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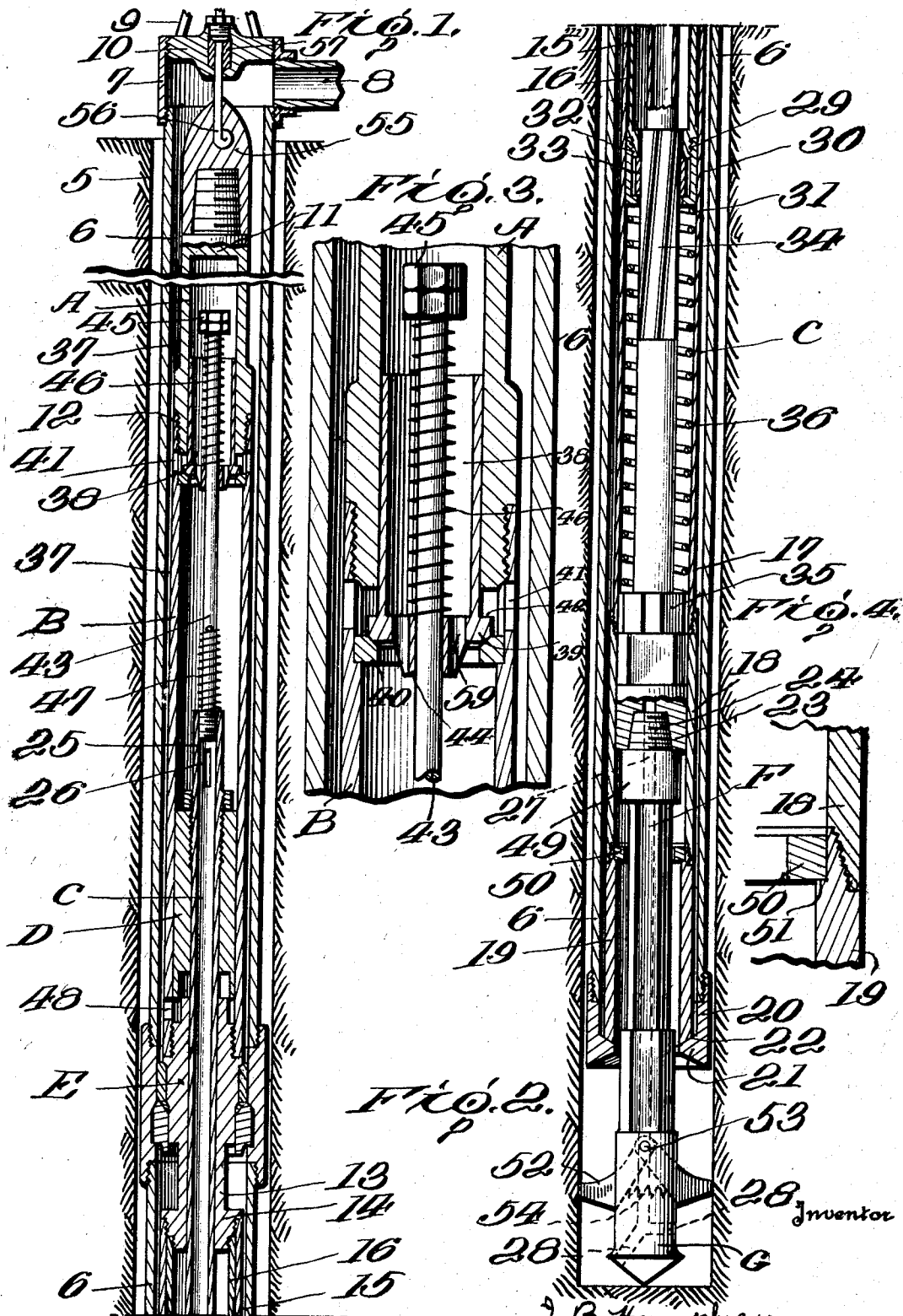
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1,828,604

HYDRAULIC DRILL

Filed Sept. 19, 1924

2 Sheets-Sheet 1



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FIG. 5.

