is merely a drawing convention intended to show that apparatus 10 is connected (threaded) to jet triggering assembly 80 at threads 83a) or apparatus 10 may be directly connected to drill string 207 interposed between apparatus 10 and jet triggering assembly 80 (again, with apparatus 10 on top (but not directly on top due to the interposed drill string 207) as shown in FIG. 14). Also, a plurality of the apparatus 10 may be installed at various spots in a drill string yet only one jet triggering assembly 80 is required so long as the jet triggering assembly 80 is installed in the drill string below all of the plurality of apparatus 10.

[0071] Referring also to FIGS. 1, 2, 12 and 13, the plurality of sets of brushes 30a and 30b, the plurality of sets of scrapers 40a and 40b and the plurality of sets jet spray assemblies 50a and 50b are slid in, affixed to and embedded in, respectively, the casing body 20. The casing body 20 includes a cylindrically shaped structure dimensioned to be journalled down the annulus of wellbore 5 and has a linearly straight hollow center C for communicating fluid therethrough. The cylindrically shaped structure has first (top and bottom) sections 22 with a first wall thickness T1 and second (top and bottom) sections 24 with a second wall thickness T2 wherein the hollow center C maintains, essentially, the same diameter along the length of the casing body 20. The ends of the second sections 24 transitioning from or to the wall thickness T1 of the first sections 22 transition at a 45° angle.

[0072] The second sections 24 have a length of approximately 8.000 inches and a diameter of approximately 5.127 inches. The first sections 22 have a length of approximately 18.000 inches and a diameter of approximately 4.370 inches.
The diameter of the hollow center C is approximately 1.250 inches. In the second sections 24, the plurality of sets of jet spray assemblies 50a and 50b are embedded or recessed in a respective cavity 25 formed in the casing body 20.

[0073] The cylindrically shaped structure further includes third (top and bottom) sections 26 and a fourth section 28. The third sections 26 have a third wall thickness T3 smaller than the first wall thickness T1. The top third section 26 is positioned immediately adjacent the top end of the fourth section 28. The bottom third section 26 is positioned immediately adjacent the bottom end of the fourth section 28. The third section 26 has a diameter of 3.120 inches.

[0074] Since each set of brushes 30a and 30b are identical, only one such set of brushes will be described in detail. The set of brushes 30a includes a plurality of brush units 32a, 32b, 32c and 32d where each brush unit is essentially identical. Thus, only one such brush unit 32a will be described in detail. Brush unit 32a includes an array 35 of bristle clusters 37a, 37b, 37c, 37d, 37e and 37f. The brush unit 32a further includes a brush chassis 33 with a plurality of holes 34 formed therein, where each hole 34 receives a respective one of the bristle clusters 37a, 37b, 37c, 37d, 37e and 37f. Each bristle cluster includes a band 39 which bundles together the bristle cluster and is secured or secured in hole 34. The brush chassis 33 includes a guide or flange 36 projecting laterally from the side of the brush chassis 33. In the exemplary embodiment, the longitudinal length of slots 42 are angled, arched or curved. Furthermore, in the preferred embodiment, a plurality of brush units 32a, 32b, 32c and 32d when installed form a 45° left hand brush array 35 and are contoured to fit in the annulus of the interior wall of the wellbore 5 without bending or crushing of the bristles of the bristle clusters 37a, 37b, 37c, 37d, 37e and 37f. In the exemplary embodiment, the bristles of the bristle clusters are made of steel or other durable metal.

[0075] The set of brushes 30b are identical to the set of brushes 30a. However, slot 42 is oriented to curve in a right handed counterclockwise direction. On the other hand, slot 42 is oriented to curve in a left handed clockwise direction. Hence, the set of brushes 30b are installed to create a 45° right hand brush array 35.

[0076] Returning again to the casing body 20, in a top end of the fourth section 28, a top set of slots 42 are formed therein for installation of the set of brushes 30a around the circumferential perimeter of the fourth section 28. In the bottom end of the fourth section 28, a second set of slots 42 are formed therein. The second set of slots 42 receive the set of brushes 30b. The top end of the fourth section 28 has a top edge 29a while the bottom end has a bottom edge 29b. Moreover, the opening of each slot 42 is along the top edge 29a while the opening of each slot 42 is along the bottom edge 29b.

[0077] The slot 42 is contoured to track the shape of the brush chassis 33 and includes a recessed groove 43. The recessed groove 43 receives and mates with the guide or flange 36. Thereby, the brush chassis 33 is cradled in the slot 42 and does not fall through the slot 42.

