May 8, 1945. L. C. MILLER 2,375,313

WELL TOOL

Filed Feb. 7, 1941 3 Sheets-Sheet 1

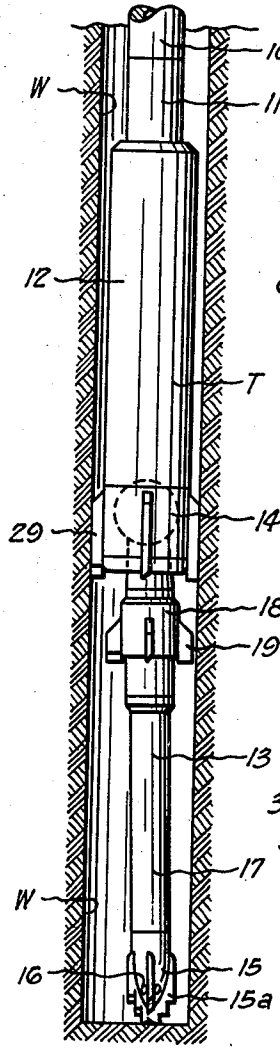

Fig. 1.

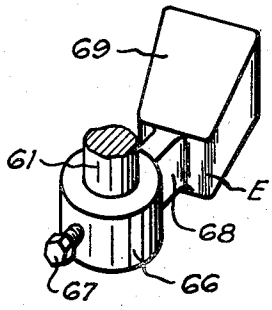

Fig. 8.

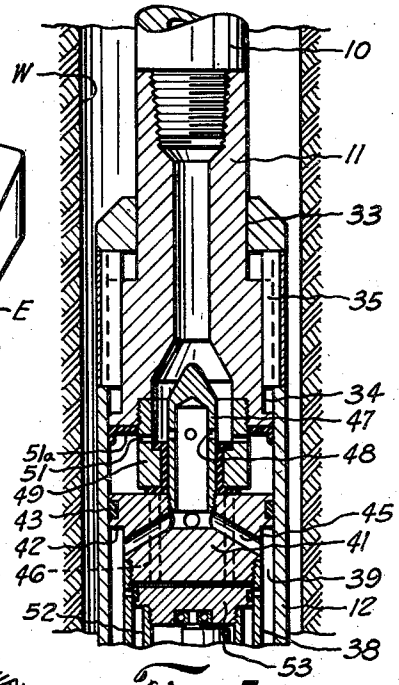

Fig. 5.

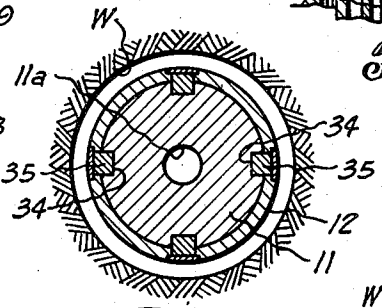

Fig. 6.

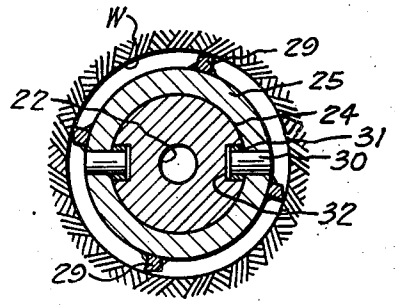

Fig. 7.

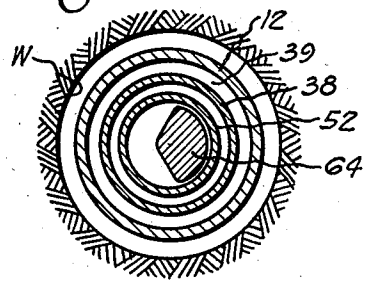

Fig. 4.

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WELL TOOL

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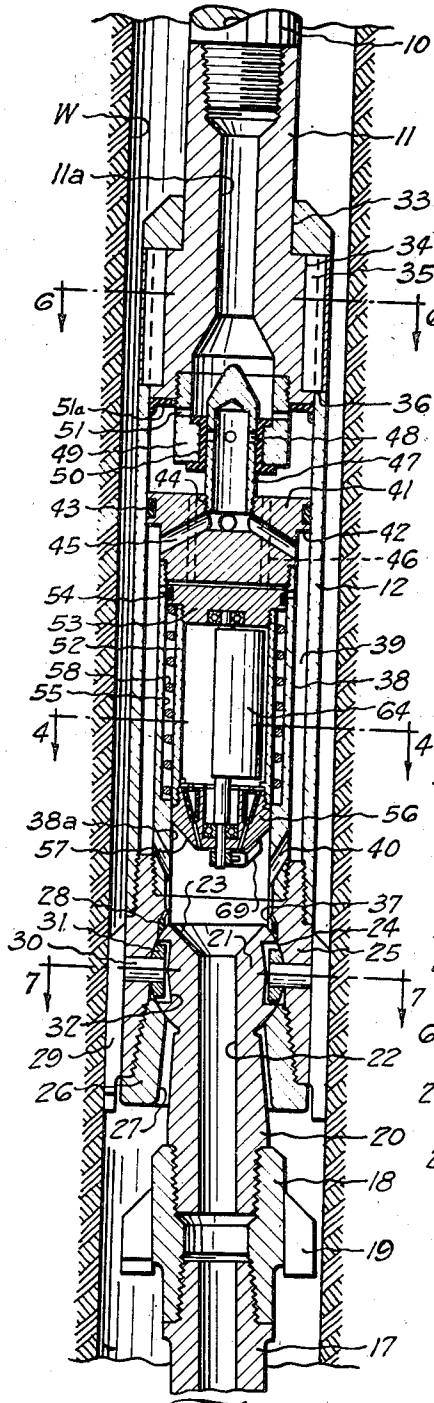

Fig. 2.

