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JUNK BASKET WITH POSITIVE FLUID CIRCULATION
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This invention relates to a device for cleaning drill holes. In one aspect it relates to a device for removing objects too heavy to circulate out of the hole during rotary drilling operations. In another aspect it relates to an apparatus for removing metal and other heavy fragments from drill holes.

This invention particularly relates to the removal of material which is inside of cased holes, such as heavy objects, cement retainers, and the like. It is therefore, particularly adaptable to workover operations.

Many small heavy objects can be suspended in drilling mud and carried out of the hole by normal circulation of the mud. These objects are then removed from the mud by gravity settling. Some objects, particularly metal objects, are frequently too heavy to be carried out of the hole by the mud, and to remove these well cleaning devices such as that hereindisclosed can be used. Heavy metal objects, such as ball bearings, drill bit teeth and the like can be recovered from the hole by use of my device.

My well cleaning apparatus includes an apparatus element to be installed in the string of drill tubing, just above the rotary drill bit. It includes a basket for catching the heavy objects and a venturi operated by downflowing drilling mud to obtain positive circulation of mud through the basket to direct the movement of heavy objects from the annulus surrounding the drill end of the drill tubing assembly into the basket.

An object of my invention is to provide an efficient junk basket apparatus for use with rotary drill bits.

Another object of my invention is to provide a junk basket apparatus for use with rotary drill bits which basket apparatus is simple and relatively inexpensive to manufacture.

Another object of my invention is to provide a junk basket apparatus for use with rotary drill bits which basket is positive in its operation for recovery of solid objects at the bottom of the well during drilling.

These and other objects and advantages of my invention will be obvious to those skilled in the art upon reading the following specification and drawing, which respectively describes and illustrates preferred embodiments of my invention.

My invention provides a junk catcher apparatus, annular in shape and disposed between the rotary drill bit and the bottom section of drill tubing. The apparatus has a heavy interior cylindrical wall around which is disposed the junk catcher. To make certain that heavy objects enter the catcher or basket I provide for drilling fluid circulation through the basket. Drilling fluid is pumped downward through a tubular opening in the apparatus and by a venturi effect draws drilling fluid from the basket into the downflowing fluid. The fluid flows through the drill bit against the bottom of the drill hole and upward in the annulus between drill apparatus and the earth. A portion of this upward rising drilling fluid is drawn into the basket by this venturi effect and heavy solid matter is filtered therefrom and retained in the basket.

My invention further provides a well tool comprising a body having a solid material collecting chamber therein, an inlet conduit connecting said chamber to the exterior of said tool to receive said solid material, said body having a passageway adapted to convey fluid therethrough, a reduced diameter portion disposed in the fluid passageway, an outlet conduit connecting said chamber to the reduced diameter portion of said passageway whereby an aspirating effect is created due to the flow of said fluid through said passageway which aids in the movement of solid material through said conduit into said chamber.

In the drawing Figure 1 is a longitudinal sectional view of one embodiment of my invention.

Figure 2 is a longitudinal view, partly in section, of a portion of the apparatus of Figure 1, on an enlarged scale. Figure 3 is a longitudinal sectional view of another embodiment of my invention.

Figure 4 illustrates the positioning of the apparatus of my invention in a drill hole.

Figure 5 is a section, on an enlarged scale, taken on the line 5—5 of Figure 2.

Referring now to the drawing and specifically to Figure 1 reference numeral 11 identifies an elongated cylindrical heavy body member of my apparatus. This apparatus is relatively long in comparison to its diameter since the latter must be sufficiently small that it can be easily lowered down a drill hole. It must also possess considerable strength so that it can support the weight of the drill string. On the top end of body member 11 is disposed a connection 12 provided with external threads for attachment to a drilling collar or other connection apparatus. The lower end is provided with a connecting element with interior threads for attachment to a rotary drill bit.

The upper connection element 12 is provided with a shoulder 23. The portion of the body 11 below shoulder element 23 is of smaller diameter than that of the shoulder section. Attached, as by welding, to the lower sloping side of the shoulder element 23 is an annular ring or baffle 15. Immediately below this annular ring or baffle 15 is a screen 16. This screen may be made of heavy gage woven wire or punched plate. If this screen element is a punched plate it is preferable that the ratio of the area of the holes to that of the entire plate be large to give relatively free passage of liquid. This screen 16 extends downward and terminates at a shoulder 24. The screen should be rigidly attached, as by welding, to the shoulder 24 and to the annular ring 15. Below shoulder 24 the body member 11 has about the same diameter as the diameter of the shoulder section 23. A cylindrical wall 14 is provided as shown. The junk basket or junk receiving space 21 is bounded by outer wall 14, shoulder 24 and the screen 16. The annular baffle ring 15 extends downward some short distance below the top of the wall 14 to divert material entering the basket 21 and cause it to flow in a downward direction and well into the basket.