[0078] When assembling or replacing one or more of the brush units 32a, 32b, 32c and 32d, the brush chassis 33 can be easily slid in and out of its respective slot 42 via the opening. As will be seen from the description provided below, in the exemplary embodiment, the brush units 32a, 32b, 32c and 32d of the set of brushes 30a are locked into their respective slot 42 via the brush collar 45 of the set of scrapers 40a clamped to the top third section 26. Likewise, the brush units of the set of brushes 30b are locked into their respective slot 42 via the brush collar 45 of the set of scrapers 40b.

[0079] Referring still to FIGS. 12 and 13, since each set of scrapers 40a and 40b are identical, only one such set of scrapers 40a will be described in detail. The set of scrapers 40a includes a two-piece bracelet collar 45 having integrated thereon an array of circumferentially spaced blade units 44a, 44b, 44c, 44d and 44e. The two-piece bracelet collar 45 clamps together the spaced-apart blade units 44a, 44b, 44c, 44d and 44e around the top third section 26. Likewise, the set of scrapers 40b are clamped circumferentially around the bottom third section 26.

[0080] The bracelet collar 45 includes two separate semi-circular sections 46a and 46b. The bracelet collar 45 when secured or fastened together has an inner circumference that tracks the outer circumference of the third section 26 of the casing body 20. The two semi-circular sections 46a and 46b includes first and second (right and left) aligned hole sets 47a and 47b intended to receive fasteners 48a and 48b, respectively, such as a screw or bolt, to fasten or clamp together the two semi-circular sections 46a and 46b. Loosening and removing the fasteners 48a and 48b allow the set of scrapers 40a to be removed and/or replaced when worn or damaged. The length of the bracelet collar 45 extends from the second section 24 to the top edge 29a of the fourth section. In view of the foregoing, fastening or clamping the bracelet collar 45 locks the brush units 32a, 32b, 32c and 32d of the set of brushes 30a by closing the opening to slot 42 and serves as a retaining cap to maintain the brush units 32a, 32b, 32c and 32d in their respective (angled) slot 42.

[0081] In the preferred embodiment, the scrapers are not spring loaded. Standard scrapers used in the industry often use spring loaded scrapers; and, spring loaded scrapers could be used with this tool 10.

[0082] Referring now to FIGS. 2-11, the sets of jet spray assemblies 50a and 50b will now be described in detail. However, since each of the jet spray assembly of the set 50a and the set 50b is identical, only one such jet spray assembly 50a will be described. The jet spray assembly 50a comprises a spray head 51 having two jet spray orifices 52a and 52b and an internal check valve subassembly 60. The spray head 51 includes two (top and bottom) recessed holes 54a and 54b adapted to receive fasteners 56a and 56b, respectively. The fasteners 56a and 56b are screws or bolts with heads that are adapted to be recessed in the holes 54a and 54b. In the exemplary embodiment, the spray head 51 has rearwardly projecting guide prongs 58 intended to align with holes formed in a valve seat 62, nestled in the second section 24 behind the spray head 51. The spray head 51 further includes a center aperture 59 between the two jet spray orifices 52a and 52b.

[0083] The internal check valve subassembly 60 includes the valve seat 62 having a front side mated with the spray head 51 and a back side dimensioned to be seated in the cavity 25 in the second section 24. The back side has a fluid inlet port 64 has a coupler 64a adapted with a recessed
groove 66 for receipt of an O-ring 68. The front side of the valve seat 62 has an elongated opening 70 with a gasket 72 placed between the spray head 51 and such front side. The center axis of the elongated opening 70 is aligned with the center axis of the fluid inlet port 64. The center axis of the fluid inlet port 64 is also aligned with the center aperture 59. The fluid inlet port 64 is aligned with a fluid exchange port in the casing body 20 (section 24). The fluid inlet port 64 is shown as one with the fluid exchange port which is not separately numbered.

[0084] The internal check valve subassembly 60 further comprises a valve plunger 74 having a plunger head 75 and a plunger shaft 76. The valve plunger 74 is spring biased to a closed position (FIGS. 2 and 21) via spring 78 wound around plunger shaft 76 and presses against the surface around the center aperture 59. The plunger shaft 76 is adapted to be received in the center aperture 59. The valve plunger head 75 is generally shaped as a pyramid. The apex of the pyramid when in the closed position is received in the fluid inlet port 64 such that fluid flowing in the hollow center of the casing body 20 is prevented from passing out of the fluid inlet port 64 and into the valve seat 62. The internal check valve subassembly 60 will remain closed so that the jet spray orifices 52a and 52b will remain closed, as well.