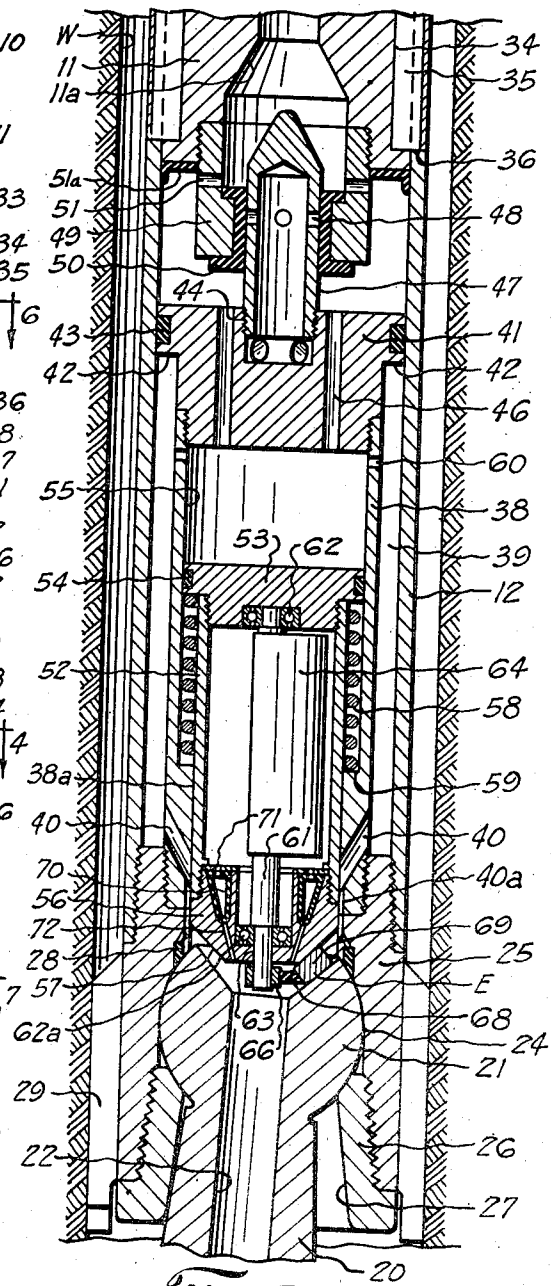

Fig. 3.

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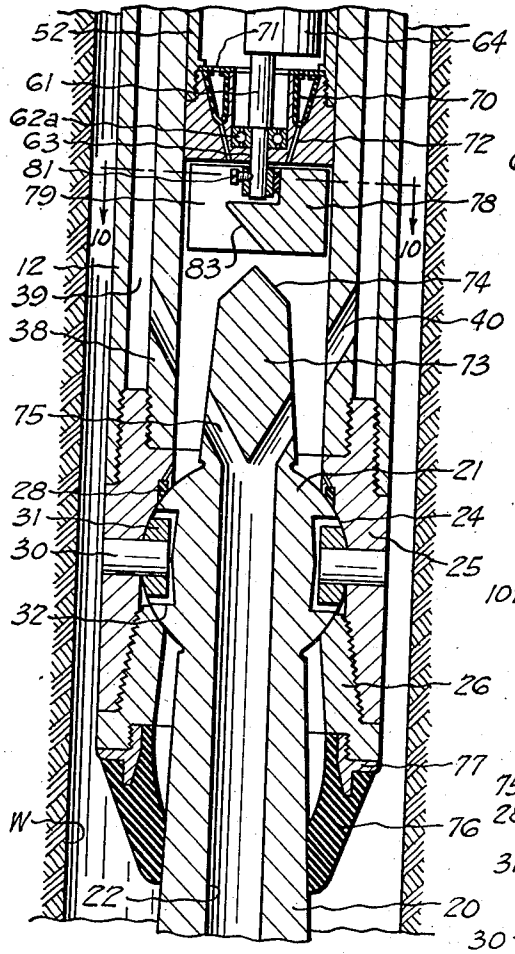

Fig. 9.

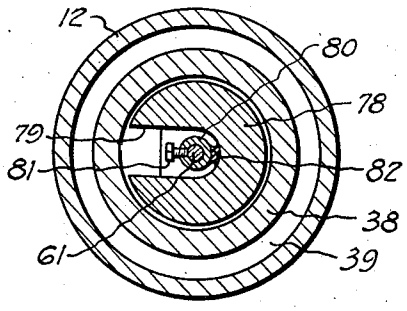

Fig. 10.

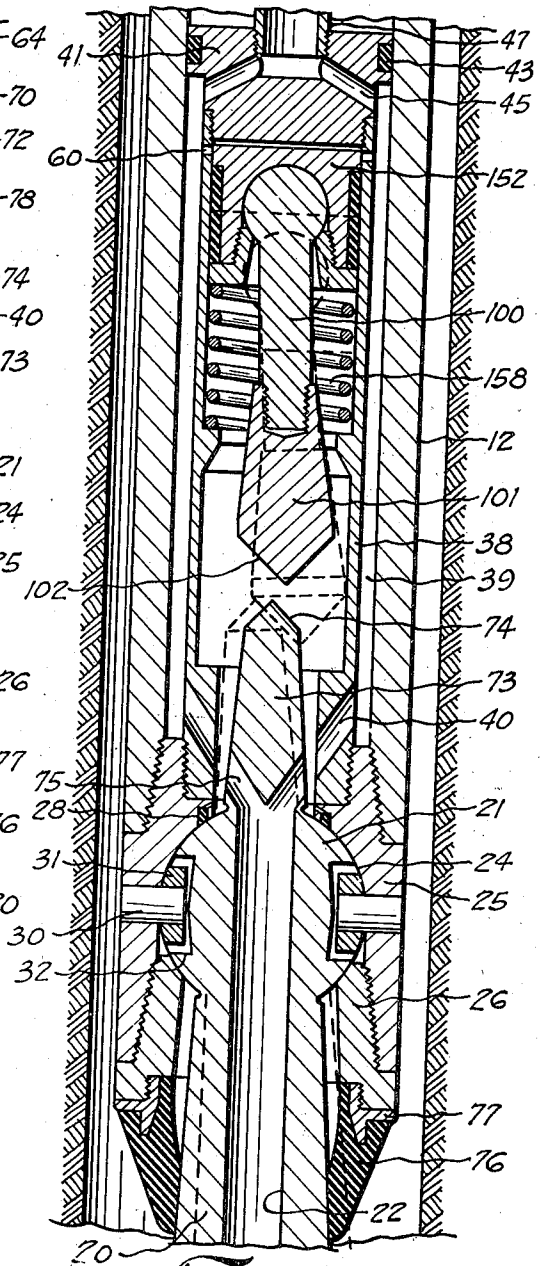

Fig. 11.

