

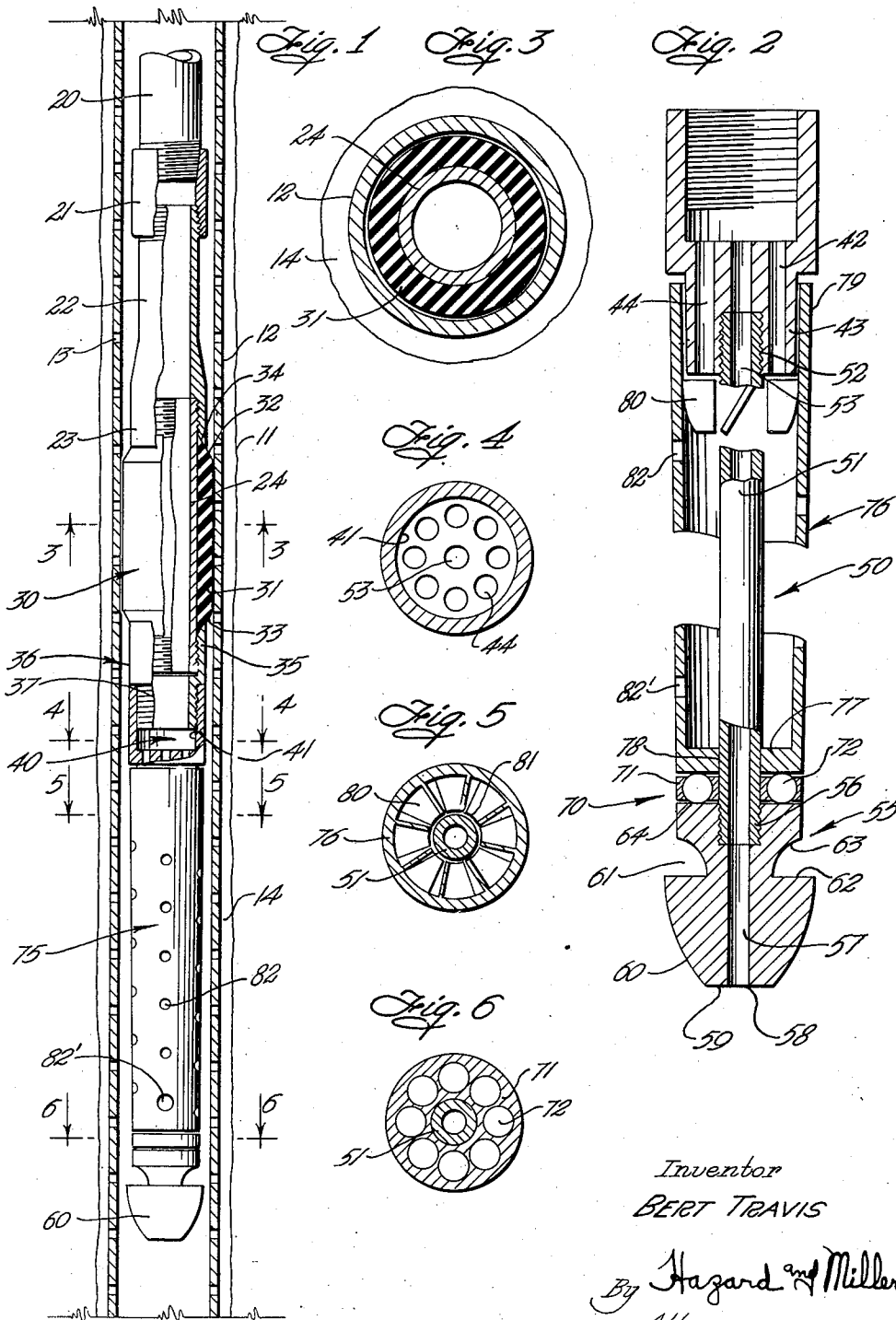
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ROTARY WASHER FOR CASING PERFORATIONS

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ROTARY WASHER FOR CASING
PERFORATIONS

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9 Claims. (Cl. 166—20)

My invention relates to a washer of a rotary type constructed and adapted to wash or clean out the perforations in a well casing which perforations are designed and intended to allow inflow of oil or other liquid from the formation of a well to thereby permit an upward flow or pumping of such oil or other liquid.