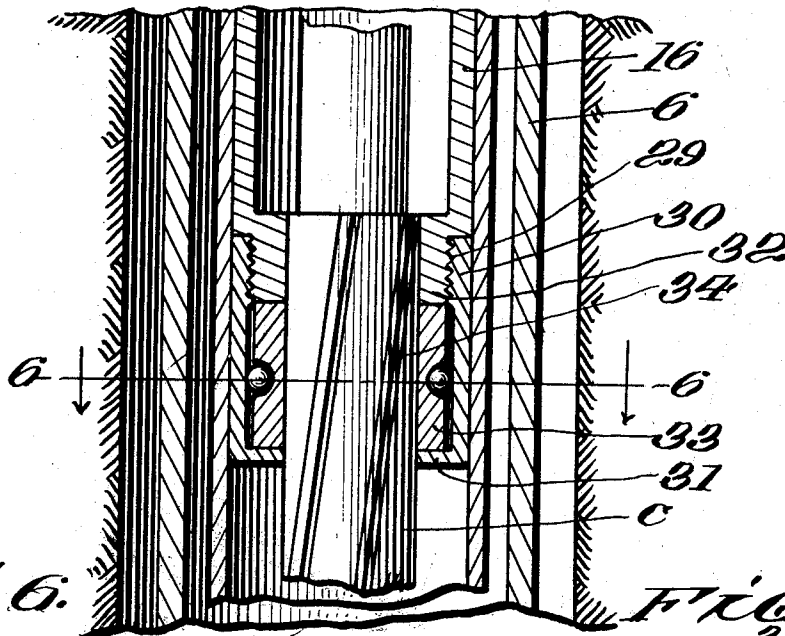


FIG. 6.

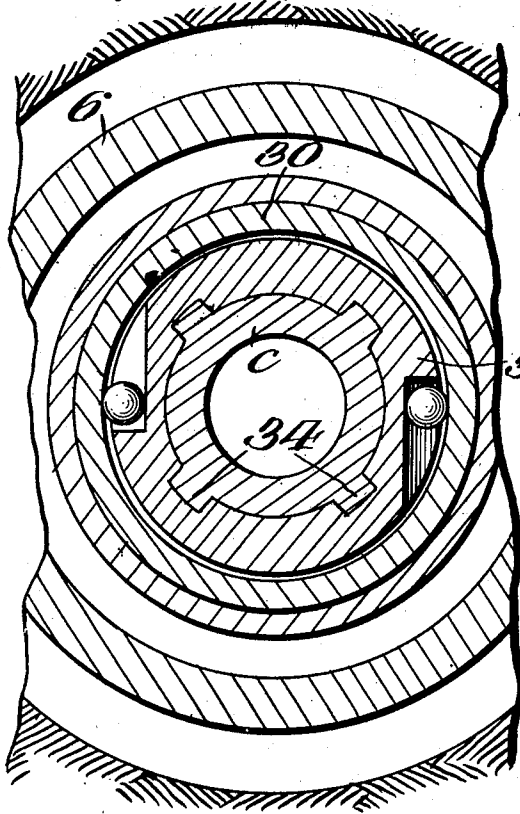
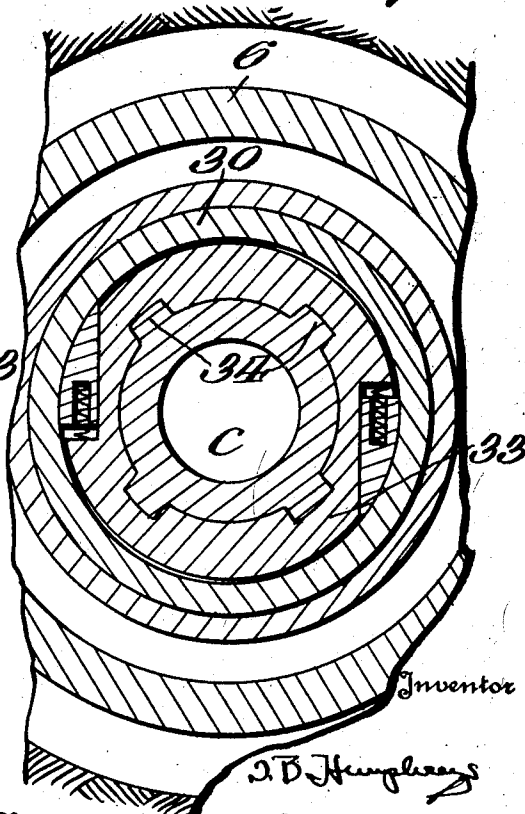


FIG. 7.