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Patented May 8, 1945

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UNITED STATES PATENT OFFICE

2,375,313

WELL TOOL

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Application February 7, 1941, Serial No. 377,771

16 Claims. (Cl. 255—1.6)

This invention relates to new and useful improvements in well tools.

One object of the invention is to provide an improved well tool which is adapted to be lowered into position within a well bore and oriented into a predetermined known angle or position relative to the low side of the hole; the tool being adapted for use in properly locating a wall hook, or other device in the bore and being particularly useful in controlled or directional drilling operations.

The invention will be described herein as combined with a drill bit assembly but it is not to be limited to such combination for it will be apparent that the tool may be employed with other devices for locating the same within the well bore.

An important object of the invention is to provide an improved well tool wherein a well device is arranged to be positively swung or off-set in a predetermined known direction after the tool has been lowered into the well bore, whereby accurate orientation of the device without the necessity of rotating said tool and device may be accomplished to permit subsequent well operations.

A particular object of the invention is to provide an improved well tool wherein an element or device is suspended from the body of the tool so as to be capable of deflection in any direction, together with hydraulically actuated means for engaging and deflecting said element in a predetermined known direction; said means not only acting to initially deflect the element but also functioning to lock said element in its deflected position, whereby the element is properly oriented within the well bore and subsequent operations may be immediately commenced.

Another object of the invention is to provide an improved well deflecting tool which is so constructed that the hydraulically actuated means for accomplishing deflection of the bit assembly may be operated by the pressure of the drilling fluid which normally circulated downwardly through the drill pipe and around the bit during the drilling operation, whereby the necessity of providing a separate or auxiliary conductor for actuating said hydraulic means is eliminated.

Still another object of the invention is to provide an improved valve arrangement for controlling the flow of fluid pumped downwardly through the drill stem to the tool, whereby said fluid may be directed to the hydraulically operated deflecting and locking means to deflect and lock the bit in a predetermined position; the arrangement being such that after the bit has been properly oriented and actual drilling started, the valve is automatically actuated to permit circulation of the fluid through the drill bit and also to the deflecting and locking means to retract the same.

A further object of the invention is to provide an improved tool of the character described, wherein a gravity controlled actuating means is adapted to be moved into engagement with the suspended drill bit to cause a deflection of said bit in a predetermined known direction, said gravity controlled means being readily adjustable to cause deflection of the bit in any desired direction.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, as an example of the invention is shown, and wherein:

Figure 1 is an elevation of a deflecting tool, constructed in accordance with the invention, and illustrating the tool lowered within a well bore,

Figure 2 is an enlarged, transverse, vertical, sectional view of the deflecting tool with the hydraulic deflecting and locking means in a retracted position,

Figure 3 is an enlarged transverse, vertical sectional view of the deflecting and locking means in engagement with the upper end drill bit, said bit being in its deflected position,

Figure 4 is a horizontal, cross-sectional view, taken on the line 4—4 of Figure 2,

Figure 5 is a transverse vertical, sectional view of the valve arrangement, with the parts in position during actual drilling and following retraction of the deflecting and locking means,

Figure 6 is a horizontal, cross-sectional view, taken on the line 6—6 of Figure 2,

Figure 7 is a horizontal, cross-sectional view, taken on the line 7—7 of Figure 2,

Figure 8 is a detail of the actuating shoe,

Figure 9 is an enlarged, transverse, sectional view of a modified form of the invention,

Figure 10 is a horizontal cross-sectional view, taken on the line 10—10 of Figure 9, and

Figure 11 is a view, similar to Figure 4, of still another form of the invention.

In the drawings, the numeral 10 designates the usual rotatable drill pipe or stem which has an elongate coupling sleeve 11 threaded onto its lower end. The drill stem is adapted to be lowered through the well bore W and has the im-

proved deflecting tool T connected to its lower end by means of the coupling sleeve 11. The deflecting tool includes a main body or housing 12 which is connected to a pilot bit assembly 13 by means of a ball and socket connection 14 and, manifestly, the pilot bit assembly is free to swing with relation to the longitudinal axis of the housing 12 and drill stem 10.

The assembly 13 includes a pilot bit 15 having radially extending cutting blades 15a formed on its outer surface. The body of the bit is preferably bored and is formed with the usual fluid circulating passages 16 which have their lower ends terminating adjacent the cutting blades 15a. The bit 15 is connected to the lower end of an elongate, tubular stem 17 and the upper end of this stem is threaded into the body 18 of a main cutting bit or reamer. The reamer includes vertically extending cutting blades 19 which project radially outwardly from the body of said reamer a desired distance so that upon rotation of said blades within the formation, a bore of the desired diameter is drilled. A tubular shank 20 has its lower end threaded into the body of the reamer 18 and a ball 21 is preferably formed integral with the upper end of this shank. It is preferable that the shank have a general tapered, external surface, being slightly reduced toward its upper end and immediately below the ball 21. An elongate passage or bore 22 extends through the shank 20 and through the ball 21 and the upper end of this passage or bore is flared outwardly to provide an amplified inclined or bevelled seating surface 23. Since the shank 20 is directly threaded into the body 18 of the reamer, it will be obvious that the passage 22 through said shank and through the ball establishes communication between the area above the ball and the pilot bit assembly.