In the construction of deep wells such as oil wells, this is frequently done by a system known as rotary hydraulic drilling in which a drill string and drill bit rotate, the bit doing the cutting at the bottom of the hole. At the same time a slushing mud is forced through the drill string and bit, one of the purposes being to carry the cuttings upwardly through the well hole. In addition the slushing mud has the function of forming a coating on the bore cut by the bit to restrain the material of the formation from cave-ins and for other purposes. When a perforated well casing is installed in the well, for instance in an oil well with the perforations adjacent the so-called oil sands or oil bearing formation, this bore outside of the casing is frequently plugged with a surface and a penetrating coating of the slushing mud. This frequently, due to the high temperatures, has caked and formed a relatively hard material. In addition the perforations in the casing frequently become plugged or blocked so that even if the formation at the oil sands was clean, the oil could not flow inwardly through the casing.

A main object and characteristic therefore of my invention is to forcibly produce a washing action outwardly through the perforations in a section of the perforated casing adjacent the oil sands by means of a plug restricting the upward flow of the washing liquid which may be oil or water, thereby forcing this washing liquid to flow upwardly on the outside of the perforated casing, at least to a location above the plug whence it may flow inwardly through the perforations above the plug and thence upwardly in the casing. A further characteristic and feature of my invention is the development of a plurality of piercing jets of the washing liquid, such jets rotating and there being a sufficiently large number of these jets so that a relatively large proportion of these will strike directly in alignment with the perforations of the casing and thereby produce a direct and powerful jet action in blowing any blocking material out of the perforation casings and further, to cause the jets to impinge directly on the well bore outside of the perforations. One of the main purposes of the direct action of the jets on the well bore being to

forcibly dislodge any coating of the slushing mud. A further characteristic of my invention is at the same time that the jets are discharged laterally, by rotating a jet device I continue a direct downward flow of the washing liquid, this being discharged through a heavy base member having a discharge nose at the bottom.

A further characteristic and feature of my invention is the provision of jet orifices which may be designated spray perforations, are formed in a rotatably mounted pipe which may be designated as a rotor, this being mounted on a small suspension pipe depending from a head or block structure below the plug, such head has a plurality of perforations extending longitudinally and positioned in a circle, the washing liquid pumped downwardly is discharged at a relatively high velocity through these perforations and engages sloping vanes mounted in the rotor, such vanes having somewhat the same function as blades of a turbine and thereby causing the rotor spray pipe to rotate on the suspension pipe. This suspension pipe has the additional function of transmitting the washing liquid through to the bottom to discharge through the base member. Other detail features of my invention involve an anti-friction bearing between the base member and the bottom of the rotor spray pipe and also providing adjacent the base member, an annular notch or the like in which large particles of solid material may lodge and hence not interfere with the flow of the washing liquid.

In my construction the plug below which the washing fluid is discharged is of slightly smaller diameter than the casing, to allow ready lowering and raising of the washer and to clear any inwardly projecting burrs at the perforation of the casing. The supporting structure below the plug for the rotor spray pipe is of smaller diameter than the plug, the spray pipe is preferably tapered and is supported on a perforated stationary nose at the bottom, the washing liquid is thus discharged through the rotary spray pipe and through the bottom perforated nose and hence all of the fluid washes upwardly, some of this will pass between the plug and the casing, however the major portion will pass through the perforations of the casing and between the casing and the wall of the well to a position above the plug.