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HYDRAULIC DRILL

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This invention relates to improvements in hydraulic drills pertaining more particularly to a combined hydraulic and spring operated drill adapted for use in deep drilling, such

as for instance the drilling of oil wells.

Heretofore in deep well drilling it has been the practice to use either cable operated drills or rotary drills in which a very long drill stem is used to extend from the bottom of the well, where the work is being done, to the top of the well where suitable means are provided for rotating the stem. These methods of drilling present a problem as the cables or the drill stem often become broken which necessitates the pulling of the drill from the well casing and fishing for the lost part of the drill left in the well due to the breakage. It will be readily apparent that when a breakage occurs that the result is the loss of considerable time with a resultant trouble and expense.

One of the objects of the present invention is to combine the advantages of both the standard and rotary method of drilling.

Another object of the invention is to provide a hydraulically operated drill which does away with the use of cables and long drill stems.

A further object of the invention is to provide a combined hydraulic spring operated drill of a construction whereby the entire drilling mechanism is lowered into the well casing to the point where the actual work is being done.

Another and further object of the invention is to provide a combined hydraulic and spring operated drill for deep well drilling.

A still further object of the invention is to provide a combined hydraulic and spring operated drill in which the hydraulic pressure is used both to operate the drill and to wash the cuttings from the well.

Another object of the invention is to provide a simplified construction of hydraulic drill whereby the number of operating parts are few, reducing the weight of the device as a whole, and to apply the power to the drill in such a manner as to reduce to a minimum the recoil and vibration of the device which

would tend to lift or strain the device in any of its parts.

A still further object of the invention is to provide a novel means in a hydraulic drill for controlling and directing the hydraulic pressure to operate the device in the desired manner.

Another and still further object of the invention is to provide a combined hydraulic and spring operated drill which is simple of construction and highly efficient in operation.

Another object of the invention is to provide a hydraulic drill in which the length of the stroke is variable as desired.

Other further objects, novel features of construction and improved results of the invention will appear in the following description and accompanying drawings.

In the drawings:

Figure 1 is a vertical sectional view of the upper portion of the drill, the mechanism being shown lowered within a well casing.

Fig. 2 is a vertical sectional view of the lower portion of the drill, this figure of the drawings being a continuation of Figure 1.

Fig. 3 is an enlarged detail vertical sectional view of the valve construction of the drill.

Fig. 4 is a fragmentary enlarged vertical sectional view showing the manner in which the retaining ring is supported in the drilling mechanism.

Fig. 5 is an enlarged vertical sectional view showing the one-way clutch.

Fig. 6 is a transverse sectional view taken on the line 6-6, Fig. 5.

Fig. 7 is a transverse sectional view, similar to Fig. 6, showing a modified form of clutch.

In broad terms the present invention comprises a deep well drill in which hydraulic pressure is utilized to lift the drill bit and drill head against the tension of a spring and at a predetermined time to balance the hydraulic pressure within the mechanism to allow the drill bit and head to be driven downwardly by the energy stored in the compressed spring and to provide means to impart a rotary movement to the drill.

Attention is directed to the fact that the present construction of drilling mechanism can be used for drilling holes through any substance such as earth, sand, stone, or the like. Although the invention is particularly adapted for drilling deep oil wells the invention is not limited to this particular use.

Throughout the drawings and description similar reference numerals are used to designate like parts, the drilling mechanism broadly comprising a valve housing A, a cylinder B, a hollow piston rod C carrying a piston D, a cylinder head E, a drill stem F and a drill head G.

