July 25, 1939. A. ANDERSON 2,167,194

APPARATUS FOR DEFLECTING DRILL HOLES

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Fig. 1

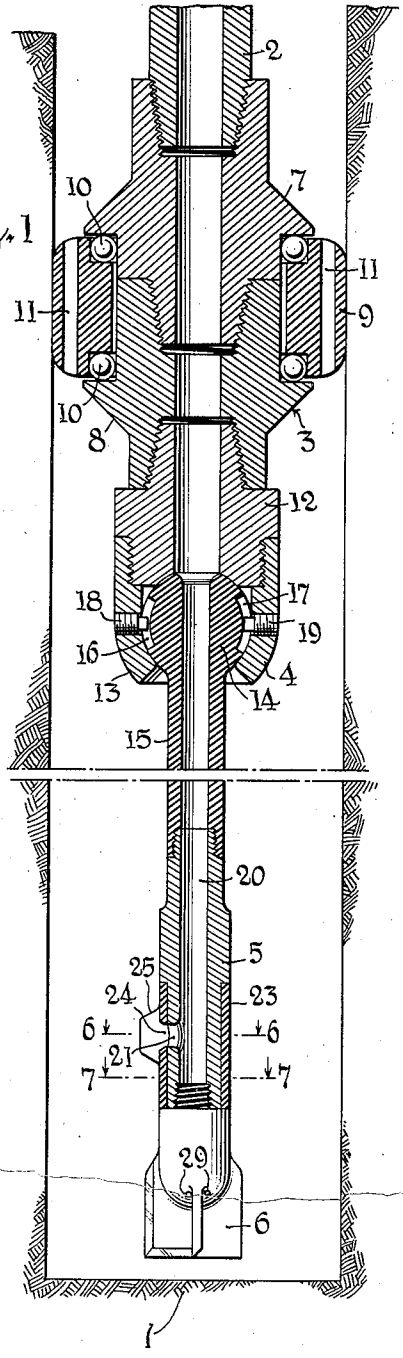
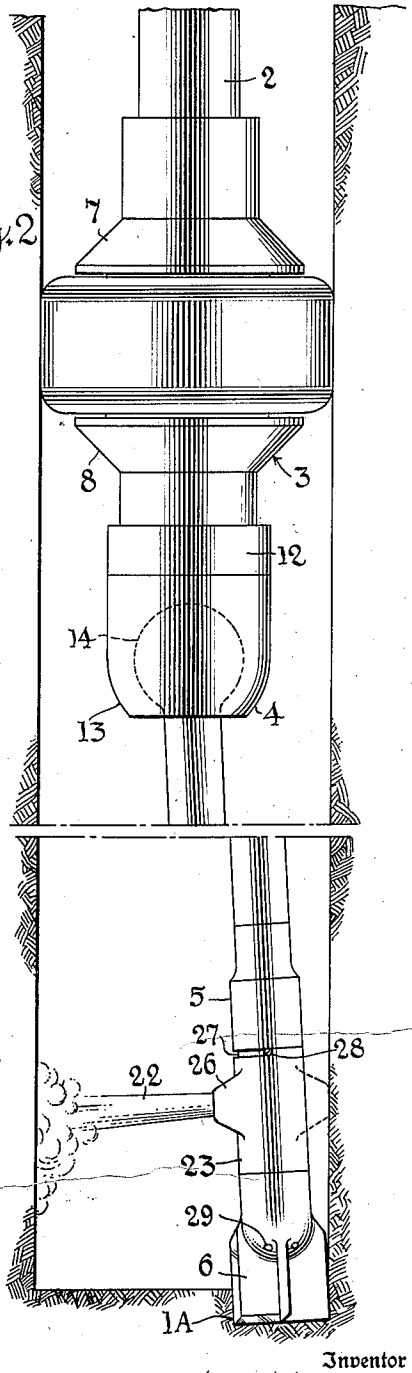


Fig. 2



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APPARATUS FOR DEFLECTING DRILL HOLES

