March 30, 1937. J. H. SCHUMACHER ET AL 2,075,064

DIRECTION CONTROL MECHANISM FOR WELL DRILLING TOOLS

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Fig. 1.

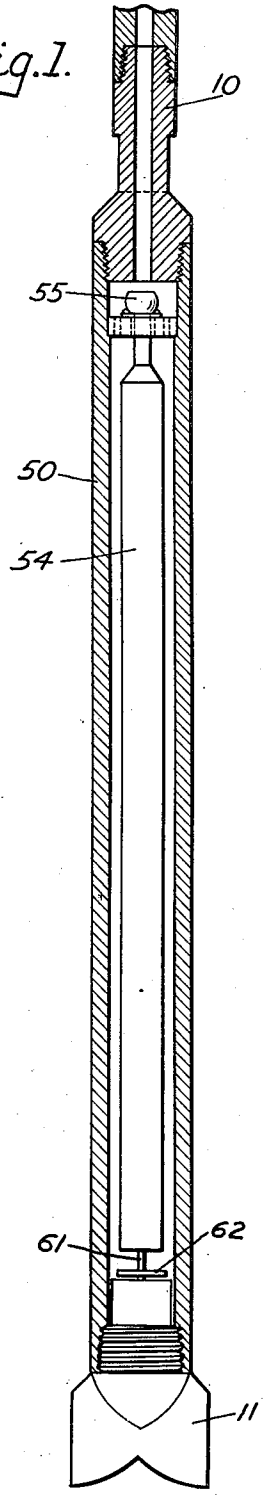


Fig. 6.

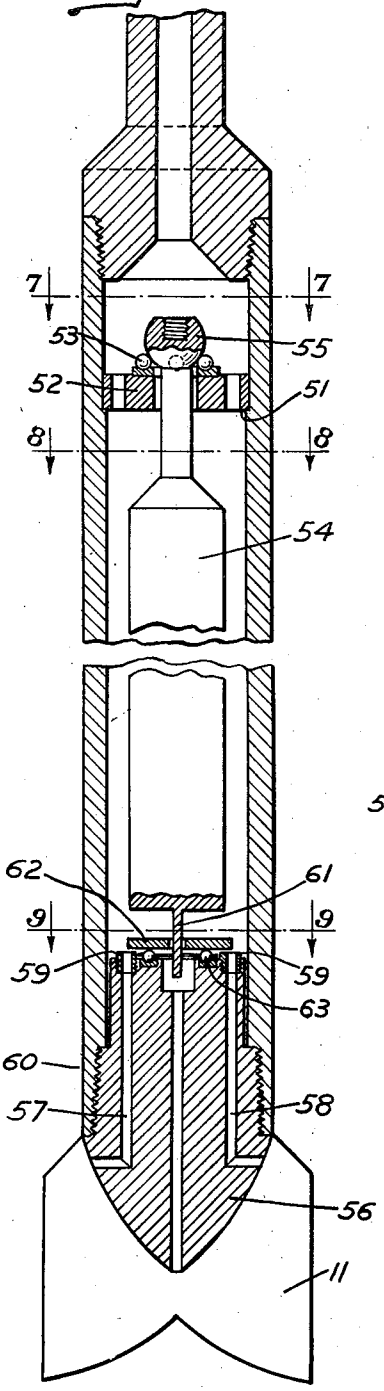


Fig. 7.

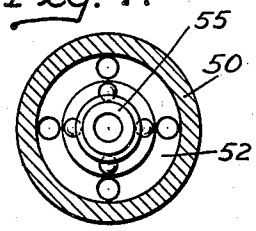


Fig. 8.

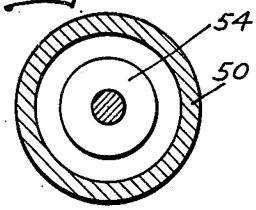


Fig. 9.

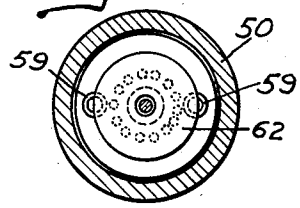
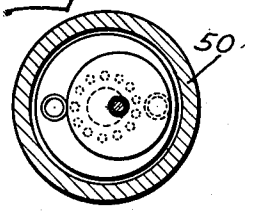


Fig. 10.



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DIRECTION CONTROL MECHANISM FOR WELL DRILLING TOOLS

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Fig. 2.