[0085] In the preferred embodiment, a first set of jet spray assemblies 50a are embedded in the casing body 20 at a location above the set of brushes 30a and the set of scrapers 40b. In the exemplary embodiment, the first set of jet spray assemblies 50a includes two jet spray assemblies 50a spaced 1800 from the other. On the other hand, the second set of jet spray assemblies 50b are embedded in the casing body 20 at a location below the set of brushes 30b and the set of scrapers 40b. In the exemplary embodiment, the second set of jet spray assemblies 50b includes two jet spray assemblies 50b spaced 1800 from the other. However, the second set of jet spray assemblies 50b are offset from the first set of jet spray assemblies 50a by 90°. Thus, the plurality of sets of jet spray assemblies 50a and 50b project high velocity jet sprays from the casing body 20 at an angle (30°), 90°, 180°, and 270°. As can be appreciated, additional jet spray assemblies may be included.

[0086] When moving from drilling to completion, the wellbore 5 needs to be cleaned. Generally, jets are placed on every tool body for each transition. However, this becomes a problem when going down hole.

[0087] Referring now to FIG. 14, the wellbore cleaning tool system 100 is shown. The system 100 includes the wellbore cleaning tool apparatus 10 and the jet triggering assembly 80 coupled at a location in the drill string 7 below the wellbore cleaning tool apparatus 10. In the embodiment of FIG. 14, the jet triggering tool apparatus 80 is preferably positioned anywhere along the drill string 7 below the wellbore cleaning tool apparatus 10 but before the drill bit 110. In operation, the jet triggering tool apparatus 80 is constructed and arranged to selectively trigger the opening or closing of the internal check valve subassembly 60 which turns the high-velocity jet sprays ON or OFF, respectively. In FIG. 23, the internal check valve subassembly 60 is open to permit the flow of fluid through the fluid inlet port 64 (and, it is open due to the ball 105 being seated in the jet triggering assembly 80 as shown in FIG. 22) and the back pressure created thereby when fluid flows in C in the direction shown in FIG. 23). In FIG. 21, the internal check valve subassembly 60 is closed to stop the flow of fluid through the fluid inlet port 64 (and it is closed as the ball 105 is not seated in the jet triggering assembly 80 as shown in FIG. 20).

[0088] Referring now to FIGS. 15-20, the jet triggering tool apparatus 80 comprises casing body 82 having a hollow center C adapted to allow fluid to flow therethrough down to the drill bit 110 before, during and after cleaning operations. In other words, the jet triggering tool apparatus 80 is constructed and arranged to allow for a continuous flow of fluid to the drill bit 110 or other tools located down stream, as needed. The casing body 82 (for illustrative purposes) is shown to have a top-end coupler 83a which is threaded, as shown in the cut-away portion, in a manner to mate with the bottom end coupler 15b of the wellbore cleaning tool apparatus 10 or the bottom end coupler of any interposed drill string. Below the top-end coupler 83a, the casing body 82 has a cradle 85 formed therein for receipt of a portal ball seat 90. The casing body 82 (for illustrative purposes) is shown to have a bottom-end coupler 83b which is threaded, as shown in the cut-away portion, for attachment of another tool. In the example, the drill bit 110 is shown immediately below the casing body 82 or more drill string 7.

[0089] The ported ball seat 90 provides a means for triggering the internal check valve subassembly 60 from the first mode of operation to the second mode of operation when ball 105 is seated therein, as best seen in FIG. 22. The ported ball seat 90 includes a cylindrical structure 94 having a hollow center C2 formed in the center of its longitudinal length or axis. The ball 105 may be a float Baker-Lite ball. The cylindrical structure 94 has a plurality of circumferential grooves 94a formed therein. The plurality of circumferential grooves 94a receive O-rings 99 (FIG. 22).

[0090] The top end inner diameter ID1 of the hollow center C2 gradually tapers at approximately 30° from 2.062 to 0.9375 inches. Thereafter, the inner diameter ID2 of the hollow center C2 is the same (0.9375 inches) until a predetermined distance D1 from the bottom end. At the bottom end, the inner diameter slopes approximately 45° for slightly less than 0.2000 of an inch from 0.9375 to approximately 0.7500 inches. The bottom end inner diameter ID3 is approximately 0.7500 inches. The gradually tapering inner diameter provides a ball seat area 96 for seating the ball 105 therein, as best seen in FIG. 22. The length of the cylindrical structure 94 is approximately 5.000 inches and the outer diameter OD is approximately 2.406 inches.