The drilled hole or well is designated by the numeral 5 and as is common in the drilling of wells a well casing 6 is lowered into the hole as the drilling progresses. This well casing extends above the top of the well hole 5 and is provided with a head 7 with which communicates an inlet pipe or conduit 8 through which is pumped or otherwise suitably forced by an engine or the like (not shown) the hydraulic pressure fluid used in the operation of the drilling mechanism. The well casing head 7 is provided with suitable means 9 which permits the casing to be lowered as the drilling progresses or to be lifted from the well when desired. The well casing head 7 is further provided with a removable top or cover 10.

The valve housing A is closed at its top by a head 11 while its lower end is open and adapted for communication with the cylinder B. The cylinder B comprises in reality an elongated pipe, the upper end of which is suitably attached as at 12 to the valve housing while the lower end of the cylinder screw-threadedly or otherwise suitably carries the lower cylinder head E.

The cylinder head E is provided at its lower side with an extending sleeve 13 terminating in a head 14 which screw-threadedly or otherwise suitably carries the concentrically arranged pipes 15 and 16. The pipe 15 is the outer pipe and extends downwardly a much greater distance than the inner pipe its lower end 17 screw-threadedly carrying a pipe 18 the lower end of which in turn screw-threadedly carries a pipe 19.

The lower end of the well casing 6 carries a sleeve 20 provided with an inwardly extending circumferential flange 21. The entire drilling mechanism is supported upon this flange through the engagement of the lower end 22 of the pipe 19 with the flange.

The hollow piston rod C extends from within the cylinder B, down through the cylinder head E and its extension sleeve 13 and head 14, through the pipes 16, 17 and 18. The lower end 23 of the hollow piston rod screw-threadedly carries as at 24 the drill stem F.

Within the cylinder B the hollow piston rod C is provided with the piston D which is adapted to reciprocate within the cylinder.

As clearly appears the piston rod has an extending end 25 above the piston and this extending end is provided with ports or openings 26 which are in communication with the cylinder B while the lower end 23 of the hollow piston rod is in communication with the channel 27 extending the length of the drill stem F. The channel 27 extends downwardly through the drill head G terminating in outlet openings 28.

Again referring to the pipe 16 which is the inner of the two concentrically arranged pipes, it will be seen that the lower end of this pipe screw-threadedly carries as at 29 a sleeve 30 provided at its lower end with an inwardly extending circumferential flange or shoulder 31. Carried between the flange 31 and the lower end 32 of the pipe 16 is a splinted or spirally threaded nut 33. It will be seen that that portion of the hollow piston rod C which passes through this splinted nut is provided exteriorly with spiral threads 34 or the like.

This splinted nut is provided for the purpose of rotating the hollow piston rod and the drill stem and head. It will be readily seen that the nut is locked against vertical movement. The nut 33 is furthermore provided with some common form of clutch such as appears in Figs. 5 to 7 inclusive construction whereby it is locked against rotation on the upward movement of the hollow piston rod thereby causing the rod to rotate. The clutch arrangement of the nut is such however as to allow it to rotate on the downward movement of the piston rod and consequently the piston rod, drill stem and head are not rotated through their downward movement.

Surrounding the piston rod C between the splinted nut 33 and the enlarged portion 35 adjacent the end of the piston rod is a spiral spring 36. The upper end of this spring engages the lower side of the collar or sleeve 30 while the lower end of the spring engages the enlarged portion 35 of the drill stem. It will be seen that any upward movement of the piston rod will cause this spiral or coiled spring to be compressed.

If it has not already been understood, attention is directed to the fact that the valve housing A, the cylinder B, and the pipes 15, 17, 18 and 19 are smaller in diameter than the well casing 6 and that there is thus formed between the well casing and the exteriors of the members mentioned a space or channel 37. Additionally it will be seen that the well casing does not fit tightly the well or drilled hole 5.

Within the valve housing A is a sleeve valve 38 provided at its lower end with an enlarged head 39 adapted to seat upon the tapered valve seat 40 carried by the upper end of the cylinder B.

Immediately above the valve seat 40 the cylinder B is provided with ports 41 which

are in communication with the interior of the well casing 6 and are likewise in communication with the interior of the valve housing when the valve 38 and its enlarged head 39 is lifted. The upward movement of the valve is limited by the shoulder 42 of the valve head coming into engagement with the lower end of the valve housing while the downward movement of the valve is of course limited by the valve seat 40.