As soon as material enters the basket and reaches the bottom end of the ring 15 the fluid passes through the screen 16 and enters an annular space 22 between the ring 15 and body member 11. One or more conduits 19 are provided for passage of fluid from the upper section of the annular space 22 into an interior conduit 17. This interior conduit 17 is provided with a venturi throat 18. The conduit or conduits 19 enter the venturi 18 at a point just below the point of minimum diameter. Each conduit 19 is provided with a check valve 20 which permits flow of liquid from the annulus 22 into the venturi but does not permit flow of liquid in the reverse direction.

In the operation of this embodiment of my apparatus when a well is being drilled either through casing or in an open hole drilling mud is pumped downward through conduit 17 and as the mud passes the venturi throat 18 liquid is drawn through conduit 19. Liquid entering
3 conduit 19 from annulus 22 comes from the well bore by way of the upper portion of the basket 21 through the screen 16 and upward through the annulus 22. In this manner drilling fluid is drawn positively into the junk basket and solid objects suspended therein are separated by screen 16 and dropped downward in the basket.

Materials which are frequently encountered in the drilling of wells and which will be caught in such a junk catcher are drill bit bearings, broken drill teeth and other such material. This junk basket is particularly well suited for use when a drillable piece of equipment such as a drillable packer or plug is being removed. It is well known that in such cases pieces of metal are broken into smaller pieces by the drill and the smaller pieces can then be circulated upward a sufficient distance with the mud and caught in the basket.

Figure 2 represents a portion of the apparatus of Figure 1 on an enlarged scale. The check valves 20 are illustrated diagrammatically in Figure 1 and it is a check valve section of Figure 1 which is shown on an enlarged scale in Figure 2. Reference numeral 18 in Figure 2 identifies the venturi throat into which conduits 19 open. Each conduit 19 is provided with a large diameter section 34 for accommodation of the O-ring 35 shown in element 33. This valve check 31 is intended to seal against seat 35 of seat element 32. Seat element 32 may be threaded into conduit 34 at the end adjacent annulus 22. The seat element 32 is provided with an opening 33 for passage of fluid when the valve check 31 is unseated. In Figures 1 and 2 and it is seen that the thickness of webs 36 of the valve check 31 is considerably less than the diameter of the small diameter section of conduit 19. Openings 37 are therefore present, as illustrated in Figure 5 and as seen in Figure 2, and provide passages through which fluid flows from the large diameter section 34 into the small diameter section of conduit 19 to which reference numeral 19 is attached by its tie line. The diameter of the valve check 31 is smaller than the diameter of the wall of the large section 34 so that fluid can flow through the annulus therebetween. From this arrangement of apparatus parts it is obvious that fluid can flow in a direction from opening 33 toward the venturi throat and not in the reverse direction.

Figure 3 of the drawing represents another embodiment of the invention in which openings 62 serve as venturi throats for drawing fluid from outside of this high pressure fluid through the junk catcher and into the space in the region of the drill bit 54. The general construction of the junk catcher is the same as that illustrated in Figure 1. In Figure 3 the outer wall of the basket 56 has about the same thickness as the diameter of the entire apparatus, excluding the drill bit. An annular ring 57 serves as a means for holding the upper end of the screen 50 rigid. A ring 49 is disposed at the lower end of the screen 50 and is fastened rigidly thereto. This ring 49 is also attached rigidly to a shoulder 48 which serves as the bottom of the junk catcher. This ring 49 also prevents solid material from entering annulus 47 at a point in the immediate vicinity of the upper ends of passageways 59. These passageways 59 extend downward to about the lower end of the body member 51. At the lower end of the body member 51 an annular recess 60 is provided as shown into which conduits or passageways 59 open. The drill bit 54 is threaded into position as illustrated with the connecting portion 55 having exterior threads meshing with interior threads of the body member 51. An O-ring 63 is provided in the bottom end of body member 51 as shown. This O-ring 63 provides a seal against the leakage of fluid into recess 60. A separate conduit 61 is provided, as shown, connecting each passageway 62 with the recess 60. The number of passageways 62 is ordinarily that number provided in conventional drill bits, for example, there may be two, three, four, and are usually equally spaced, angularly. There may also be provided any number of passageways 59, as desired. Such a number of passageways 59 and their diameters are so selected as to give sufficient flow of fluid to divert an appreciable amount of drilling fluid therethrough. Drilling fluid pumped downward through conduit 53 within body member 51 flows through passageways 62 at a high velocity and therefore suction is provided through conduits 61, annular recess 60, any number of passageways 59 to draw fluid from the basket 58. Each passageway 59 can if desired be provided with a separate enlarged section similar to enlarged section 34 of Figure 2 to accommodate a check valve 64 similar to check valve 20, which is also illustrated in Figure 2. These check valves permit flow of fluid downward through the drill bit 54, if the condition should arise that pressure within the passageways 62 is greater than that in the region of the basket liquid cannot flow upward through passageways 59 and remove accumulated solid material from the basket 58. The upper end of the apparatus of Figure 3 is provided with a threaded connection 52 for fastening to a drill tubing or drill collar.