[0091] Additionally, the wall structure of the cylindrical structure 94 has formed therein a plurality of spaced apart through holes 98 each having a longitudinal axis that is parallel with the longitudinal axis of the cylindrical structure 94. The through holes 98 extend from the top end to the bottom end of the cylindrical structure 94 and permit the flow of fluid in the hollow center C to flow therethrough. The through holes 98 are spaced apart approximately 45° with a diameter of 0.2500 to 0.2450 inches. In the preferred embodiment, the inner diameter of the through holes 98 is significantly smaller than the inner diameter ID of hollow center C2.

[0092] In the exemplary embodiment, there are eight (8) through holes 98 which are constructed and arranged to
permit a sufficient amount of drilling fluid to flow though the ported ball seat 90 down to drill bit 110 such as during drilling operations. Therefore, the wellbore cleaning tool apparatus 10 does not need to be removed. Hence, any delays for trips in and out of the wellbore to install or de-install the wellbore cleaning tool apparatus 10 is effectively eliminated. Moreover, the amount of fluid flowing downstream through the through holes 98 can be controlled by closing one or more of the through holes 98 before installing system 100 down hole.

[0093] The jet triggering tool apparatus 80 may include a float valve (NOT SHOWN) directly below the ported ball seat 90 to allow for reverse circulating.

[0094] The operation of the internal check valve subassembly 60 in combination with the jet triggering tool apparatus 80 will now be described.

[0095] In a first mode of operation, the internal check valve subassembly 60 is closed as best seen in FIGS. 2 and 21. The bias spring force exerted by the spring 78 biases the apex of the pyramid of the plunger head 75 in the fluid inlet port 64 such that fluid flowing in the hollow center C of the casing body 20 is prevented from passing out of the fluid inlet port 64 and into the valve seat 62. Thereby, the internal check valve subassembly 60 is closed and the high velocity jet sprays through orifices 52a and 52b are OFF. The first mode of operation maintains the jet sprays OFF.

[0096] It should be noted, the spring biasing force is stronger than a first predetermined PSI (pressure per square inch) in the hollow center C of casing body 20. Thereby, fluid flowing in the casing body 20 is not squirted, jetted, streamed or sprayed out through the orifices 52a and 52b until the pressure in the hollow center C exceeds the first predetermined PSI. In this mode, the ball 105 is not seated in ported ball seat 90 of the jet triggering tool apparatus 80.

[0097] In a second mode of operation, once the first predetermined PSI is exceeded, the fluid in the hollow center C exerts a sufficient counter force to push (trigger the transition of) the plunger head 75 out of the fluid inlet port 64 such that some fluid flowing in the hollow center C of the casing body 20 flows from the fluid inlet port 64 and into the valve seat 62. Thereby, the internal check valve subassembly 60 is open and the high velocity jet sprays through the orifices 52a and 52b are ON.

[0098] The PSI in the hollow center C is increased above the first PSI by floating ball 105 down casing body 20 to the jet triggering tool apparatus 80 such that ball 105 is seated in the ball seat area 96. When the ball is seated in the ball seat area 96, a restriction is created causing some of the fluid to take the path of least resistance through the internal check valve subassembly 60 (noting that some of the fluid can still flow through holes 98). The internal check valve subassembly 60 remains ON until the pressure in the annulus of wellbore 5 is greater than the second predetermined PSI or the pressure in the casing body 20 is below the second predetermined PSI whereby the spring biasing force closes the fluid inlet port 64 with the plunger head 75.

[0099] In the second mode, fluid from the center C of casing body 20 is squirted, jetted, streamed or sprayed out at a high velocity through the orifices 52a and 52b. For example, upon completion of the jetting application, the ball 105 may be extracted by reverse circulation. Thus, the high-velocity jet sprays are selectively turned OFF. The ball 105 serves as the jet spray triggering mechanism to restrict the fluid flow to turn the sprays ON and to un-restrict the fluid flow to turn the sprays OFF.