The ball 21, which is provided at the upper end of the shank 20, fits or engages within a ball socket 24 which is formed within a socket element 25 and the ball is retained within said socket by means of a flanged collar 26 which is threaded into the lower end of the socket element 25. The bore 27 of the retaining collar 26 is flared or tapered complementary to the tapered external surface of the shank 20 and this bore co-acts with the shank to limit the swinging movement of the pilot bit assembly 13 with relation to the socket element 25. A suitable packing ring 28 may be interposed between the socket 24 and the upper portion of the outer surface of the ball 21 and this ring may be exposed to the pressure surrounding the ball and socket, whereby such pressure will urge the ring into a tighter sealing engagement. The socket element 25 within which the ball 21 is mounted is axially alined within the well bore W by means of radially extending cutting blades 29 which extend vertically on the outer surface of said element.

For rotatably connecting the socket element 25 with the ball 21 so that a rotation of the element will impart rotation to the ball and thus to the pilot bit assembly 13, said element is provided with a plurality of inwardly extending pins 30 which are suitably secured within the body of the element. A bearing collar 31 is mounted on the inwardly projecting end of each pin and each collar is disposed within a vertical recess 32 which is formed in the external surface of the ball 21 above the retaining collar 26. The recesses 32 are of a sufficient length with relation to the diameter of the collars 31 to permit the ball 21 to undergo a rotative or swinging movement within its socket 24. Thus, the pilot bit assembly 13 may undergo a swinging movement with relation to the socket element 25 but upon a rotation of said socket element, a similar rotation is imparted to the pilot bit assembly through the co-action of the connecting pins 30 and the recesses 32.

The tubular body or housing 12 of the deflecting tool has its lower end threaded onto the upper end of the socket element 25 and said housing extends upwardly from said element. The extreme upper end of the bore of the housing 12 is reduced as shown at 33 and the coupling sleeve 11 which connects the drill stem 10 with the housing slidably extends through this reduced portion, whereby the lower portion of said sleeve is disposed within the upper end of the housing. For rotatably connecting the sleeve 11 to the housing 12, while permitting a limiting sliding movement of said sleeve relative to the housing, said sleeve is formed with a plurality of vertical key-ways 34 in its lower portion. Each key-way 34 is adapted to receive an elongate, vertically extending key 35 which is suitably secured within an opening 36 provided in the upper end of the housing 12. It is noted that the keys 35 may, if desired, be made integral with the wall of said housing. Manifestly, with this arrangement, the coupling sleeve 11 may undergo a limited longitudinal movement with relation to the housing 12 but a rotation of the sleeve will impart a similar rotation to the housing through the co-action of the key-ways 34 with the keys 35.

From the above it will be seen that the drill stem 10 has a direct connection with the housing 12 through the sleeve 11 and any rotation of the stem will rotate said housing. The lower end of the housing, being threaded onto the socket element 25, will impart a rotation to said socket element and the pin and recess connection between said element 25 and the ball 21 will result in a rotation of the pilot bit assembly 13. The socket element 25 is formed with an axial bore 37 which extends upwardly from the socket 26 and the upper end of this bore is enlarged and threaded to receive the lower end of an elongate cylinder 38. As is clearly shown in Figure 2, the cylinder 38 is concentric to the housing 12 and is of a smaller diameter than the bore of said housing, whereby an annular space or passage 39 is formed between said cylinder and the wall of the housing. The extreme lower end of the cylinder 38 is provided with inclined ports 40 which establish a communication between the annular passage 39 and the interior of the cylinder at its lower end.

The upper end of the cylinder 38 is closed by a flanged head or cap 41 which is threaded into the upper end of the cylinder. The flange 42 of the head has an external diameter substantially equal to the diameter of the housing bore and this flange has an annular packing element or ring 43 mounted therein to provide a seal between the cap and the housing, whereby the upper end of the annular passage 39 is sealed or packed off. The upper end of the cap or head 41 is formed with an axial bore 44 which extends downwardly from the top of the head. The lower end of the bore 44 communicates with the annular passage 39 through a plurality of radially extending, inclined ports 45 which are formed in the head and which are open to the extreme upper end of the annular passage 39. Communication between the housing 12 above the head or cap 41 and the interior of the cylin-

der 38 is established through a plurality of vertical passages 46 which are drilled through said head and which are located between the radial ports 45, as is clearly evident from Figures 2 and 3.

A tubular valve stem 47 has its lower end threaded into the axial bore 44 of the closure head or cap 41 and this stem extends upwardly above said head and into the lower, enlarged end of the bore 11a of the coupling sleeve 11. This tubular stem has its lower end in communication with the annular passage 39 between the cylinder 38 and the housing 12, such communication being through the inclined ports 45 which are formed in the head 41. A plurality of openings 48 are provided in the upper end of the tubular stem 47 and establish communication between the bore of said said stem and the exterior thereof. A valve sleeve 49 is threaded into the lower end of the bore 11a of the coupling 11 and this sleeve surrounds the valve stem 47. The lower portion of the sleeve 49 has a packing element 50 mounted within its bore and when the coupling sleeve is in a raised position, as shown in Figure 2, the packing element 50 overlies the openings 48 in the tubular valve stem to close said openings. When the coupling 11 is moved downwardly with relation to the housing 12, such movement being permitted by the key connection between said sleeve and housing, the valve sleeve 49 is moved downwardly on the valve stem so as to uncover the openings 48; at the same time, the lower end of the packing element 50 engages the upper end of the head or cap 41, as shown in Figure 5, to overlie and close the vertical passages 46 in said head and thereby cut off communication to the upper end of the cylinder 38. Immediately above the packing element 50, the valve sleeve 49 is provided with a plurality of radial ports or openings 51 which establish a communication between the bore 11a of the coupling 11 and the upper end of the housing 12 above the head 41. A suitable packing cup 51a may be secured to the underside of the coupling 11 so as to seal off between said coupling and the bore of the housing 12 and prevent the escape of a fluid from within the housing outwardly through the key slots 34.