A further characteristic of my invention in its operation and functions is that it may be used as a quick acting washing device for a well in order to bring the well into flowing condition. Thus if the internal pressure forces the oil with

or without much gas upwardly, the entire washing equipment may be pulled upwardly above the perforated casing, then the oil will flow upwardly through the perforations of the rotor of the washer and upwardly through the vanes and the jet ports thereof continuing through the string of tubing suspending the rotary washer. This may be left in the well until such time as it is found expedient to remove the same as for instance when it is necessary to install pumping equipment.

My invention is illustrated in connection with the accompanying drawing, in which:

Fig. 1 is a vertical section through a portion of a well and of a perforated casing showing my washer in elevation partly broken away in section to show portions of the interior of the stationary structure, the rotor spray head or cylinder being shown in elevation.

Fig. 2 is a vertical diametrical section through the rotary spray cylinder with the adjacent parts of my invention.

Fig. 3 is a horizontal section on the line 3-3 of Fig. 1 in the direction of the arrows through the plug and the casing.

Fig. 4 is a horizontal section on the line 4-4 of Fig. 1 through the suspension cup illustrating the jet ports for the rotor.

Fig. 5 is a transverse section on the line 5-5 of Fig. 1 through the upper portion of the rotor, illustrating the propeller vanes.

Fig. 6 is a transverse section on the line 6-6 of Fig. 1 illustrating an anti-friction bearing rotatably supporting the rotor jet cylinder.

In the drawing a portion of a well bore is indicated by the numeral 11 and part of a perforated well casing by the numeral 12, this casing having a large number of perforations 13 for the flow of oil or other fluid from the well formation into the casing and hence by free flow or pumping to the ground surface. There is usually an annular space 14 which is more or less irregular between the wall of the well bore and the casing. The wall of such well bore becomes plastered with the mud of the hydraulic fluid used in drilling. This mud frequently penetrates the formation adjacent the well hole and in addition the perforations of the casing become plugged. It is the purpose of my invention to clean the perforations of the casing, also to wash the surface of the bore and to clean out the mud penetrating the formation.

In employment of my invention I illustrate the lower section of a string of tubing 20 having a coupling 21 connected to the upper sub 22. This sub has an internally threaded socket 23 at its lower end in which is threaded a lower tubular sub 24. The internal diameter of both subs is preferably the same. On this sub 24 is mounted the plug 30, such plug includes a relatively long rubber sleeve 31 illustrated as beveled at its upper and lower edges 32 and 33, the upper edge being gripped by a complementary bevel 34 on the lower edge of the socket 23. The lower bevel 33 is gripped by the upper beveled edge of a collar 35 on a socket type of coupling 36, the collar being internally threaded and connected to the lower end of the tubular sub 24. By this connection and the form of the rubber sleeve forming a plug of slightly less diameter than the casing, this plug may be expanded to engage the inside of the casing and prevent longitudinal flow of any fluid in the casing past the plug.

The lower portion of the coupling 36 has an

externally threaded pin end 37 to which is connected a suspension cup 40. Such cup has a cylindrical wall 41 with internal threads engaging the external threads of the pin end 37. This cup is provided with a heavy base 42 with a downwardly projecting cylindrical end portion 43. There are a series of vertical jet ducts 44 arranged in a circle as shown in Fig. 4 and extending downwardly through the bottom 42 and the end portion 43.