[0100] In a third mode of operation, if the second predetermined PSI in hollow center C is exceeded in the annulus of the wellbore 5, the internal check valve subassembly 60 is constructed and arranged to immediately shut OFF by exerting pressure though the center aperture 59 on plunger shaft 76. The valve plunger 74 is thereby pushed (triggering the transition of) the plunger head 75 to a closed position (FIGS. 2 and 21). The apex of the pyramid when in the closed position is received in the fluid inlet port 64. However, in the third mode of operation, fluid in the annulus of the wellbore 5 is prevented from reaching in the hollow center C. The third mode of operation is a safety shut-off feature to prevent a reversed flow of the jet stream.

[0101] If all internal check valve subassembly 60 are constructed and arranged to trigger or transition between modes on the same first predetermined PSI and second predetermined PSI, then all jet sprays would be effectively turned on and off essentially simultaneously with a single jet spray triggering mechanism (ball 105).

[0102] In view of the foregoing, the design described above can be varied. For example, the spring 78 can be replaced by removing the spray head 51. Therefore, the strength of the spring 78 can be varied, as needed for different wellbore 5 characteristics, to increase or decrease the biasing force proportionately to at least the first predetermined PSI. The number and size of the through holes 98 may also be varied.

[0103] The number and size of jet spray orifices 52a and 52b in the spray head 51 may be varied. Furthermore, the casing bodies 20 and 82 may be varied by changing the scheduled pipe size. In most applications, a 9/16 inch schedule pipe and a 7 inch schedule pipe will be used.

Cleaning Operations

[0104] Referring now to FIG. 24, the wellbore 5 (through which drilling operations occur) includes a plurality of sections wherein the top section is a riser section 6a which in turn is followed by a blow-out preventer section 6b. The blow-out preventer (BOP) section 6b is followed by an intermediate casing 6c which in turn is followed by a casing liner 6d.

[0105] The wellbore cleaning tool system 100 brings a third dimension of cleaning to scraping and brushing when cleaning out the wellbore 5 including below the blow-out preventer 6b or 8b. The wellbore cleaning tool apparatus 10 is effective in removing mud cake, oily residue, cement sheath, and pipe scale (hereinafter referred to as “matter”). The wellbore cleaning tool apparatus 10 is designed to provide superior contact at all angles of inclination and may be oriented pin-up or pin-down. Furthermore, the wellbore cleaning tool apparatus 10 is fully rotational and centralized by non-rotating top and bottom stabilizers (NOT SHOWN) to protect the wellbore from wear and enabling long hours of rotating and reciprocation typically associated with drilling fluid exchange operations.

[0106] During normal drilling operations, the drilling fluid path 120 is shown. Drilling fluid from fluid tank 122 is
pumped via pump source 124 using pump gauges 126, in the direction of ARROWS A, down the wellbore 5 through a preliminary length of drill string 7 to the wellbore cleaning tool system 100. At the wellbore cleaning tool system 100, the fluid further flows down the hollow center C, through center C of the jet triggering tool apparatus 80 (with the ported ball seat 90), then out of the drill bit 110 and up the annulus of the wellbore 5, in the direction of ARROWS B, without any restrictions. In general, the fluid is pumped by the pump source 100 such that, at the wellbore cleaning tool apparatus 10, the PSI is below the first predetermined PSI. During the normal drilling operation, the internal check valve subassembly 60 will remain closed so that the jet spray orifices 52a and 52b are OFF.

[0107] The fluid flowing in the direction of ARROWS B is recycled by circulating the fluid, in the direction of ARROWS C, out through the annulus of the wellbore 5 through shale shakers 128 and a filter unit 130. The fluid flowing through the filter unit 130 is sent back to the fluid tank 122 where it is stored until recycled.

[0108] As can be seen readily, the wellbore cleaning tool system 100 does not interrupt or restrict the flow of the drilling fluid during normal operations. Thus, one (or more) ofwell bore cleaning tool 10 of the wellbore cleaning tool system 100 can be installed in the wellbore 5 until needed.

[0109] The drilling fluid path described herein in relation to FIG. 24 is for illustrative purposes only. The production of drill fluid and the circulation thereof has been well established in the oil field exploration industry and does not require further explanation. In FIG. 25 another wellbore arrangement is shown. The wellbore 5' includes a riser section 8a followed by a blow-out preventer (BOP) section 8b. The blow-out preventer (BOP) section 8b is followed by a wellhead wear bushing 8c where the inner diameter of the wellbore decreases immediately below the bushing 8c. The section below the wellhead wear bushing 8c terminates at a liner top 8d. The liner top 8d is followed by a section of casing wall 8e having a inner diameter smaller than the liner top 8d. The casing wall 8e has an orifice collar 8f. In operation, the system 100 is operable to clean and wash one or more of the BOP section 8b, the wellhead wear bushing 8c, the liner top 8d, the orifice collar 8f and casing wall 8e while allowing fluid to continuously flow all the way to the end of the drill string or bottom of the wellbore 5.