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Fig. 3

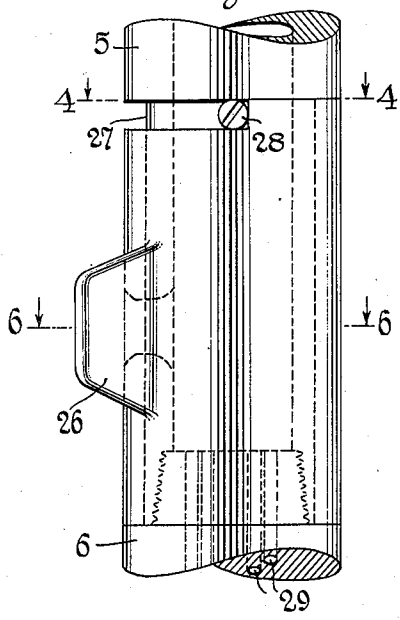

Fig. 4

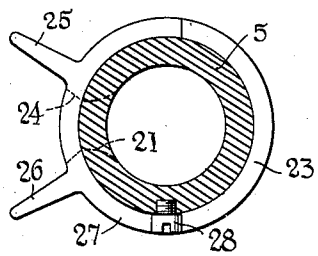

Fig. 5

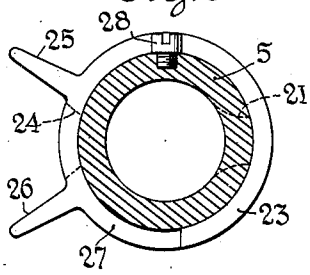

Fig. 6

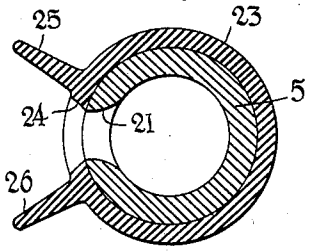

Fig. 7

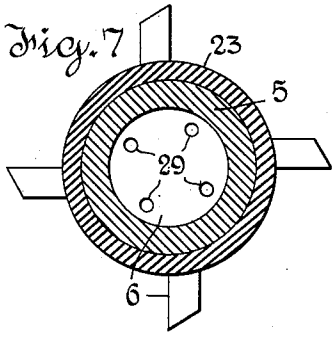

Fig. 9

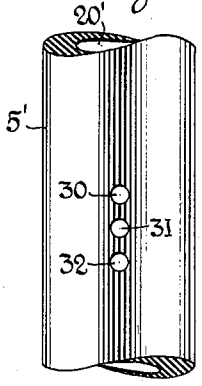

Fig. 8

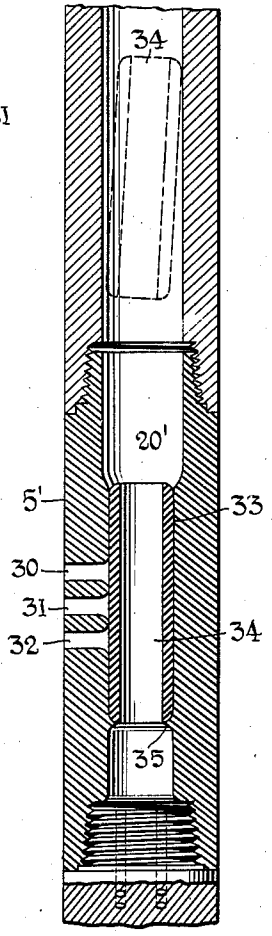

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Fig. 10

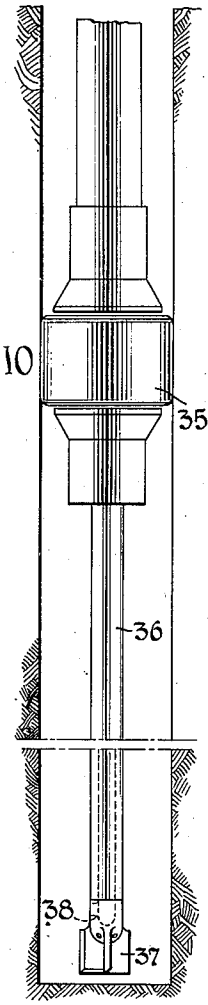


Fig. 11

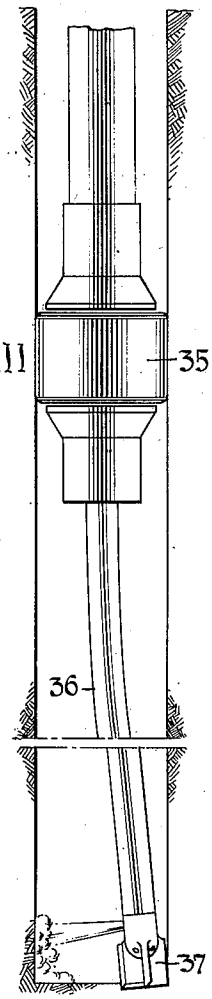


Fig. 13

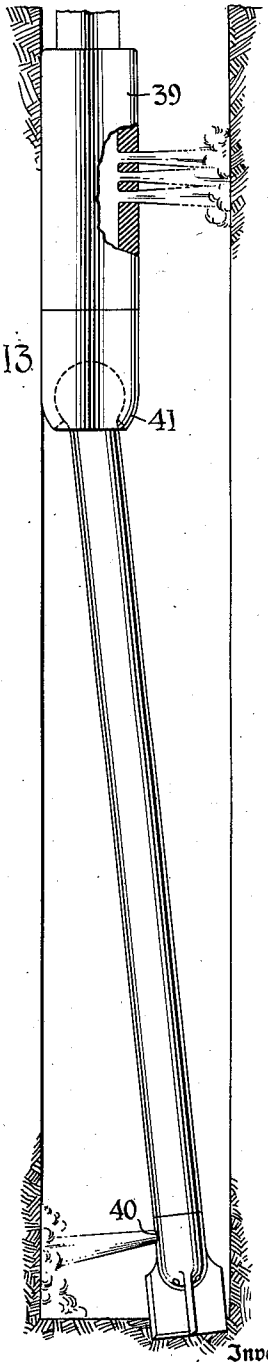
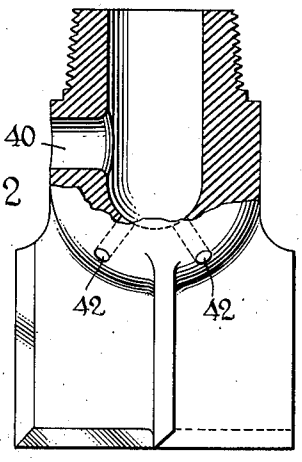


Fig. 12



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Patented July 25, 1939 2,167,194

UNITED STATES PATENT OFFICE

2,167,194

APPARATUS FOR DEFLECTING DRILL HOLES

Alexander Anderson, Fullerton, Calif., assignor, by mesne assignments, to Lane-Wells Company, Los Angeles, Calif., a corporation of Delaware

Application March 14, 1936, Serial No. 68,941

13 Claims. (Cl. 255—1)

This invention relates to improved methods and apparatus for drilling bore holes, and is directed particularly to methods and apparatus for deflecting or altering the course of a bore hole as to either inclination or direction or both.

It is well known that the influence of alternating hard and soft strata and many other conditions encountered in the drilling of a well often causes the drilling tools to deviate from a straight line. The problem of deflecting the bore hole back to its original direction or of directing it to another course is one that drillers constantly have before them. A common type of drilling problem occurs, for example, where a refinery has been located in an oil field and the operator wishes to tap the oil sand underneath the refinery but is precluded from erecting a derrick within the refinery area at the location which would normally be selected for that purpose. In such event the derrick can be located outside the limits of the refinery or to one side or another of the underground point to be tapped and then by utilizing deflecting tools and methods devised for that purpose the operator can proceed to direct the course of the bore hole toward the intended objective, making surveys of the hole from time to time and re-directing its course if and when it may be necessary.

Numerous methods and special equipment have been utilized in the past for deflecting bore holes, with varying degrees of success, but among those methods and devices with which I am acquainted there is none which is entirely satisfactory from the standpoint of both economy and practicability.

It is an object of this invention to provide a new and improved bore deflecting tool which can easily be lowered into a bore hole and can be easily oriented therein.