The tubular valve stem 47 and the valve sleeve 49 which co-acts therewith provides an efficient means for controlling the flow of fluid which is circulated downwardly through the drill stem 10. When the parts are in the position shown in Figure 2, the fluid flowing downwardly through the drill stem will pass outwardly through the ports 51 in the valve sleeve 49 and then downwardly through the vertical passages 46 in the head to the interior of the cylinder 38. When the coupling 11 and drill stem 10 have been moved downwardly with relation to the housing 12 so that the valve sleeve 49 is moved downwardly on the valve stem 47, as shown in Figure 5, a flow through the vertical passages 46 in the head 41 and to the cylinder 38 is shut off. However, the downward movement of the valve sleeve relative to the stem has uncovered the radial openings 48 in the upper portion of said stem, whereby fluid from the drill pipe 10 may pass downwardly into the tubular stem 47 and then through the inclined ports 45 in the head 41 to the annular passage 39 within the housing 12. From this passage, the fluid flows through the inclined ports 40 in the lower end of the cylinder and then downwardly through the shank 20, tubular extension 13 and finally out through the circulating ports 16 in the pilot bit 15. Thus, with the valve in the position shown in Figure 5, a normal circulation of drilling fluid downwardly to the pilot bit may be accomplished, such fluid being bypassed around the cylinder 38.

A tubular or hollow piston 52 is reciprocable within the bore 38a of the cylinder 38. The piston has its upper end closed by a flanged cap 53 which is threaded therein and the outer periphery of the cap carries a suitable packing ring 54 which has a sealing engagement with the counterbore 55 of the cylinder 38. The lower end of the piston is closed by a plug 56 which has its lower portion formed with a bevelled or inclined surface 57. The piston 52 is normally held in a raised position within the cylinder, as shown in Figure 2, by a coiled spring 58 which is confined between the flange of the cap 53 and an internal shoulder 59 which is formed within the cylinder by the counterbore 55. When the valve stem 47 and its co-acting valve sleeve 49 are in the positions shown in Figure 2, a fluid pressure from the drill stem may pass downwardly into the upper end of the housing above the head 41 and then downwardly through the vertical passages 46 into the upper end of the cylinder 38, whereby the tubular piston 52 is moved downwardly within the cylinder. Upon a release of pressure from above the piston 52, the spring 58 will raise said piston upwardly to its original position (Figure 2), any pressure above said piston escaping through bleeder ports 60 which are formed in the upper end of the cylinder 38 below the head 41.

A gravity controlled actuating means is carried by the piston 52 and this means is clearly shown in Figure 3. The actuating means is provided for the purpose of deflecting the pilot bit assembly 13 in a predetermined direction within the well bore and includes a shaft 61 which extends axially through the tubular piston 52. The upper end of the shaft is rotatably mounted in bearings 62 which are mounted within the cap 53, while the lower end of the shaft extends outwardly to an opening 63 formed in the plug 56 which closes the lower end of the piston. The lower portion of the shaft 61 is mounted within ball bearings 62a which are suitably supported within the plug 56 and, thus, it will be seen that the shaft 61 is freely rotatable within the interior of the piston 52. A weight 64, which is arcuate in cross-section (Figure 4) is permanently secured on the shaft 61 and, obviously, will tend to fall to the low side of the well bore when the device is lowered therein. Therefore, the weight will tend to rotate the shaft 61 to a predetermined position with relation to the low side of said well bore.

An actuating element E is mounted on the lower projecting end of the rotatable shaft 61 and includes a collar 66 which is fastened to the shaft by means of a set screw 67 or by some other adjustable means. A radially extending, flexible arm 68 which is made of rubber or other yieldable material, extends outwardly from the collar 66 and has a bearing shoe 69 secured to its outer end. The bearing shoe 69 is constructed of a relatively light material, such as aluminum, and disposed at an angle from the horizontally extending arm 68, such angle being substantially complementary to the incline or bevel of the seating surface 23 at the upper end of the ball 21. The interior of the piston 52 contains a suitable dampening fluid or liquid and in order to equalize the pressure interiorly and exteriorly of said piston an annular packing element 70 is mounted within the plug 56 (Figure 3). The interior of

the packing element 70 is exposed to the liquid within the interior of the piston 52 through ports 71, while the exterior of said element is exposed to the pressure of the fluid within the entire tool through inclined passages 72. The annular element 70 provides a compensating means whereby the pressure within the piston and outside of said piston may be equalized.

The bearing shoe 69 is secured to the shaft 61 in a predetermined position with respect to the weight 64, which is also fastened on said shaft and when the piston is in a raised position, as shown in Figure 2, the shoe 69 is spaced a slight distance from the lower end of the piston, as is clearly shown in Figure 2. As the device is lowered into the well bore, it will be obvious that the weight 64 will find the low side of said bore and will rotate the shoe 69 to a predetermined position relative to the low side of said well bore. Since the shoe is of a relatively light material, it will not interfere with or effect the rotation of the shaft 61, as controlled by the weight. When a fluid pressure is admitted to the upper end of the cylinder, the piston 52 is moved downwardly, whereby the bearing shoe 69 is engaged with the inclined seating surface 23 of the ball 21. A continued downward movement of the piston will clamp the shoe 69 between the surface 23 of the ball 21 and the inclined surface 57 of the lower end of the piston, such clamping being made possible by the flexible arm 68 which supports the shoe 69. The provision of the flexible or yieldable arm 68 also prevents the transmission of any strain to the shaft 61, whereby any danger of said shaft being bent or broken is obviated. After such position is reached a continued pressure on the piston 52 will result in a deflection of the pilot bit assembly, such deflection being in a direction 180° opposite the point of contact of the shoe 69 with the ball 21. By properly positioning the shoe 69 on the shaft 61 with respect to the weight 64, it will be obvious that deflection of the pilot bit assembly in a desired direction may be accomplished.