[0110] Cleaning of the wellbore 5 with scraping and brushing can take place essentially continuously during drilling operations since system 100 can be installed anywhere on the drill string above the drill bit 110. Accordingly, two-dimensional cleaning, via brushing and scraping, can take place continuously. The continuous flow of fluid floats removed (brushed and/or scraped) debris to the top of the wellbore 5. Even if not drilling, the cleaning operations can take place in the wellbore 5 with the benefits of the drilling fluid recirculated up the annulus to assist in washing the “matter” being knocked off of the scrapers, brushes and inner wellbore 5.

[0111] To add the third dimension of cleaning, high-velocity jet sprays through orifices 52a and 52b are turned ON. To turn the high-velocity jet sprays ON, the ball 105 is pumped down, in the direction of ARROWS A, with the fluid flowing through the hollow center C of the casing body 20 to ported ball seat 90. Since the ball 105 has an OD greater than the ID of the ball seat area 96, the ball 105 is seated or cradled in the recessed area of the ball seat area 96 restricting or sealing off the flow of fluid through hollow center C. The restriction causes some of the fluid to take the path of least resistance which is through the internal check valve subassembly 60 and the jet spray orifices 52a and 52b as the force (PSI) exerted by the fluid is stronger than spring 78 (again, noting that some of the fluid can flow through the holes 98). Thereby, plunger head 75 is moved out of the fluid inlet port 64, which then becomes open. As can be appreciated, the restriction increases the PSI of the fluid flowing in hollow center C above the first predetermined PSI, thereby triggering the transition from the first mode to the second mode.

[0112] In the preferred embodiment, limited fluid flow through the ported ball seat 90 via the plurality of spaced apart through holes 98 to the drill bit 110 is permitted after the ball 105 has been seated in the ball seat area 96. The application of the ball 105 seated in ball seat area 96 and the fluid being re-directed through the jets spray orifices 52a and 52b is observed remotely by the operator via pump gauges 126. Flow rates are established before the ball 105 is pumped down to the ported ball seat 90. After the ball 105 is pumped down the same flow rate will be used. An increase in fluid pressure (PSI) occurs when the ball 105 is seated in the ported ball seat 90.

[0113] In the preferred embodiment, no more than 20 bbls. per minute and no more than 3000 PSI is applied.

[0114] During cleanout operations, the wellbore cleaning tool apparatus 10 brushes via the sets of brushes 30a and 30b and scrapes via the sets of scrapers 40a and 40b the “matter” on the interior wall of the wellbore 5. Thereby, “matter” may buildup or stick on the brushes and scrapers. The third dimension of cleaning by the jet spray orifices 52a and 52b to produce high-velocity jet sprays loosens and clean “matter” on the interior wall and on the sets of brushes 30a and 30b and the sets of scrapers 40a and 40b.

[0115] Upon completion of the cleanout operations, the ball 105 is extracted from the ported ball seat 90. The ball extraction takes place by reverse circulating the ball 105 up the tool apparatus 10 and casing 7. Alternately, the ball 105 can be extracted by allowing the ball 105 to float up the tool apparatus 10 and drill string 7 when a float valve (NOT SHOWN) is used in the tool apparatus 10 which will not allow for reverse circulation.

[0116] While not wishing to be bound by theory, a ball 105 of 0.875 is pumped down at approximately 11 feet per second as per pumping 10 bbls. minute. Once the ball 105 is seated, approximately two-thirds of the fluid will still flow through the through holes 98 down to the drill bit 110 allowing for debris to be pushed up the annulus from the bottom of the wellbore 5 or drill bit 10. The projected restriction in the fluid is approximately 5 ft. per second as per pumping bbls. minute.

[0117] Because many varying and differing embodiments may be made within the scope of the inventive concept herein taught and because many modifications may be made in the embodiment herein detailed in accordance with the descriptive requirement of the law, it is to be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.
What is claimed as invention is:

1. A wellbore cleaning tool system for cleaning an interior surface of the wellbore comprising:
   a wellbore cleaning tool apparatus operable to clean a section in a wellbore with brushes, scrapers and selectively actuated high-velocity jet sprays and operable to continuously communicate fluid through a hollow center; and,
   a jet spray triggering tool apparatus having a jet spray triggering mechanism which is selectively operable to restrict a flow of the fluid in the jet spray triggering tool apparatus to a location below the wellbore cleaning tool apparatus wherein the restriction causes the fluid to take a path of least resistance to selectively turn on the high-velocity jet sprays while simultaneously permitting a limited amount of fluid to flow below the jet spray triggering tool apparatus.