The annular recess 66, as shown in Figure 3, is bounded on two sides and on the top by the body member 51 and on the lower side by the drill bit 54, and is connected by separate conduits 61 to corresponding passageway 62. The annulus therebetween is open to the well. It will be seen that a liquid-tight annular recess 60 will not be formed until the drill bit is threaded into the drilling position on the bottom end of body member 51. Figure 4 illustrates the positioning of a junk basket apparatus in the well. The well may be cased or not, however Figure 4 illustrates the case wherein the well contains a casing 71. Reference numeral 72 identifies the junk basket apparatus mounted on the bottom end of a rotary drill tubing and collar assembly 73. On the bottom of the basket assembly 72 is illustrated a drill bit 79. Reference numeral 74 identifies the surface of the ground while subterranean formations are identified by reference numeral 75. The actual junk catcher or accumulation chamber is identified by reference numeral 76 and the annulus surrounding the basket assembly 72 is identified by reference numeral 78. The apparatus is operative when drilling fluid is pumped downward through the tubing 73 and through the venturi throat and liquid is drawn from the annulus 76 through conduits, not shown in Figure 4, into the venturi throat since the fluid pressure in the general area of the annulus 76 is greater than the pressure of high velocity fluid being pumped through the venturi throat.

Thus, it is seen that by the venturi action of my junk catcher, action is positive in that liquid as actually flowed through the junk catcher and any solid material larger than the largest portion of the openings will be separated from the fluid passing through the screens. The size of the screen openings or perforate plate openings of the junk basket filter element may be determined by the size of solid material desired to be retained in the basket. These small openings will increase resistance to mud flow through the basket especially at times when a considerable amount of solid material is packed in the basket.

Materials of construction of my junk separation apparatus can be selected from among those commercially available and ordinarily used in such equipment.

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

I claim:

1. An improved junk basket assembly comprising, in combination, an elongated body member to attach the upper end thereof to a well tubing, a rotary drill bit being attached to the lower end of said body, an annular open top basket assembly surrounding said body below said means, said basket assembly having a non-perforate outer wall and a perforate inner wall, said perforate inner wall being spaced from the outer wall of said body providing an annulus therebetween, a first conduit through-
out the length of said body and said rotary drill bit, said conduit in said drill bit having the form of a venturi, a second conduit through the wall of said body and said drill bit and extending from said annulus to the throat of said venturi at its downstream end.

2. An improved junk basket assembly comprising, in combination, an elongated body member, means to attach the upper end thereof to a well tubing, means to attach the lower end thereof to a rotary drill means, an annular open top basket surrounding said body member at a level intermediate said upper end and said lower end of said basket comprising a non-perforate outer wall and a perforate inner wall, said perforate inner wall being spaced from the outer wall of said elongated body member providing an annulus therebetween, a first conduit throughout the length of said body member and said drill bit, said conduit having the form of a venturi, and a second conduit through the wall of said body member providing communication from said annulus to the throat of said venturi at its downstream end.

3. An improved junk basket assembly comprising, in combination, an elongated cylindrical body member, means to attach the upper end thereof to a rotary drill tubing, a drill bit assembly attached at the lower end of said body member, an annular open top basket surrounding said body member below said means, said basket comprising a cylinder having a non-perforate outer wall and a perforate cylindrical inner wall, said outer wall and said inner wall being spaced from each other and being concentric with respect to said elongated body member, said perforate inner wall being spaced from the outer surface of said body member thereby providing an annulus therebetween, a first conduit throughout the length of said elongated body member and said drill bit assembly, said conduit in said drill bit assembly having the form of a venturi, and a second conduit in the wall of said elongated body member and in said drill bit assembly providing communication from said annulus to the throat of said venturi.