Another object is to provide a tool for the above-mentioned purpose having no inherent tendency to pull away from the direction in which it has been oriented when rotational drilling force is applied.

Still another object is to provide a deflecting tool which is relatively inexpensive to manufacture and yet which is characterized by a maximum degree of reliability and ruggedness.

A feature of the invention is that the deflectable end portion of the drill string is maintained in an undeflected position, that is, in general alignment with the main portion of the drill string during the lowering operation and, for that reason, the possibility of difficulty in getting the tool down through the bore hole is practically eliminated.

Another feature of the invention resides in the fact that no additional mechanism is required either to move the deflectable portion of the tool into a deflected position or to hold it in such position; and no extra external mechanical means are required to bring about the deflection.

The invention is characterized in that the tool is deflected by the application of hydraulic means, completely under the control of the driller. The hydraulic means preferably takes the form of one or more laterally directed high velocity streams of fluid ejected from the tool or drill string at one or more points near the lower end thereof, the force of reaction of the stream or streams of fluid thus ejected from the tool serving to forcibly deflect, in the desired direction, the deflectable tool portion.

There are a variety of possible methods of applying hydraulic pressure for bringing about the desired deflections of the drill bit but according to my view the simplest and most desirable method is that previously referred to which may appropriately be termed the hydraulic reaction method.

In the drawings which accompany this specification several of the preferred embodiments of my invention are illustrated and these will be described hereinafter. Referring to the drawings, for the purposes of illustration,

Figure 1 is a longitudinal sectional view through the bottom end portion of a bore hole and of the lower end of a drill string which includes a bore deflecting tool according to the preferred embodiment of this invention.

Fig. 2 is likewise a longitudinal sectional view of the lower end of a bore hole showing the bore deflecting tool in elevation and in deflected position.

Fig. 3 is an enlarged detail elevation view of that portion of the tool of Figs. 1 and 2 which includes the discharge orifice and rotary gate valve.

Fig. 4 is a cross sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a cross sectional view similar to Fig. 4 except that it shows the discharge orifice in the closed position whereas Fig. 4 shows it in the open position.

Fig. 6 is an enlarged cross sectional view taken along the line 6—6 of Figs. 1 and 3.

Fig. 7 is an enlarged cross sectional view taken along the line 7—7 of Fig. 1.

Fig. 8 is a longitudinal sectional view through

a portion of a tool shank illustrating an alternative arrangement for closing the discharge orifices.

Fig. 9 is an elevational view showing the arrangement of discharge orifices in the structure of Fig. 8.

Fig. 10 is a longitudinal sectional view of the bottom of a bore hole in which is shown suspended a drill string with an alternative type of deflecting tool.

Fig. 11 is a view similar to Fig. 10 but showing the deflecting drill bit in position to commence drilling.

Fig. 12 is an enlarged detailed view partly in section of a drill bit suitable for using in the structure of Figs. 10 and 11.

Fig. 13 is an illustration of another alternative construction and is a longitudinal section view through the bottom portion of a bore hole showing the deflecting tool in position therein.

With reference to the deflecting tool of Figs. 1 to 7 inclusive, an existing bore hole the course of which is to be altered by deflecting it at a slight angle in some predetermined direction is designated by the numeral 1.

The entire assemblage including drill pipe, drill bit, the other associated parts, will be referred to as a drill string.

The lower end 2 of a drill pipe is suspended from the ground level and the deflecting tool is attached thereto. The tool comprises, in general, a roller guide 3, a universal joint 4, an orifice and valve member 5, and a drill bit 6:

The roller guide 3 is made up of two parts 7 and 8 in threaded engagement and an annular member 9 having an outside diameter corresponding approximately to that of the existing bore hole and two sets of bearing balls 10 which permit the drill pipe and tool bits to rotate while the annular member 9 remains stationary except for longitudinal movement along the bore hole. The annular member 9 is preferably provided with a number of openings 11 to permit the free passage of fluid upwardly therethrough from the bottom of the bore hole.