A suspension assembly 50 includes a suspension pipe 51 which has a screw threaded connection at its upper end 52 to the end portion 43. This connection is in alignment with the central flow duct 53 through the bottom 42 and the end portion 43 and communicates the hydraulic fluid through the pipe 51. Attached to the lower end of the suspension pipe there is a base or supporting plug 55, the connection being by a screw threaded joint 56, note Fig. 2. A jet duct 57 extends downwardly through the plug in alignment with the pipe 51 and has a jet orifice 58 at the bottom. The bottom of the plug preferably has a flattened end 59, a nose 60 with a convex face considered on vertical sections. There is an annular notch 61 formed by an annular horizontal shoulder 62 and the concave upper face 63 of the notch. The upper end of the plug has a horizontal bearing surface 64 and on this is mounted an anti-friction bearing 70. This bearing is illustrated as having a conventional ball retainer 71 forming a ball cage in which there are a series of balls 72 mounted therein forming a thrust ball bearing. These balls operate on the upper surface 64 of the supporting plug 55. The jet rotor designated by the assembly numeral 75 includes a cylinder 76 with a base 77, such base having an opening 78 for the pipe 51 and the lower surface of the base operates on the balls of the anti-friction bearing 70. The upper end of the cylinder 79 is cylindrical on its inside surface and has an operating clearance with the cylindrical surface of the end portion 43. Mounted on the inside of the rotor there are a plurality of propeller blades 80. These extend radially inwardly towards the pipe 51 and each blade is preferably made with the inner edge 81 forming a segment of a circle. The blades are inclined or tilted as shown in Fig. 2 so that the downwardly directed jets of liquid such as oil pumped down under pressure impinges on the vanes and causes the rotor to rotate. The cylinder of the rotor is provided with a plurality of spray jet ports 82, these being positioned longitudinally from below the vanes towards the bottom and are positioned arranged circularly of the cylinder.

In the operation of my washer, this may be lowered into the well by a string of drill pipe or oil tubing. On account of the plug 30 having a slight clearance with the casing, there is no resistance to its being lowered. When located at the desired position in the casing, a liquid, preferably oil is pumped down through the suspending tubing by powerful force pumps on the ground surface. The jets of liquid as above mentioned, drive through the jet ducts 44 and impinge on the vanes 80 causing the rotor to rotate. The anti-friction bearing at the bottom reduces the frictional resistance to such rotation. The cylinder of the rotor becomes filled with oil or the fluid pumped and this is discharged through the jet orifices 82 in a radial direction and under high pressure. It is not necessary that the speed of rotation of the rotor

be very high. This action causes the jets to spray outwardly substantially radially towards the inside of the casing. Certain of these jets, there being so many of them, will in one portion at least of their rotation, be in alignment with one or more of the perforations of the casing and drive directly therethrough.

This action of the washing liquid driving directly through the perforations of a casing cleanses these and causes jets to impinge on the wall of the well bore 11. Thus the jets outside of the casing break down the coating or plastering of the hydraulic slushing mud coating the well bore and also penetrate the formation, washing this clear of the mud to varying depths.

As above mentioned, the plug 30 is of slightly less diameter than the inside of the casing so that it may readily be raised and lowered, the outside diameter of the suspension cup 40 and of the nose 60 are preferably of the same diameter and less than that of the plug. The perforated cylinder 75 has a slight downward taper and adjacent the bottom has large holes 82' which are larger than the jet orifices 82. These are also larger than the vertical jet ducts 44. Therefore any dirt or material which would obstruct the jet orifices 82 is discharged through the large perforation 82' and may drop until it contacts the shoulder 62. Also, on account of having the diameter of the nose greater than the lower portion of the perforated rotary pipe, dirt or obstructions from the lower part of the well cannot work upwardly.

The downward flow of the washing oil is thus discharged through the jet perforations 82 and also there is a downward flow through the suspension pipe 50, the duct 57 in the supporting plug 55. This builds up a reacting pressure of the washing liquid against the oil or other liquid in the lower portion of the perforated casing so that there is an upward flow of the whole volume of the washing liquid pumped downwardly. The major portion of this is discharged through the casing perforations and flows upwardly above the plug and then inwardly to the inside of the casing. Also there is always an upflow of the washing liquid or oil outside of the plug 30, that is, between such plug and the casing. Therefore there is no opportunity for any downward settlement of the sediment which might either freeze, locking the washing tool in the well or prevent rotation of the rotor.