In the operation of the device, the bearing shoe 69 is fastened on the rotatable shaft 61 in a predetermined, known position with relation to the weight 64. For example, the shoe might be disposed in vertical alinement with the weight 64, in which case said shoe would be moved to a position in alinement with the low side of the well bore when the device was lowered into said bore. As illustrated, the shoe 69 is shown in a position offset a number of degrees from the position of the weight 64.

The device is lowered downwardly into the well bore by means of the drill stem 10 in the usual manner. During such lowering, the housing 12 is maintained in substantial axial alinement with the well bore by means of the blades 29 which are formed on the exterior surface of the socket element 25, the outer edges of said blades engaging and riding upon the wall of the well bore W. During lowering of the device, the piston 52 within the cylinder 38 is held in its raised position by the coiled spring 58 and in such position, the bearing shoe 69 is spaced upwardly above the seating surface 23 of the ball 21. Due to the ball and socket connection, the pilot bit assembly 13 is free to swing with relation to the housing 12 and, manifestly, said assembly will swing in a direction toward the low side of the well bore. Thus, when the lower end of the bore is reached, it is probable that the pilot bit assembly is in a position with the bit 15 engaging the low side of said bore; however, said bit might be in any other position at this time.

After lowering of the tool is completed, a pressure fluid is pumped downwardly through the drill stem and such pressure will flow downwardly through the bore 11*a* of the coupling 11 and then through the ports or openings 51 in the valve sleeve 49. This pressure fluid will then pass downwardly through the vertical passages 46 in the closure head 41 and into the upper end of the cylinder 38 above the piston 52, whereby said piston will be moved downwardly against the pressure of the spring 58. Upon downward movement of the piston, any pressure below said piston can readily escape either through the ports 40 in the cylinder wall or through the bore 22 of the shank 20 and then downwardly through the bore of the drill bit assembly. As explained, the weight 64 will have swung to the low side of the hole; whereby the shoe 69 is located in a predetermined position with relation to the low side of the bore. As the piston 52 is moved downwardly by the application of pressure thereto, the shoe 69 is moved into engagement with the seating surface 23 of the ball 21 and said shoe will be clamped between this seating surface and the inclined lower end 57 of the piston. A continued downward movement of the piston causes a downward pressure on the seating surface 23 at its point of contact with the shoe 69, whereby the ball 21 is rotated within its socket and the entire pilot bit assembly deflected or swung into a predetermined or known position, as controlled by the initial setting of the bearing shoe 69.

After the bit assembly 13 has been deflected in the manner above described, the entire assembly is lowered so that the bit 15 engages the bottom of the well bore. The weight of the drill stem is then placed upon the deflecting tool and such lowering of the drill stem causes the coupling sleeve 11 to move downwardly with relation to the housing 12, such downward movement being permitted by the key connection between the housing and the sleeve. Downward movement of the coupling 11 with relation to the housing 12 continues until the parts assume the position shown in Figure 5, at which time the packing element 50 of the valve sleeve 49 secured to the lower end of the coupling 11 strikes the top of the closure head 41. When this occurs, the packing element 50 overlies the vertical passages 46 in the head and shuts off the communication with the upper end of the cylinder 38 above the piston 52. The downward movement of the coupling 11 with relation to the housing 12 causes the valve sleeve 49, which is carried by said coupling, to move downwardly on the tubular valve stem 47, whereby the packing element 50 of said sleeve which normally closes the ports or openings 48 in the stem 47 is moved downwardly below said openings so as to uncover the same. When the ports or openings 48 are uncovered, the fluid from the drill stem may pass downwardly through the openings 48, through the stem 47, ports 45 and then downwardly into the annular passage 39 between the cylinder 38 and the housing 12. This fluid then flows downwardly through the annular space and through the inclined ports 40 in the lower end of the cylinder 38, from where said fluid passes through the bore 22 of the ball 21 and shank 20. From the shank the fluid may pass through the tubular stem 13 and then outwardly through the

circulating passages 16 of the pilot bit 15 in the usual manner.

The pressure fluid which is circulated downwardly to the pilot bit 15 also passes into the lower end of the cylinder 38, through the ports 40 and recesses 40a provided in the external surface of the piston to equalize pressures across the piston 52, whereby the spring 58 will act to cause the piston to move upwardly to its original position (Figure 2), such upward movement being permitted by the equalizing or bleeder ports 60 which permit any pressure within the upper end of the cylinder to pass into the annular flow passage or space 39.

As soon as the weight of the drill stem is imposed upon the deflecting tool to cause the valve mechanism which controls the flow of fluid to be shut off from the upper end of the piston and to be conducted to the pilot bit 15, the drill stem is rotated and such rotation is imparted through the coupling 11, housing 12, ball and socket 14 and to the pilot bit assembly 13, whereby said bit is rotated to perform the drilling operation.

From the foregoing, it will be obvious that the pilot bit assembly 13 is at all times free to swing with relation to the body or housing 12. The housing is maintained in substantial alinement with the well bore by means of the cutter blades 29. The gravity controlled actuation means which include the bearing shoe 69 is actuated solely by the weight 64. This weight will at all times fall or swing to the low side of the hole, whereby the shaft 61 will be rotated thereby. By disposing the actuating shoe 69 in a predetermined radial position with relation to the weight 64, it will be manifest that said shoe may be disposed in any desired position. In other words, the shoe 69 may be oriented within the cylinder 38. When the piston is actuated, the shoe is moved downwardly into engagement with the ball 21 and will co-act therewith to swing the pilot bit assembly in a direction 180° opposite the point of contact between the shoe 69 and the ball 21. In this manner an accurate control of the direction of deflection and accurate orientation of the bit 15 may be had.