Suitably fastened within the extending end 25 of the hollow piston rod C and closing it is a valve rod 43 which extends through the sleeve 44 of the valve head 39, terminating within the valve housing in an enlarged head 45. Surrounding the valve rod 43 between the upper end of the valve head sleeve and the enlarged head 45 of the rod is a coil spring 46.

A second coil spring 47 surrounds the valve stem 43 within the cylinder B. This spring rests upon the upper end of the hollow piston rod and the upper end of the spring is adapted for engagement with the sleeve 44 of the enlarged valve head 39.

The cylinder B is provided at its lower end with a port 48 which is in communication with the well casing channel 37.

The drill stem F is provided with an enlarged head 49 at its upper end. This head however is of a size which would permit its passage through the sleeve 20 carried by the lower end of the well casing. From this it will be seen that in the event the drill stem became broken it would be possible to lose the drill in the well hole. To guard against this there is provided a split ring 50 which rests upon the shoulder 51 adjacent the upper end of the pipe 19. In the event that the threaded connection 24 of the drill stem with the lower end of the piston rod becomes dis-connected or broken it will be seen that the split ring 50 will engage the head 49 of the drill stem and prevent the stem from dropping from the pipe 19 or the well casing.

To permit the drilling of a hole of sufficient size to accommodate the well casing and at the same time provide a construction of drill head which will allow the head to be drawn upwardly through the well casing the head is provided with under-reamers 52. These under-reamers are of a common construction, being pivotally mounted at 53 and normally held in their expanded positions due to a spring 54. As the drilling mechanism is pulled from the well casing these under-reamers will spring inwardly against the tension of the coil spring 54 and thereby permit the passage of the drill head through the well casing.

A weight 55 is suitably mounted upon the top of the valve housing A. This weight holds the entire drilling mechanism in place upon the shoulder 21 of the sleeve 20 at the

lower end of the well casing. This weight is really a safe-guard only as the weight of the apparatus itself and the pressure which operates it will tend to hold the mechanism in place upon the supporting flange. However this weight additionally aids in the drilling as it adds to the impact stroke of the drill head.

Suitably fastened within the weight 55 is a cable 56 which passes upwardly through a stuffing box 57 or some like fitting to a point above the well. It will be readily apparent that upon removing the cover 10 of the casing head 7 that the entire drilling mechanism which includes the valve housing A, the cylinder B, the pipes 16, 17, 18 and 19 and the drill bit F, and head G can be removed from the well casing. This arrangement is very important as it permits the ready and rapid removal of the drilling mechanism from the well to effect any repairs or adjustments and likewise permits the rapid installation of the drilling mechanism as it is only necessary to lower the mechanism until the lower end of the pipe 19 rests upon the flange 21 at the bottom of the well casing.

It will also be seen that due to the manner in which the drilling mechanism can be lowered into the well casing and removed from the casing that the entire mechanism can be assembled on the ground above the well. This of course would be necessary because the split ring 50 would have to be placed in position before the pipe 19 is screwed into place upon the lower end of the pipe 18.

It is not thought necessary to go further in the assembling of the drill as this can be readily accomplished by anyone skilled in the art as the drill is not at all complicated, it being merely necessary to position the proper parts by screwing them into place in their proper positions as shown in the drawings.

Operation

The fluid which will preferably be used as the motive power for the drill will be water as is common in rotary drilling.

This fluid will be forced under high pressure, by some suitable engine or the like, into the inlet 8 in the head of the well casing.

With the parts as shown in the figures of the drawings the piston D is about to start its upward stroke.

The high pressure fluid passing down the well casing in the space 37 enters the port 48 at the lower end of the cylinder B and causes an upward pressure upon the piston. As the piston ascends it carries with it the hollow piston rod, and the drill bit and drill head, all of which are in operative engagement. It will be seen that as the piston rises it also carries with it the valve rod 43 which is fas-

tened in the upper open end of the piston rod.