2. The system of claim 1, wherein the high velocity jet sprays are arranged in close proximity to the brushes and the scraper and being operable to clean off and release matter built-on any one brush or any on scraper.

3. The system of claim 1, wherein the limited amount of the fluid is operable to flow to a drill bit drilling in the wellbore when the high velocity jet sprays are on.

4. The system of claim 1, wherein the section being cleaned comprises one of a blow-out preventer section, a wellhead wear bushing section, a liner top section, an orifice collar section and wellbore casing wall section.

5. The system of claim 1, wherein the wellbore cleaning tool apparatus comprises a casing body having a string of sections, said string of sections comprises:
   a top first section;
   a top second section, coupled to said top first section, with a first set of said high-velocity jet sprays installed therein, the top second section includes fluid exchange ports;
   a top third section, coupled to said top second section, with a first set of said scrapers affixed thereto;
   a fourth section, coupled to said top third section, with top and bottom sets of said brushes installed;
   a bottom third section, coupled to said fourth section, with a second set of said scrapers affixed thereto;
   a bottom second section, coupled to said bottom third section, with a second set of said high-velocity jet sprays installed therein; and,
   a bottom first section, coupled to said bottom second section.

6. The system of claim 1, wherein the jet spray triggering tool apparatus comprises:
   a casing body having a cradle therein; and,
   a ported ball seat operable to be cradled in said cradle and having a cylindrical structure with a hollow center, a seat area and a plurality of through holes formed in a wall of said cylindrically structure to permit said limited amount of the fluid to flow therethrough wherein said jet spray triggering mechanism comprises a ball operable to be circulated through the wellbore cleaning tool apparatus to said seat area to restrict the flow of the fluid.

7. The system of claim 1, wherein each of said high-velocity jet sprays comprise:
   a spray head with at least one of jet spray orifice; and,
   an internal check valve subassembly having a spring biased plunger to automatically seal close a fluid inlet port to said jet spray orifice wherein said restriction causes the fluid to take the path of least resistance which pushes said plunger from said fluid inlet port to selectively turn on the high-velocity jet spray through said at least one jet spray orifice.

8. The system of claim 7, wherein the internal check valve subassembly is operable to shut off automatically said fluid inlet port when pressure in said wellbore exceed pressure of the restricted fluid.

9. A wellbore cleaning tool system for cleaning an interior surface of the wellbore comprising:
   means for brushing and scraping said interior surface while continuously communicating the fluid down the wellbore
   means for selectively spraying said interior surface while continuously communicating the fluid down the wellbore; and,
   means for triggering said spraying means by restricting a flow of the fluid in the at a location below the brushing and scraping means and said spraying means wherein the restriction causes the fluid to take a path of least resistance to selectively turn on the spraying means while simultaneously permitting a limited amount of fluid to flow below and down the wellbore.

10. The system of claim 9, wherein the spraying means is arranged in close proximity to the brushing and scraping means for cleaning off and releasing matter built-on the brushing and scraping means.

11. The system of claim 9, wherein the limited amount of the fluid is operable to flow to a drill bit drilling in the wellbore when the spraying means are on.

12. The system of claim 9, wherein the interior surface being cleaned comprises one of a blow-out preventer section, a wellhead wear bushing section, a liner top section, an orifice collar section and wellbore casing wall section.

13. The system of claim 9, wherein the brushing and scraping means and the spraying means are integrated in a wellbore cleaning tool apparatus comprising:
   a casing body having a string of sections, said string of sections comprises:
   a top first section;
   a top second section, coupled to said top first section, with a first set of sprays of said spraying means installed therein, the top second section includes fluid exchange ports;
   a top third section, coupled to said top second section, with a first set of scrapers affixed thereto;
   a fourth section, coupled to said top third section, with top and bottom sets of said brushes installed;
   a bottom third section, coupled to said fourth section, with a second set of said scrapers affixed thereto;
   a bottom second section, coupled to said bottom third section, with a second set of high-velocity jet sprays installed therein; and,
   a bottom first section, coupled to said bottom second section.
a bottom second section, coupled to said bottom third section, with a second set of said high-velocity jet sprays installed therein of said spraying means; and, a bottom first section, coupled to said bottom second section.