In Figure 9, a slightly modified form of the invention is shown. In this form, the ball 21 is provided with an upstanding extension 73, the upper end of which is bevelled or inclined as shown at 74. The bore 22 of the ball 21 and the shank 20 communicates with the lower end of the cylinder 38 through inclined ports 75 which extend through the extension 73. Instead of the pilot bit assembly being being free to swing at all times, as in the case in Figures 1 to 8 the shank 20 is maintained in substantial axial alinement with the housing 12 by means of a flexible collar 76 which surrounds said shank. This collar may be constructed of rubber, rubber compound or other suitable material and is bonded to an annular coupling ring 77 which is threaded into the lower end of the retaining collar 26. The flexible collar 76 normally and yieldably holds the shank 20, together with the ball 21 and extension 73, which are preferably made integral therewith in substantial alinement within the housing 12.

The extension 73 projects upwardly into the lower end of the cylinder 38 and is adapted to be engaged by an actuating block 78 which block is substituted for the actuator E shown in the first form. As illustrated, the block 78 is substantially circular and is formed with a radially extending slot 79 into which projects the lower end of the shaft 61. A collar 80, which is secured on the lower end of the shaft 61 by means of a set screw 81 is connected to the block 78 by means of a flexible or yieldable connecting member 82. As is clearly shown in Figure 9, the collar 80 is disposed within the slot 79 of the block 78. The underside of the block 78 is formed with an inclined surface 83 at its central portion and this inclined surface is adapted to co-act with the inclined or bevelled upper end 74 of the extension 73.

The operation of this form is obvious. The extension 73, as well as the entire pilot bit assembly is maintained axially alined with the housing 12 by means of the flexible collar 76. Thus, the upper end of the extension is disposed below the inclined surface 83 of the block 78. By disposing the block 78 in a predetermined known position with relation to the weight 64 of the shaft 61, it will be manifest that upon a downward movement of the piston, the inclined surface 83 will co-act with the inclined surface 74 of the extension to cause a deflection of the pilot bit assembly in a desired direction.

In Figure 11, still another form of the invention is shown. The construction of the shank 20, ball 21 and extension 73 is substantially the same as that shown in Figure 8. However, in place of the piston 52 having the weight controlled shaft 61 and the actuating block 78, the form shown in Figure 9 is provided with a piston 152 which is normally urged to a raised position by a coil spring 158 confined within the cylinder 38. The piston 152 has a plumb bob 100 mounted therein, the upper end of said plumb bob being secured to the piston by a ball and socket connection. The lower end of the plumb bob is provided with an actuating member 101 having its lower surface tapered at 102, such taper being complementary to the inclination 74 at the upper end of the extension 73.

In the operation of this form, the plumb bob 100 will always swing to the low side of the hole and upon actuation or depression of the piston 152, the actuating member 101 on the lower end of said plumb bob will engage the upper end of the extension 73 to swing said extension to the position shown in dotted lines in Figure 11. Since it is known that the plumb bob will always swing to the low side of the hole, it is obvious that the pilot bit assembly will be deflected in the same direction since the extension 73 at its upper end will be moved in a direction 180° opposite the low side of the bore. In the form shown in Figure 11, there is no adjustment as to which direction the pilot bit will be deflected since it must always be deflected in a direction toward the low side of the hole. However, in the form shown in Figures 1 to 10, an adjustment is possible and the deflecting tool may be oriented in any desired direction. In all instances, the deflecting mechanism is operated by hydraulic fluid, which fluid may be the usual drilling fluid circulated downwardly through the drill stem.

It is again pointed out that the invention resides primarily in the knuckle joint and the improved means of orienting a device, which is illustrated as a drill bit assembly; obviously other well devices may be substituted for this assembly and could be accurately oriented in the well bore.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made,

within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. An orienting apparatus for well devices including, a body adapted to be connected to the lower end of a well pipe, a well device suspended from the body and capable of a limited universal movement relative thereto, means movable longitudinally within the body relative to the well device, a deflecting member carried by the movable means and arranged to engage the well device at one radial point to effect deflection of said well device, whereby said device may be deflected without deflecting the body within which the movable means is mounted, and a gravity actuated means connected with the deflecting member for orienting said member whereby the well device is deflected in a predetermined direction with respect to the oriented member.

2. An orienting apparatus for well tools including, a body adapted to be connected to the lower end of a well pipe, an element suspended from the body and capable of a limited universal movement relative to said body, said element having means for connecting a well tool thereto, actuating means within the body normally spaced from the upper end of the element, orienting means associated with the actuating means for orienting said actuating means within the body, and hydraulic means for operating the actuating means to move the same into engagement with the element to deflect said element with relation to the body and thereby deflect the well tool connected with said element, such deflection being in accordance with the position of the oriented actuator.

3. An orienting apparatus for well devices including, a body adapted to be connected to the lower end of a well pipe, a well device suspended from the body and capable of a limited universal movement relative thereto, actuating means within the body normally spaced from the upper end of the well device, hydraulic means for operating the actuating means to move the same into engagement with the device to deflect said device with relation to the body, and gravity controlled means associated with the actuating means for orienting the actuating means within the body, whereby when said actuating means is operated, the well device is deflected in a predetermined known direction relative to said actuating means.

4. An orienting apparatus for well tools including, a tubular body adapted to be coupled to the lower end of a well pipe, an elongate element connected to the lower end of the body by means of a knuckle joint so that said element may undergo a limited universal movement relative to the body, said element having means for connecting a well tool therewith, an actuator within the body adapted to engage and co-act with the upper end of the element to cause deflection or inclination of said element and of the tool connected therewith, means associated with the actuator for orienting said actuator within the body, hydraulic means within the body connected with the actuator for imparting movement thereto to operate the actuator and deflect the element in a direction in accordance with the position of the oriented actuator, and means for conducting a pressure fluid downwardly through the well pipe to the hydraulic means to actuate the same.

5. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly may undergo a limited universal movement relative to the body, an actuator within the body adapted to engage and co-act with the upper end of the drill bit assembly to cause deflection or inclination of said assembly, hydraulic means within the body connected with the actuator for imparting movement thereto to operate the actuator and deflect the assembly, means within the body for orienting the actuator within said body whereby when said actuator is operated the drill bit assembly is deflected or inclined in a predetermined direction with respect to said oriented actuator, and means for conducting a pressure fluid downwardly through the drill stem to the hydraulic means to actuate the same.

6. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly may undergo a limited universal movement relative to the body, an actuator within the body adapted to engage and co-act with the upper end of the drill bit assembly to cause deflection or inclination of said assembly, hydraulic means within the body connected with the actuator for imparting movement thereto to operate the actuator and deflect the assembly, gravity controlled means within the body for orienting the actuator, whereby when said actuator is operated by the hydraulic means the drill bit assembly is deflected or inclined in a predetermined direction with respect to the gravity controlled means, and means for conducting a pressure fluid downwardly through the drill stem to the hydraulic means to actuate the same.

7. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly may undergo a limited universal movement relative to the body, an actuator within the body adapted to engage and co-act with the upper end of the drill bit assembly to cause deflection or inclination of said assembly, hydraulic means within the body connected with the actuator for imparting movement thereto to operate the actuator and deflect the assembly, said tool having a flow passage establishing communication between the drill stem and the hydraulic means and also having a second passage establishing communication between the drill stem and drill bit assembly, and valve means for controlling the flow through said passages, whereby pressure fluid from the drill stem may be first conducted to the hydraulic means to operate the actuator and thereby deflect or incline the bit assembly after which said fluid may be directed to the drill bit assembly during the drilling operation.

8. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly may undergo a limited universal movement relative to the body, an actuator within the body adapted to engage and co-act with the upper end of the drill bit assembly to cause deflection or inclination of said assembly, hydraulic means within the body connected with the actuator for imparting movement thereto to operate the actuator and deflect the assembly, said tool having a flow passage establishing communication between the drill

stem and the hydraulic means and also having a second passage establishing communication between the drill stem and drill bit assembly, valve means for controlling the flow through said passages, whereby pressure fluid from the drill stem may be first conducted to the hydraulic means to operate the actuator and thereby deflect or incline the bit assembly after which said fluid may be directed to the drill bit assembly during the drilling operation, and means for controlling the valve by the imposition of the weight of the drill stem on the tool.

9. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly is capable of a swinging movement relative to the body, a rotatable shaft within the body, an actuator mounted on said shaft, a weight secured eccentrically to the shaft so as to cause rotation of said shaft and actuator to a predetermined position relative to the low side of the well bore, and means for moving the actuator into engagement with the upper end of the assembly to cause a deflection or inclination of the assembly relative to the body and in a direction in accordance with the point of contact between the actuator and said assembly, whereby the assembly is deflected in a predetermined direction.

10. A well bore deflecting tool including, a tubular body adapted to be coupled to the lower end of a drill stem, a drill bit assembly connected to the lower end of the body by means of a knuckle joint so that said assembly is capable of a swinging movement relative to the body, a rotatable shaft within the body, an actuator mounted on said shaft, a weight secured eccentrically to the shaft so as to cause rotation of said shaft and actuator to a predetermined position relative to the low side of the well bore, and a hydraulically operated piston secured to the shaft and actuator for moving the actuator into engagement with the upper end of the assembly to cause a deflection or inclination of the assembly relative to the body and in a direction in accordance with the point of contact between the actuator and said assembly, whereby the assembly is deflected in a predetermined direction.

11. The combination with a drill stem, of a deflecting tool rotatably and slidably connected to the stem so as to be capable of a limited sliding movement relative thereto, said tool including, a body, a drill bit assembly swingably connected to the body, an hydraulically operated actuator within the body arranged to co-act with the assembly to deflect the same, means for orienting the actuator so that said actuator will deflect the assembly in a known direction, means in the body for conducting pressure fluid from the drill stem to the drill bit assembly and to the hydraulically operated actuator, and valve means operated by the relative movement of the drill stem and body for controlling the flow of fluid through the body to these parts.

12. A well bore deflecting tool including, a body adapted to be connected to the lower end of a drill pipe, a drill bit assembly suspended from the body and capable of a limited universal movement relative thereto, the upper end of said assembly extending into the body, a deflecting shoe within the body arranged to be moved downwardly into engagement with the upper end of the assembly to deflect the same, and gravity controlled means for orienting said shoe prior to its engagement with the assembly, whereby said assembly is deflected in a known direction relative to the oriented shoe.

13. A well bore deflecting tool including, a body adapted to be connected to the lower end of a drill pipe, a drill bit assembly suspended from the body and capable of a limited universal movement relative thereto, an extension on the assembly projecting upwardly into the body, an actuator within the body adapted to move downwardly into engagement and to co-act with the extension to swing or deflect the assembly relative to the body, and gravity operated means for orienting the actuator to effect deflection of the assembly in a predetermined direction with respect to the oriented actuator.

14. A well bore deflecting tool including, a body adapted to be connected to the lower end of a drill pipe, a drill bit assembly suspended from the body and capable of a limited universal movement relative thereto, an extension on the assembly projecting upwardly into the body, a plumb bob within the body above the extension and arranged to swing toward the low side of the well bore, and means for moving the plumb bob downwardly into engagement with the extension to swing the same and thereby swing or deflect the assembly in a predetermined known direction relative to the plumb bob and with respect to the low side of the well bore.

15. A well bore deflecting tool including, a body adapted to be connected to the lower end of a drill pipe, a drill bit assembly suspended from the body and capable of a limited universal movement relative thereto, the upper end of said assembly extending into the body, a deflecting shoe extending radially within the body arranged to be moved downwardly into engagement with the upper end of the assembly to deflect the same, and gravity controlled means for orienting said shoe prior to its engagement with the assembly, whereby said assembly is deflected in accordance with the position of the oriented shoe.

16. An orienting apparatus for well devices including, a body adapted to be connected to the lower end of a well pipe, a well device suspended from the body and capable of a universal movement relative thereto, means movable longitudinally within the body relative to the well device, and a self-orienting deflecting member attached to the movable means and arranged to engage the well device at one radial point to effect deflection of said well device.

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