The fluid in the cylinder B above the piston is discharged through the piston rod ports 26 as the piston ascends and passes downwardly through the hollow piston rod, the channel 27 in the drill bit and outwardly through the channel 28 in the drill head, forcing the cuttings upwardly out of the well on the outside of the well casing.

It will be also seen that due to the upward movement of the piston and piston rod that eventually the coil spring 47 surrounding the valve stem will engage the portion 44 of the enlarged valve head 39 and force the sleeve valve 38 from its seat. This valve is so made that very little pressure is required to raise it from its seat. It will be understood that high pressure fluid is constantly on the outside of the valve head and the valve is therefore held on its seat until raised by the action of the upwardly moving piston rod and the spring 47. It will also be understood that as the piston ascends the coil spring 36 is compressed between the enlarged piston rod portion 35 and the sleeve 30 which holds the splinted nut 33 in place.

When the piston has reached the top of its stroke the sleeve valve has been lifted from its seat and high pressure is allowed to enter the ports 41 and flow downwardly beneath the valve head into the cylinder B above the piston. This high pressure likewise enters the valve housing A through the open end 59 of the sleeve valve.

It will now be seen that high pressure is acting on both the upper side of the piston and on the lower side of the piston, as the ports 48 are always open, and is balanced.

As the drilling mechanism has ascended the drill stem and head have been rotated due to the splinted nut 33 and the spiral teeth 34 on the exterior of the hollow piston rod.

The piston, piston rod, drill stem and drill head will now start their downward stroke the driving power being the compressed coil spring 36.

As the piston descends the piston rod, drill stem and drill head are carried downwardly but are not rotated because the clutch of the splinted nut operates to release and allow the splinted nut to rotate as the piston rod passes through it.

As the piston continues to descend the fluid in the cylinder below the piston is forced outwardly through the ports 48 up the well casing.

It will also be seen that as the piston descends that eventually the enlarged head 45 of the valve rod will engage and compress the coil spring 46 which will, after being sufficiently compressed overcome the pressure on the valve head 39 and cause the valve to seat and thus cut off the high pressure fluid being delivered into the cylinder above the piston.

The downward movement of the piston and drill is rapid so that the drill will strike the bottom of the well or hole forcibly, striking in a different place or different position on each stroke due to the fact that the drill head is rotated during its upward movement.

A complete reciprocation of a full upward and downward stroke of the drill and co-acting parts has been described. The upward stroke of the drill is now ready to begin again and is merely a repetition of the stroke heretofore described.

It will of course be understood that as the drilling progresses the well casing is lowered. At all times however the lower end of the well casing is above the bottom of the well or hole being drilled.

It has been heretofore mentioned that the length of the stroke of the drill is variable. This is accomplished through the medium of the well casing as it will be clearly seen that the length of the downward stroke of the drill is controlled entirely by the distance the lower end of the well casing is above the bottom of the hole being drilled. To shorten the stroke of the drill it is only necessary to lower the well casing until its lower end is quite near the bottom of the hole.

The action of the valve to change the direction of movement of the piston is automatic and will act immediately upon the impact of the drill head with the bottom of the hole irrespective of the length of the downward stroke of the drill.

With the valve in a closed position the fluid under pressure from the pressure providing mechanism above or adjacent the well enters the port 48 and the piston is raised to the top of its stroke at which time the spring 47 surrounding the guide rod 43 engages and presses against the guide fins 44 of the valve 38. The valve is being held on its seat by the pressure of the operating fluid, which pressure is, of course, free to enter the ports 41 and act upon the valve. Due to the shape of the valve, particularly the shoulder 42 of the valve head, this pressure upon the outside of the valve is acting on a greater area and exerting a downward force thereupon than the area subjected to the upward pressure and, furthermore, the pressure or head of the fluid acting to lift the valve is less than the pressure or head of the fluid exerting an upward pressure upon the valve, for the reason that what little fluid is present above the piston at the time the piston starts upward is being discharged through the hollow drill bit or stem as the piston is raised.