14. The system of claim 9, wherein the spray triggering means comprises:

a casing body having a cradle therein;
a ball; and,
a ported ball seat operable to be cradled in said cradle and having a cylindrical structure with a hollow center, a seat area and a plurality of through holes formed in a wall of said cylindrical structure to permit said limited amount of the fluid to flow therethrough wherein the ball is operable to be circulated through to said seat area to restrict the flow of the fluid.

15. The system of claim 9, wherein spray means comprises:

a spray head with at least one of jet spray orifice; and,
an internal check valve subassembly having a spring biased plunger to automatically seal close a fluid inlet port to said jet spray orifice wherein said restriction causes the fluid to take the path of least resistance which pushes said plunger from said fluid inlet port to selectively turn on the high-velocity jet spray through said at least one jet spray orifice.

16. The system of claim 15, wherein internal check valve subassembly is operable to shut off automatically said fluid inlet port when pressure in said wellbore exceed pressure of the restricted fluid.

17. A method of cleaning an interior surface of the wellbore comprising the steps of:

communicating fluid down hole in a drill string in the wellbore;
brushing matter from said interior surface while continuously communicating the fluid down hole in the wellbore;
scraping said matter from said interior surface while continuously communicating the fluid down hole in the wellbore; and,
selectively spraying via sprays said interior surface to clean, loosen and release said matter from the interior wall of the wellbore while continuously communicating the fluid down hole in the wellbore.

18. The method of claim 17, further comprising the step of:
simultaneously, spraying brushes during the brushing step and spraying scrapers during the scraping step to loosen and release matter sticking on or adhering to said brushes and said scrapers.

19. The method of claim 17, further comprising the step of:
drilling in said wellbore during the communicating, brushing, scraping and spraying steps.

20. The method of claim 17, further comprising the step of:

floating in said wellbore, during the communicating, brushing, scraping and spraying steps, debris from a bottom of said wellbore.

21. The method of claim 17, further comprising the steps of:

floating a ball down hole to restrict a portion of said fluid; and,
increasing pressure in said drill string to turn on said sprays on.

22. The method of claim 17, further comprising the step of:

automatically turning off said sprays when pressure in said wellbore is greater than said pressure in said drill string.

23. The method of claim 17, further comprising the step of:

floating in said wellbore, during the communicating, brushing and scraping steps, debris from a bottom of said wellbore.

24. A wellbore cleaning tool apparatus for cleaning an interior surface of the wellbore comprising:
a casing body adapted to be centralized in the wellbore;
a plurality of brushes coupled to said casing body for brushing matter from said interior surface;
a plurality of scrapers coupled to said casing body for scraping said matter from said interior surface; and,
a plurality of jet spray assemblies, coupled in said casing body, for selectively emitting jet sprays from jet orifices to clean, loosen and release said matter from the interior wall of the wellbore and said plurality brushes and said plurality of scrapers.

25. The apparatus of claim 24, wherein the jet sprays are high-velocity jet sprays which are selectively actuated and arranged in close proximity to the plurality of brushes and the plurality of scraper to clean off and release matter built-on any one brush of said plurality of brushes or any one scraper of said plurality of scrapers.

26. The apparatus of claim 24, wherein said casing body includes a string of sections, said string of sections comprises:
a top first section;
a top second section, coupled to said top first section, with a first set of said jet orifices;
a top third section, coupled to said top second section, with a first array of said plurality of scrapers;
a fourth section, coupled to said top third section, with a set of said plurality of brushes;
a bottom third section, coupled to said fourth section, with a second array of said plurality of scrapers;
a bottom second section, coupled to said bottom third section, with a second set of said jet orifices; and,
a bottom first section, coupled to said bottom second section.
27. The system of claim 24, wherein each of jet spray assembly comprises:

a spray head with at least one of jet spray orifice; and,

an internal check valve subassembly having a spring biased plunger to automatically seal close a fluid inlet port to said jet spray orifice wherein said restriction causes the fluid to take the path of least resistance which pushes said plunger from said fluid inlet port to selectively turn on the jet spray through said at least one jet spray orifice.

28. The system of claim 27, wherein the internal check valve subassembly is operable to shut off automatically said fluid inlet port when pressure in said wellbore exceed pressure of the restricted fluid.

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