Various changes may be made in the details of the construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. A well washer comprising in combination a tubular sub having means at its upper end for connection to a string of oil tubing and having a suspension cup at its lower end, an upper plug mounted on the said sub to have a slight clearance with a perforated well casing, the said cup having a heavy cylindrical base with a series of vertical jet ducts arranged in a circle and a central duct, a suspension pipe connected to the lower portion of the said cup and connecting to the central duct, a bottom plug attached to the suspension pipe, said bottom plug having a jet duct discharging downwardly, a jet rotor including a cylindrical shaped structure surrounding the suspension pipe and rotatably supported on the bottom plug and having an upper end overlapping the cylindrical portion of the suspension cup, blades mounted in the cylindrical-like rotor

and positioned to receive the downward flow of washing liquid through the circle of vertical jet ducts to rotate the rotor, said rotor having a plurality of spray jet ports to discharge washing liquid radially from the rotor.

2. A well washer as claimed in claim 1, the bottom plug being of a diameter greater than the lower portion of the jet rotor and being circular at such portion whereby obstructions are prevented from flowing upwardly to engage between the rotor and the inside of a well casing.

3. A well washer as claimed in claim 1, the rotor having relatively large sized spray ports adjacent the bottom to pass material which would obstruct the other ports, the bottom plug being of greater diameter than the rotor and having a ledge to receive obstructing particles forced through the larger spray ports.

4. A well washer as claimed in claim 1, the means to rotatably mount the rotor on the bottom plug including a ball race on the upper face of such plug and a complementary ball race on the lower end of the cylindrical-like rotor, there being an anti-friction bearing between the said races, the weight of the rotor being carried by the anti-friction bearing.

5. A well washer comprising in combination a tubular structure having means for connecting to oil tubing for the downward flow of washing liquid, a relatively long rubber plug mounted on the tubular structure and of slightly less diameter than a perforated casing in which it is to fit, a tapered tubular rotor having peripheral perforations suspended below the tubular structure, a bottom plug below the rotor and having means connecting same to the tubular structure, the bottom plug being of greater diameter than the lower end of the tubular rotor to prevent upward flow of obstructing particles, means to rotate the rotor by the downward flow of washing fluid, means to discharge part of the washing fluid through the bottom plug downwardly, the remainder of the flow being discharged through the perforations of the rotor.

6. A well washer as claimed in claim 5, the means to rotate the rotor comprising vanes secured to the inside of the rotor and extending towards the center, each vane having an inclination as to horizontal and means to discharge jets of the washing fluid against the vanes.

7. A well washer comprising in combination a tubular structure having means for connecting to oil tubing for downward flow of washing liquid, a relatively long rubber plug mounted on the tubular structure and adapted for expansion to form a swab on the inside of a perforated casing, a tubular rotor having peripheral perforations located below the tubular structure, a suspension pipe connected to the tubular structure and having a plug with a discharge duct in alignment with the pipe, the said rotor being rotatable between the plug and the tubular structure, the said suspension pipe having a communication for the flow of washing liquid from the tubular structure, means operative by the flow of the washing liquid into the rotor to rotate such rotor, there being thus a discharge of washing liquid through the perforations of the rotor and through the duct of the plug.

8. A well washer as claimed in claim 7, the bottom plug having a diameter greater than the lower portion of the rotor, thus preventing obstructions being carried upwardly by the discharge of washing liquid from the duct of the plug.

9. A well washer comprising in combination a tubular structure having means for connecting to oil tubing for downward flow of washing liquid, a relatively long rubber plug mounted on the tubular structure and adapted for expansion to form a swab on the inside of a perforated casing to be cleaned by the washing liquid, a suspension pipe having a low connection to the tubular structure, a plug having a circular periphery with an annular notch and a shoulder below such notch, there being a liquid discharge duct axially through the plug communicating with the suspension pipe, a perforated jet rotor surrounding the suspension pipe and supported for rotation on the plug, means forming a liquid flow connection from the tubular structure to the jet rotor together with means operated by the liquid flow to rotate the rotor, the said rotor having a downward taper from its top towards the bottom and the circular periphery of the plug being of greater diameter than the lower portion of the rotor to prevent upward flow of obstructions carried by the washing liquid discharged through the duct of the plug.
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