When the spring 47 presses upon the valve guide fins sufficiently to overcome the unbalanced pressure on the valve which is holding the valve closed, the valve will open and the high pressure fluid entering the ports 41 will pass under the valve and into the cylinder above the piston. The extension below the

valve carrying the fins partly fills or obstructs the opening through the valve seat and, hence, forms a restriction through which the high pressure fluid must pass to get into the cylinder.

When the valve is opened, the downward movement of the drill and piston is very rapid, due to the energy stored in the driving spring 36 and thus the area of the cylinder above the piston into which the fluid is flowing is rapidly increasing. Furthermore the passage of the fluid through the restriction causes a material acceleration of the speed of flow of said fluid and causes what might be termed an ejector action in respect to the passageways 59 in the valve thus preventing a building up of pressure in the valve housing above the valve in an amount equal to the pressure head existent under and acting upward upon the valve head 39. Due to this differential of pressure the valve remains in its open position until the downward movement of the piston is arrested.

When the piston for any reason stops its downward movement the flow of fluid beneath the valve and through the restriction is reduced, in fact, practically stopped so that the pressure head in the restriction, in the chambers below the valve and above the valve are practically the same as exist adjacent the ports 41 and above the restriction. The pressure head acting upwardly and downwardly upon the valve are practically balanced and the spring 46 acts and closes the valve and the entire operation begins over again.

From the foregoing it will be seen that the apparatus is automatic insofar as reversing the direction of movement is concerned and that its work will be continuous as long as high pressure fluid is supplied to the well casing inlet 8.

It is proposed that in practice that the well casing which is used during the drilling operation will be left in the well after it has been completed. The entire drilling mechanism will be pulled from the casing for use upon another job.

It will be additionally seen from the foregoing description that a combined hydraulic and spring operated drilling mechanism is provided, which can be readily and quickly lowered into the hole being drilled, or removed from the hole, and that as the drilling takes place, the cuttings are washed upwardly and outwardly from the hole.

Having thus described my invention what I claim and desire to secure by Letters Patent is:—

1. A drilling machine, comprising a drill, a reciprocating piston for imparting movement to said drill, means for supplying liquid pressure and said liquid pressure acting on said piston, means to alternately direct a portion of, said pressure above said piston, and resilient means compressed by said piston

and the drill for driving said members in one direction.

2. In a drilling machine, an inner and an outer pipe, a reciprocating member within the inner pipe carrying a drill, means for supplying liquid pressure and said pressure communicating with one of said pipes above said reciprocating member, and reciprocating means above said reciprocating member for alternately directing a portion of the pressure above said reciprocating member to balance the pressure above and below the same.

3. In a drill, the combination with a cylinder carrying a piston adapted to be reciprocated and thereby impart movement to the drill, means for supplying liquid pressure to said cylinder, means to alternately direct a portion of said pressure above said piston, and resilient means for driving said piston and drill in one direction arranged to be compressed by the upward movement of the piston and drill.

4. In a drill, means for supplying liquid pressure to said drill, a cylinder, a piston adapted for reciprocation in said cylinder and provided with a piston rod carrying a drill, said pressure acting constantly on said piston to lift the same, means to alternately direct a portion of said pressure above the said piston, and resilient means compressed by the upward movement of said piston and adapted to drive said piston downwardly at a predetermined time.

5. A drill, means for supplying liquid pressure to said drill, comprising a cylinder, a piston adapted for reciprocation in said cylinder, a hollow piston rod for said cylinder carrying a drill, said pressure acting constantly on said piston to lift the same, means operated by the movement of said piston for alternately directing a portion of said pressure to act upon the opposite side of said piston, resilient means compressed by the upward movement of said piston, and said hollow piston rod in communication with the cylinder above said piston, whereby the high pressure is discharged through the said piston rod on the upward stroke of the piston.

6. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting constantly to lift said piston, means separate and distinct from said piston to divert a portion of said pressure above the piston to balance the pressure upon the same, and means to drive the piston and drill downward.

7. In a drilling mechanism, a reciprocating piston in operative engagement with the drill, a cylinder for said piston, fluid pressure providing means, fluid pressure acting constantly to raise said piston, means to balance the pressure above and below said piston, and resilient means to drive said piston and drill downward.