The universal joint 4 comprises a member 12 connected by means of a threaded joint to the member 8, a ball housing 13 in which is housed a ball 14 having an extended shank 15. The ball 14 is provided with elongated slots 16 and 17 which engage the inner ends of pins 18 and 19 which are carried by the ball housing 13. Slots 16 and 17 are of a width to fit the engaging ends of pins 18 and 19 but as the slots are elongated, the ball is free to rotate within the housing to a limited angular extent. It will be evident that the universal joint structure permits the shank 15 to be angularly deflected in any direction with reference to the longitudinal axis of the main portion of the drill string while at the same time rotational movement of the drill pipe may be transmitted through the universal joint to the drill bit.

Through the entire assemblage down to the drill bit there is provided a passage way 20 which will be referred to as the "water course" or "internal water course".

Extending through the wall of the member 5 and in communication with the water course 20 is an orifice 21 through which a stream of water 22 can be ejected when the orifice is not obstructed and when everything is in readiness for the drill bit to be deflected from the vertical or initial position shown in Fig. 1 into an angular position as shown in Fig. 2.

Encircling and carried by the member 5 is a sleeve 23 which is rotatable about the member 5 and which serves as a gate for closing the passageway which includes orifice 21. Sleeve 23 is provided with an aperture 24 which registers with orifice 21 when the sleeve and member 5 are relatively in open position as illustrated most clearly by Fig. 6, with the orifice unobstructed.

As per Fig. 6, water flowing downwardly through the water course 20 and having a considerable applied pressure will be emitted through orifice 21 at high velocity and in a generally lateral direction thus creating a large reactionary force capable of angularly deflecting the tool as previously described with great force and positiveness. Sleeve 23, is preferably provided with one or more radially extending ears 25, 26 of such radial length as to be engaged by the side wall of the bore hole when the tool is in deflected position and rotation of the drill string has commenced. When one or more of the ears have been thus engaged the sleeve is restrained against rotation long enough to effect a closure of the discharge orifice.

Referring more particularly to Figs, 3, 4 and 5, it will be observed that the upper end of sleeve 23 is stepped down as indicated in 27 around rather more than one-half the circumference of the sleeve. A cap screw 28 threadedly secured in the member 5 serves as a stop means for limiting the angle of rotation of sleeve 23 on member 5. The relative rotation between sleeve 23 and the member 5 upon which it is mounted is preferably 180° because that angle permits of the aperture 24 having moved the greatest possible distance away from orifice 21. Ears 25 and 26 are preferably made of soft metal, as cold rolled steel, so that they will wear down quite rapidly to a diameter corresponding to that of the drill bit and thus quickly cease to impose any additional power load.

The drill bit 6 may be of any form such as that shown which is suitable for the purpose and preferably is provided with water passages 29 to permit the flow of fluid from the water course to the cutting edges of the bit. These water passages are preferably made parallel to the longitudinal axis of the bit, as shown.

In operation, the procedure is to lower the drill string into the existing bore hole with the sleeve 23 in the "open" position. Upon reaching bottom the drill string is raised sufficiently to permit the bit to come clear of the bottom and the drill string is so oriented that the orifice 21 will be disposed exactly opposite to the direction in which it is intended to deflect the bore hole. The pump is then started sending fluid down through the water course and out through the orifice at high velocity thus bringing about the desired deflection of the tool. While thus deflected the drill string is raised and lowered a few times so as to stamp out a seat in the bottom of the hole, as at 1A in Fig. 2, for the drill bit. The tool is then rotated a few times to get the new hole started. As the ears 25, 26 are of sufficient length to immediately engage the side wall of the existing bore hole, upon the initial rotation of the drill string the discharge orifice 21 will be shut off during the first revolution. The new hole having been started and the discharge orifices closed drilling may proceed until the universal joint reaches a position near the bottom of the hole 1. The deflecting tool is then withdrawn from the hole and other suitable drilling equipment is then

put down to enlarge and extend the new hole and continue the drilling operations.