4. An improved junk basket assembly comprising, in combination, an elongated cylindrical body member, first means to attach the upper end thereof to a rotary drill stem, second means to attach the lower end thereof to a rotary drill means, an annular open top basket surrounding said body member below said means, said basket comprising a cylindrical non-perforate outer wall and a cylindrical perforate inner wall, said outer wall and said inner wall being spaced from each other and being concentric with respect to said elongated body member, said perforate inner wall being spaced from the outer surface of said body member thereby providing an annulus therebetween, a first conduit throughout the length of said elongated body member, said first conduit having the form of a venturi, and a second conduit through the wall of said elongated body member providing communication from said annulus to the throat of said venturi.

5. In the assembly of claim 3, a check valve in said second conduit so disposed as to permit fluid flow only in the direction towards said venturi.

6. In the assembly of claim 4, the check valve in said second conduit so disposed as to permit fluid flow in the direction towards said venturi.

7. An improved junk basket assembly comprising, in combination, an elongated cylindrical body, means to attach the upper end thereof to a rotary drill tubing, a rotary drill bit being attached to the lower end of said cylindrical body, an annular open top basket assembly surrounding said cylindrical body below said means, a first conduit throughout the length of said cylindrical body and said rotary drill bit, said first conduit in said drill bit having the form of a venturi, a second conduit in the wall of said cylindrical body and said drill bit providing communication from said basket to the throat of said venturi.

8. An improved junk basket assembly comprising, in combination, an elongated cylindrical body, means to attach the upper end thereof to a rotary drill tubing, a rotary drill bit being attached to the lower end of said cylindrical body, an annular open top basket assembly surrounding said cylindrical body below said means, said basket assembly having a non-perforate outer wall and a perforate inner wall, said perforate inner wall being spaced from the outer surface of said body below said means thereby providing an annulus therebetween, a first conduit throughout the length of said cylindrical body and said rotary drill bit, said conduit in said drill bit having the form of a venturi, a second conduit through the wall of said cylindrical body and said drill bit providing communication from said annulus to the throat of said venturi.

9. An improved junk basket assembly comprising, in combination, an elongated body member, means to attach the upper end thereof to a well tubing, an annular open top basket assembly surrounding said body below said means, a first conduit throughout the length of said body, said conduit in said body having the form of a venturi, a second conduit through the wall of said body providing communication from said basket to the throat of said venturi, the inner wall of said basket comprising a filter screen.

10. An improved junk basket assembly comprising, in combination, an elongated body, shoulder means to attach the upper end thereof to a rotary drill means, a rotary drill bit, means to attach the lower end thereof to a rotary drill bit, an annular open top basket assembly surrounding said body below said means, means to attach said elongated body, means to attach said body having the form of a venturi, a second conduit through the wall of said body providing communication from said basket to the throat of said venturi, the inner wall of said basket comprising a filter screen.

11. A well tool having a solid material collecting chamber surrounding a body, said collecting chamber having a perforate inner wall spaced from the outer wall of said body providing an annulus therebetween, an inlet conduit communicating said chamber with the exterior of said tool to receive said solid material, said body having an unobstructed passageway adapted to convey fluid therethrough, one portion of said passageway being of smaller diameter than the remainder thereof, an outlet conduit for passage of fluid from said annulus to said passageway at the smaller diameter thereof whereby an aspirating effect is created in said outlet conduit and chamber when fluid flows through said passageway, which aspirating effect aids in the movement of solid material through said inlet conduit into said chamber.

12. In the well tool of claim 11, a check valve in said outlet conduit disposed to prevent flow of fluid from said passageway into said chamber.

13. A well tool comprising a body having a solid material collecting chamber therein, an inlet conduit communicating said chamber with the exterior of said tool to receive said solid material from said exterior, said body having an unobstructed passageway adapted to convey fluid therethrough, a venturi throat disposed in said passageway, an outlet conduit for passage of fluid from said chamber to said venturi throat whereby an aspirating effect is created in said outlet conduit and said chamber when fluid flows through said passageway, which aspirating effect aids in the movement of solid material through said inlet conduit into said chamber.

14. In the well tool of claim 13, a check valve in said outlet conduit disposed to prevent flow of fluid from said passageway into said chamber.

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15. In the well tool of claim 13, a filter screen disposed intermediate said chamber and said outlet conduit.

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