8. In a drilling mechanism, a reciprocating piston in operative engagement with the drill, a cylinder for said piston, fluid pressure providing means, fluid pressure acting constantly on said piston to raise it, means to balance the pressure above and below said piston, means to drive said piston and drill downward, and means operating said fluid pressure balancing means at the time of the drill impact to direct the entire fluid pressure upon the lower side of the piston to lift the drill.

9. In a fluid pressure operated drilling mechanism, a cylinder having a piston adapted for reciprocation therein, a hollow piston rod connecting the piston and the drill, means for providing fluid pressure to the cylinder to lift the drill, separate means for driving said drill downward, and communication between the cylinder and the hollow piston rod, whereby on the up stroke of the piston the fluid in the cylinder is discharged through the hollow piston rod and washes out the cuttings of the drill.

10. In a drilling mechanism, a drill and drill stem having internal passage-ways with outlets adjacent the drill end, a piston having a hollow rod having connection and communication with the drill stem passage-ways, fluid pressure providing means for providing pressure to opposite sides of said piston for actuating the drill, a cylinder for said piston, and the hollow piston rod in communication with the cylinder above the piston, whereby the fluid above the piston is forced down the piston rod and outwardly through the drill on the upward movement of the piston.

11. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting constantly to lift said piston, a valve separate and distinct from said piston to divert a portion of said pressure above the piston to balance the pressure upon the same, and means to drive the piston and drill downward.

12. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting constantly to move the piston in one direction, a valve to divert a portion of said pressure to balance the pressure upon the piston, separate means to drive the piston in the opposite direction; and a spring moving said valve to a closed position immediately upon the impact of the drill.

13. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting constantly to move the piston in one direction, a valve to divert a portion of said pressure to balance the pressure upon the piston, said valve normally closed, means actuated by the piston to open said valve when the pis-

ton is at one end of its stroke, separate means for driving the piston in the opposite direction, and means closing said valve immediately upon the impact of the drill.

14. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting constantly to lift said piston, a valve operated by the upward movement of the said piston for diverting a portion of said pressure above the piston to balance the pressure upon the same when it has reached the end of its upward stroke, means to drive the piston and drill downward, and a spring for closing said valve and the inlet of pressure above the piston immediately upon the impact of the drill.

15. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means constantly providing pressure at one side of the piston to move the same in one direction, a valve operated by the movement of said piston to direct a portion of the pressure to the opposite side of the piston to balance the pressure at the opposite sides thereof, and resilient means to move said piston and drill when said pressure is balanced on the opposite sides of said piston.

16. In a drilling machine, a pair of concentrically arranged pipes, a reciprocating piston movable in the inner pipe and having operative engagement with a drill, a valve at the upper end of said inner pipe and normally closing said pipe end, means for providing and delivering fluid under pressure to the outer pipe, constant communication between said inner pipe and said outer pipe below said piston for the admission of fluid under pressure, said piston movable upward by said fluid pressure, said piston adapted upon its upward movement to engage and open said valve and permit the admission of fluid under pressure above said piston, resilient means to move said piston and drill downwardly when said valve is open, and said valve automatically closing upon the impact of the drill and the stoppage of downward movement of the drill and piston.

17. In a pressure drill, means for supplying liquid pressure to said drill, an inner and an outer pipe, a drilling mechanism within the outer pipe, a reciprocating member within the inner pipe carrying a drill, said pressure communicating with one of said pipes above said reciprocating member, a valve movable by the movement of said reciprocating member for directing the pressure to balance the same at either side of said reciprocating member, and resilient means for driving said reciprocating member when said pressure is balanced as described.

18. In a pressure drill, a reciprocating piston in operative engagement with the drill, pressure means providing pressure acting

constantly to lift said piston, means operated by the upward movement of said piston diverting a portion of said pressure above the piston to balance the pressure upon the same when it has reached the end of its upward stroke, means to drive the piston and drill downward, and means for actuating said pressure diverting means to prevent the inlet of pressure fluid above the piston immediately upon the impact of the drill.

In testimony whereof I hereunto affix my signature.

IRA B. HUMPHREYS.

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