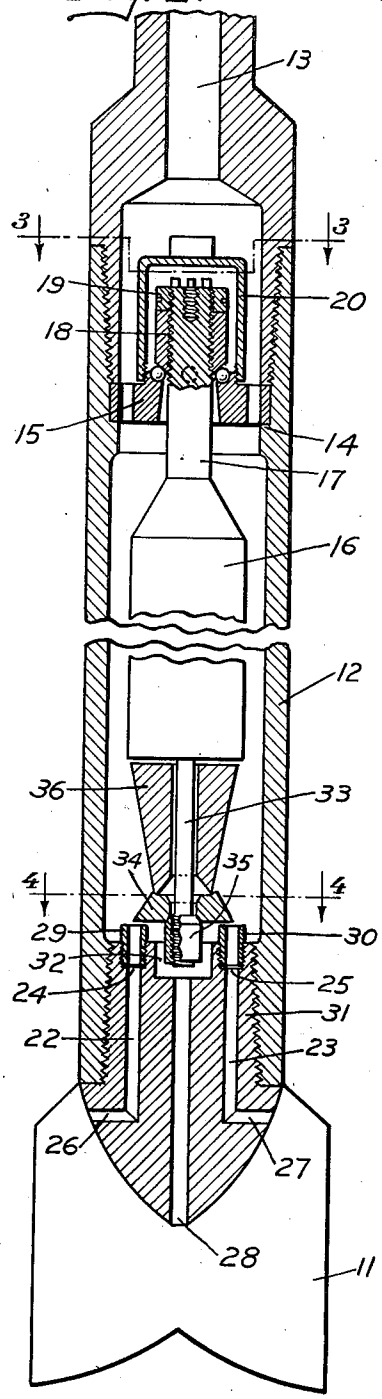


Fig. 3.

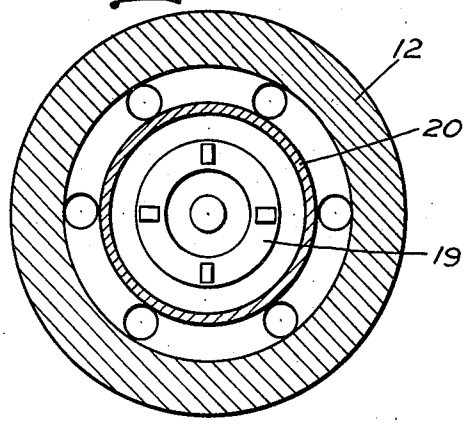


Fig. 4.

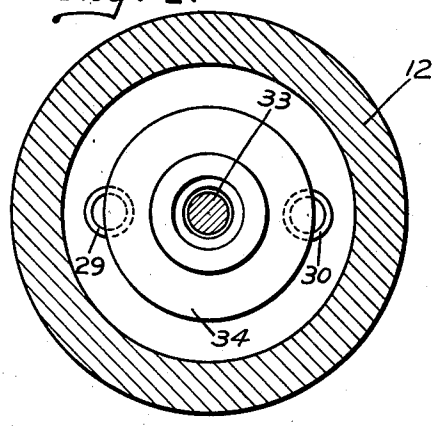
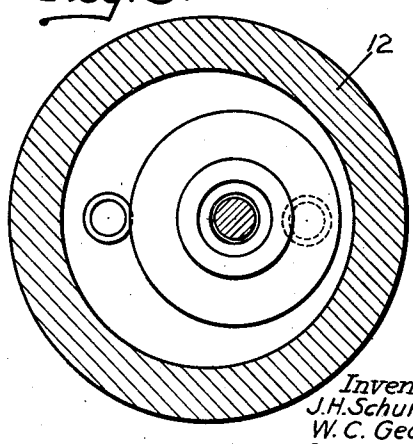


Fig. 5.



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2,075,064

DIRECTION CONTROL MECHANISM FOR WELL DRILLING TOOLS

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Application May 26, 1936, Serial No. 81,877

10 Claims. (Cl. 255—1)

This invention relates to an improved direction control mechanism for well drilling tools. It may be considered as an improvement over the method and apparatus disclosed in our copending application Serial No. 61,575 filed January 30, 1936.

An object of the present invention is to provide an improved mechanism for automatically keeping a rotary drill stem drilling in either a vertically downward direction or in a predetermined direction as desired.

Specifically, an object of the present invention is to provide an improved construction that may be readily incorporated in a rotary drill stem through which circulation fluid is adapted to be discharged and wherein discharge ports are formed for the discharge of the circulation fluid and to provide an improved means for automatically so controlling the discharge through the ports that whenever the drill stem tends to deviate from the vertical or predetermined direction greater flow of circulation fluid will take place through such ports as are directed in the direction of deviation so that reactionary forces will be developed on the drill stem tending to automatically return it to the vertical or predetermined direction.

With the foregoing and other objects in view, which will be made manifest in the following detailed description, and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Fig. 1 is a vertical section through a portion of a drill stem, illustrating the mechanism embodying the present invention as having been incorporated therein.

Fig. 2 is an enlarged view in vertical section, parts being broken away, illustrating the details of construction of the preferred form.