In the structure of Figs. 1 and 2, instead of member 5 and the rotary sleeve 23 there may be substituted the device of Figs. 8 and 9 wherein the member 5' is shown with three discharge orifices, 30, 31, and 32, and a constriction 33 in the internal water course 20' which is designed to receive and seat a tubular sleeve 34 the function of which is to close the passage ways to the discharge orifices 30, 31 and 32. The tubular sleeve 34 is dropped down through the drill pipe when the driller wishes to shut off the discharge orifices, that operation being equivalent to rotating the sleeve 23 in the structure of Figs. 1 and 2 whereby the orifice 21 is closed. In the upper portion of Fig. 8 the sleeve 34 is shown, in dot and dash lines, on its way down the water course 20' just before arriving at its destination. An annular shoulder 35 on member 5' serves to stop the sleeve 34 at the proper position. While in the structure of Figs. 8 and 9 there are shown three discharge orifices 30, 31 and 32, it is to be understood that it is not necessary to use a plurality of such orifices but that it may be preferable to do so instead of using one large orifice because a large orifice weakens the member 5' more than a plurality of small orifices arranged linearly in the direction of the axis as illustrated.

An alernative design of deflecting tool which is somewhat simpler and less expensive to build than that of Figs. 1 and 2, is illustrated in Figs. 10 and 11. It is not suggested that this tool would always be a satisfactory substitute for the preferred structure of Figs. 1 and 2 but it is one that can sometimes be used. In this alternative design, the universal joint and also the valve means for shutting off the flow of water through the discharge orifices is omitted. In the arrangement shown, in Figs. 10 and 11 there is provided a roller guide 35 of the same design as the roller guide 3 of Fig. 1 to the lower end to which is attached a flexible drill pipe 36 which is preferably of relatively small diameter. To the lower end of the flexible pipe 36 is connected the drill bit 37 having a laterally directed discharge orifice 38 which is in communication with the internal water course. The high velocity stream of water leaving the discharge orifice 38 causes the drill pipe 36 to flex in the desired direction as illustrated in Fig. 11. The pipe 36 should be of a length suitable to give the requisite flexure.

Fig. 12 is an enlarged view somewhat in detail of a drill bit such as is shown on a smaller scale in the structure of Figs. 10 and 13. This figure is shown partially in section so as to illustrate the laterally directed discharge orifice 40. A number of relatively small openings 42 connecting with the internal water course are provided in the drill bit of Fig. 12 for the purpose of conveying fluid directly to the blades of the bit.

Obviously a drilling tool having shut off means for the discharge orifices as shown in Figs. 1 and 8 could be employed in combination with the flexible drill pipe 36 shown in Figs. 10 and 11.

The structure of Fig. 13 has been included more particularly to illustrate an arrangement employing two water jets, one above the universal joint or point of flexure and the other below, the two jets being directed oppositely whereby the drill bit is kicked laterally in one direction while the portion of the drill string including the universal joint is deflected the opposite way. In this arrangement there is no roller guide or other centering device for the drill string. The member 39 of Fig. 13 may correspond to the member 5' of Fig. 8. The discharge orifice 40 of Fig. 13 may be of the type having no shut off means as in the structure of Fig. 10 or it may be provided with a suitable valve mechanism such as that used in the structure of Fig. 1. In Fig. 13 the universal joint is indicated by the numeral 41.

The method of operating the alternative forms of tools illustrated and described herein is the same in each case and as described for the preferred embodiment.

What I claim is:

1. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, and a valve mechanism operable to open and close the passageway which includes said orifice, said valve mechanism being actuable by rotating said drill string.

2. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, and a valve mechanism having a part adapted to contact the interior of the bore and operable to open and close the passageway which includes said orifice, said valve mechanism being actuable by rotating said drill string.

3. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, and a valve mechanism for opening and closing the passageway which includes said orifice, said valve mechanism including a sleeve at least partially encircling said drill string in the region of said orifice, said sleeve being rotatable about said drill string and operable to cover and uncover said orifice, said valve mechanism being actuable in response to rotation of said drill string, rotation of the drill string in one direction serving to open the passageway while rotation in the opposite direction serves to close the passageway.

4. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, and a valve mechanism for opening and closing the passageway which includes said orifice, said valve mechanism including a sleeve at least partially encircling said drill string in the region of said orifice, said sleeve being rotatable about said drill string and so disposed as to be operable to cover said orifice, said sleeve having an aperture so situated as to be capable of being brought into registration with said orifice, whereupon said passageway is rendered open, said valve mechanism being actuable in response to rotation of said drill string in one direction to effect a closure of said passageway and actuable in response to rotation of said drill string in the opposite direction to open said passageway.

5. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the

lower end of said drill string, said orifice being in communication with said water-course, a sleeve carried by and encircling said drill string, said sleeve being operable to cover said orifice and thereby obstruct the flow of water therethrough, said sleeve being rotatable about said drill string as an axis and having an aperture so disposed as to be capable of being brought into registration with said orifice by relative rotation of said sleeve and drill string, and stop means limiting the angle of possible rotation of said sleeve about said drill string in both directions of rotation, said aperture being so positioned as to be in registration with said orifice only when said sleeve occupies a predetermined one of its two extreme positions.

6. In well-drilling apparatus, a drill string having an internal water course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, and a valve mechanism for opening and closing the passageway which includes said orifice, said valve mechanism including a sleeve at least partially encircling said drill string in the region of said orifice, said sleeve having at least one radially extended projection of sufficient length to be adapted to engage the said wall of a bore hole when the said sleeve is rotated, said sleeve being rotatable about said drill string and operable to cover and uncover said orifice, said valve mechanism being actuable in response to rotation, rotation of the drill string in one direction serving to open the passageway while rotation in the opposite direction serves to close the passageway.

7. In well-drilling apparatus, a drill string having an internal water-course extending lengthwise thereof and a passageway including a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water-course, a sleeve carried by and encircling said drill string, said sleeve being operable to cover said orifice and thereby obstruct the flow of water therethrough, said sleeve being rotatable about said drill string as an axis and having an aperture so disposed as to be capable of being brought into registration with said orifice by relative rotation of said sleeve and drill string, said sleeve being provided with at least one radially extending projection of sufficient length to be adapted to engage the side wall of the bore hole when said sleeve is rotated, and stop means limiting the angle of possible rotation of said sleeve about said drill string in both directions of rotation, said aperture being so positioned as to be in registration with said orifice only when said sleeve occupies a predetermined one of its two extreme positions.

8. In well-drilling apparatus, a drill string including a drill bit at the lower end thereof and a flexible joint above said drill bit but in the vicinity thereof, whereby the portion of said drill string below said flexible joint can be angularly flexed, said drill string having a water course extending lengthwise thereof and a laterally extending discharge orifice in communication with said water course, said discharge orifice being located below said flexible joint, and a valve mechanism operable by the driller for obstructing said discharge orifice.

9. Well drilling apparatus in accordance with claim 8 characterized in that the valve mechanism comprises a rotatable sleeve mounted upon and at least partially encircling the drill stem, said sleeve being relatively rotatable with respect to said drill stem for obstructing the passageway including said orifice by rotating the drill stem.

10. In well-drilling apparatus, a drill string having an internal water course extending lengthwise thereof and a lateral discharge orifice situated in the vicinity of the lower end of said drill string, said orifice being in communication with said water course, the arrangement being such that the force of reaction of a stream of water discharged through said orifice will cause the lower end of said drill string to be deflected laterally, and means for obstructing said orifice comprising a sleeve adapted to be dropped through said water course and means for stopping the fall of said sleeve through said water course at a point adjacent to said orifice.

11. Well-drilling apparatus in accordance with claim 10 wherein the sleeve is tubular.

12. In well-drilling apparatus a drill string including a drill bit at the lower end thereof and a flexible joint above said drill bit but in the vicinity of the lower end of the drill string said drill string including an internal water course extending lengthwise thereof to said drill bit and a pair of lateral discharge orifices in communication with said water course said orifices being directed opposite, one being situated above said flexible joint and the other below said flexible joint.

13. A well drilling tool for use on a tubular drilling string handling fluid under pressure, said tool comprising a bit, means connecting the bit with the string to turn therewith and have angular movement with respect thereto and conducting the fluid from the string to the bit, and means regulable by varying the pressure on the fluid for moving the bit to an angular position relative to the string, the last named means including walls in the bit defining a fluid passage receiving the fluid from the first named means and discharging it laterally in the well whereby the bit is swung out of alignment with the string by the reaction of the fluid thus discharged.

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