Fig. 3 is a horizontal section taken substantially upon the line 3—3 upon Fig. 2.

Fig. 4 is a horizontal section taken substantially upon the line 4—4 upon Fig. 2, the parts being shown in neutral position.

Fig. 5 is a view similar to Fig. 4, illustrating the parts in the position assumed when occasion requires that the drill stem be returned to the vertical or predetermined direction.

Fig. 6 is a view similar to Fig. 2, illustrating a modified form of construction that may be employed.

Fig. 7 is a horizontal section taken substantially upon the line 7—7 upon Fig. 6.

Fig. 8 is a horizontal section taken substantially upon the line 8—8 upon Fig. 6.

Fig. 9 is a horizontal section taken substantially upon the line 9—9 upon Fig. 6, parts being shown in a neutral position.

Fig. 10 is a horizontal section similar to Fig. 9, the parts being shown in that position requiring the drill stem to be returned to the vertical or predetermined position.

Referring to the accompanying drawings, wherein similar reference characters designate similar parts throughout, 10 designates a rotary drill stem made up of conventional sections of drill pipe, tool joints, subs, etc., on the bottom of which there may be mounted a well drilling bit 11 or other drilling tool in accordance with conventional drilling practice.

The present invention comprises a suitable barrel 12 shown as incorporated in the drill stem immediately above the bit 11. The drill stem is hollow, as indicated at 13, providing for the passage of mud or circulation fluid, in accordance with conventional rotary drilling practice. The barrel 12 which is incorporated in the drill stem and forms a part thereof is provided with an internal shoulder 14 on which is seated a spider 15 which suspends a pendulum 16. The top of pendulum 16 has a reduced neck 17 extending through a large central aperture in the spider enabling the pendulum to swing. On this neck there is threaded a collar 18 which may be fastened in place by means of a lock nut 19. The collar and nut may be housed within a suitable cap 20 threaded onto the spider. Balls 21 are positioned between the collar and the spider, forming a type of anti-friction bearing which enables the pendulum to swing freely in any desired direction within the confines of barrel 12. The bit 11 is illustrated as being provided with suitable discharge ports 22 and 23. We have merely illustrated two of such discharge ports but the number may be increased if desired. The two illustrated are arranged diametrically opposite each other and have vertically disposed entrances 24 and 25 and laterally directed exits 26 and 27. We have also illustrated a further discharge port at 28 which forms no part of the present invention but which is conventionally present in various well drilling bits.

The upper ends of the entrances 24 and 25 may be provided by removable and replaceable screw threaded nipples 29 and 30 which project slightly above the top of the pin 31 of the bit. Centrally of the top of the pin the bit is shown as being provided with a well 32 within which is movable the lower end of a finger 33 formed on the bottom of the pendulum. A closure plate 34

is secured on the pendulum by means of a nut **35**, there being a slight clearance between the closure plate and the finger so that the closure plate may tilt. A weight **36** surrounds the finger loosely and rests on the closure plate. The nut **35** is so positioned that it normally supports the closure plate in such a manner that it will just barely clear the tops of the nipples. However, the closure plate, on tilting slightly with respect to the finger, may engage a nipple on one side. When the closure plate is tilted this effects a slight lifting of the weight **36** on the finger so that the tendency of the weight **36** is always to return the closure plate into such a position that it clears the nipples **29** and **30**.

The operation and advantages of the above described construction are as follows:

In normal drilling, wherein the drill stem is suspended in a truly vertical position and drilling is continuing in a vertical downward direction, the pendulum **16** occupies the position shown wherein the closure plate **34** is so positioned as to only partially cover the two nipples. The entrances to the nipples are covered by the closure plate to substantially the same extent so that the circulation fluid that is being forced down the drill stem is discharged through ports **22** and **23** in equal amounts. The reactive forces imposed upon the drill stem by these laterally discharging streams of circulation fluid counterbalance one another on opposite sides of the drill stem so that there is no resultant force imposed on the drill stem tending to deviate the drill stem from the vertical direction. However, if for any one of a number of causes the drill stem deviates from the vertical such as, for example, the drill stem as shown in Fig. 2 should deviate toward the left of the position shown, the pendulum **16** would assume a position closer to the right hand side of barrel **12**. This would swing the closure plate **34** so as to fully uncover port **22** and to more completely close port **23**. The pressure of the circulation fluid tends to tilt the closure plate and cause it to engage the top of nipple **30** while this nipple is beneath the closure plate during rotation of the drill stem. This consequently tends to shut off the quantity of circulation fluid discharged through port **23** while on that side. The result is that an excess of circulation fluid is discharged through port **22** which is not balanced by the discharge through port **23**. Consequently, there is a reactive force imposed upon the drill stem, tending to return it to vertical automatically. The tilting of the closure plate **34** lifts weight **36**, which weight tends to return the closure plate to a position which will clear the tops of the nipples. In other words, the effect of the weight is in opposition to the circulation pressure tending to force the closure plate tightly against the closed nipple and consequently reduces friction so that as the drill stem returns to vertical the closure plate may be moved by the pendulum back into its neutral position wherein conditions are restored to equal discharge on both sides of the drill stem.

In the event of whipstocking, it will be appreciated that by shifting the position of finger **33** with respect to the center of the pendulum or using a pendulum which does not have the finger directly below its center of gravity that the drill stem may be caused to follow a predetermined direction started by the whipstock and to continue in this direction rather than to continue in a vertical direction, as above described.

In the modified form of construction shown on Fig. 6, the barrel is indicated at **50**, having an internal shoulder **51** for the reception of the spider **52** on which is mounted an anti-friction bearing **53**. The pendulum is indicated at **54** having a head or cap **55** supported on the bearing which will readily enable the pendulum to swing in any direction quite freely within the confines of barrel **50**.

The bit is indicated at **56**, having the discharge ports **57** and **58** provided with nipples **59**. The well is indicated at **60** and the finger on the pendulum at **61**. In this form of construction the closure plate indicated at **62** is supported on an anti-friction bearing **63** so that it will just clear the tops of the nipples. The anti-friction bearing supporting the closure plate is designed to reduce friction of the closure plate regardless of high circulation pressures imposed thereon so as to enable the closure plate to move freely and be easily influenced as to its position by means of a pendulum.

In the preferred construction similar anti-friction bearings may be provided in the circle in alignment with nipples **29** and **30**.

The operation of this alternative form of construction is substantially the same as that previously described.

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

We claim:

1. In combination with a rotary drill stem through which circulation fluid is adapted to be forced, means providing laterally directed discharge ports through the drill stem near its bottom through which the circulation fluid may be discharged, and means operable upon the drill stem deviating from the vertical for causing the rate of discharge to decrease through the ports as they become directed toward the position the drill stem should assume in returning to vertical whereby the discharge of circulation through ports otherwise directed during rotation will develop unbalanced reactionary forces upon the drill stem tending to return it to vertical.

2. In combination with a rotary drill stem through which circulation fluid is adapted to be forced, means providing laterally directed discharge ports through the drill stem near its bottom through which the circulation fluid may be discharged, and means operable upon the drill stem deviating from the vertical for causing the rate of discharge to increase through the ports as they become directed in the direction of deviation of the drill stem whereby the discharge of circulation fluid through these ports will develop unbalanced reactionary forces upon the drill stem tending to return it to vertical.

3. In a rotary drill stem through which circulation fluid is adapted to be discharged, pendulum means suspended within the drill stem, means providing laterally directed discharge ports through the drill stem having entrances arranged to be opened and closed by a closure common to all, and a closure common to all discharge ports movable by the pendulum means for the purpose described.

4. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed circumferentially spaced exits, means arranged to increase the flow of circulation fluid through ports

on one side of the stem while decreasing it in the opposite ports, and means for operating said means in accordance with deviations of the drill stem from the vertical.

5. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed circumferentially spaced exits, means arranged to increase the flow of circulation fluid through ports on one side of the drill stem, and means for operating said means in accordance with the deviations of the drill stem from the vertical.

6. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed circumferentially spaced exits, a closure plate in the drill stem movable to consecutively decrease the flow through ports as they rotate, and means for moving said plate in accordance with deviations of the drill stem from the vertical.

7. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed circumferentially spaced exits, a closure plate in the drill stem movable to consecutively increase the flow through ports as they rotate, and means for moving said plate in accordance with deviations of the drill stem from the vertical.

8. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed circumferentially spaced exits, a closure plate in the drill stem movable to consecutively decrease the flow through ports as they rotate, and means for moving said plate in accordance with deviations of the drill stem from the vertical, said closure plate being supported upon an anti-friction bearing.

9. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed exits circumferentially spaced around the drill stem, a pendulum within the drill stem, means for suspending the pendulum for universal movement, a closure plate in the drill stem movable to consecutively decrease the flow through ports as the rotate, and means connecting the pendulum and closure plate for moving said plate in accordance with deviations of the drill stem from the vertical.

10. In a rotary drill stem through which circulation fluid is adapted to be discharged, means providing discharge ports having downwardly directed entrances and laterally directed exits circumferentially spaced around the drill stem, a pendulum within the drill stem, means for suspending the pendulum for universal movement, a closure plate in the drill stem movable by the pendulum over the entrances to the discharge ports, and a counterweight resting on the closure plate and carried by the pendulum tending to cause the closure plate to assume a normal position wherein it just clears the tops of the entrances to the discharge ports.

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