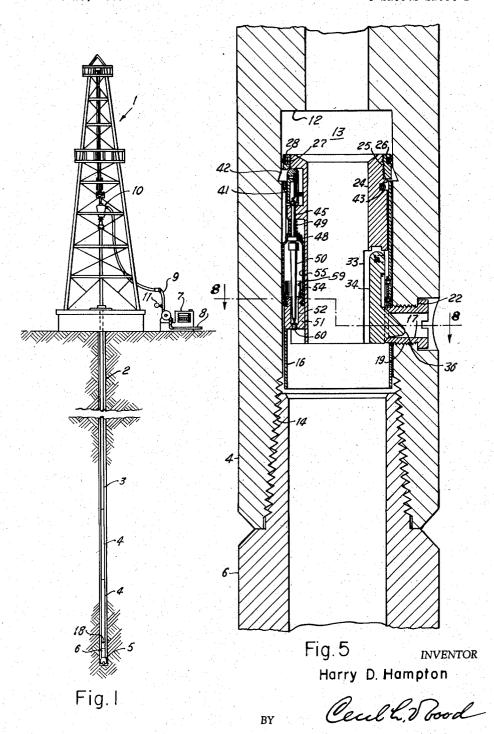
WELL BORE INCLINOMETER

Filed Feb. 26, 1958

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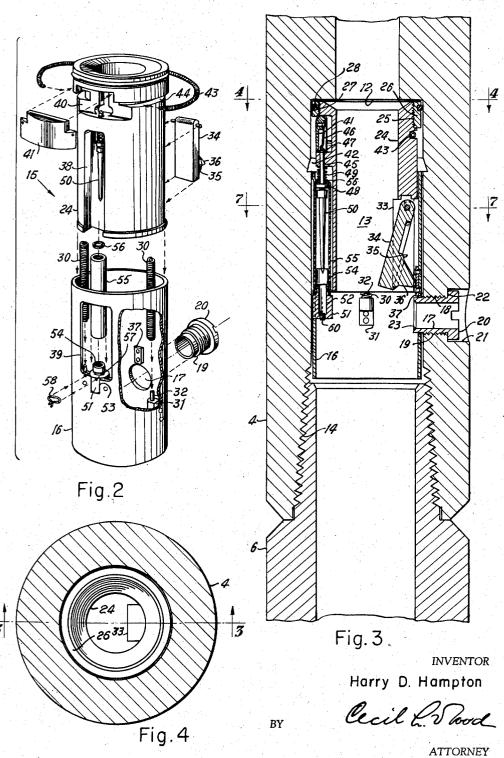


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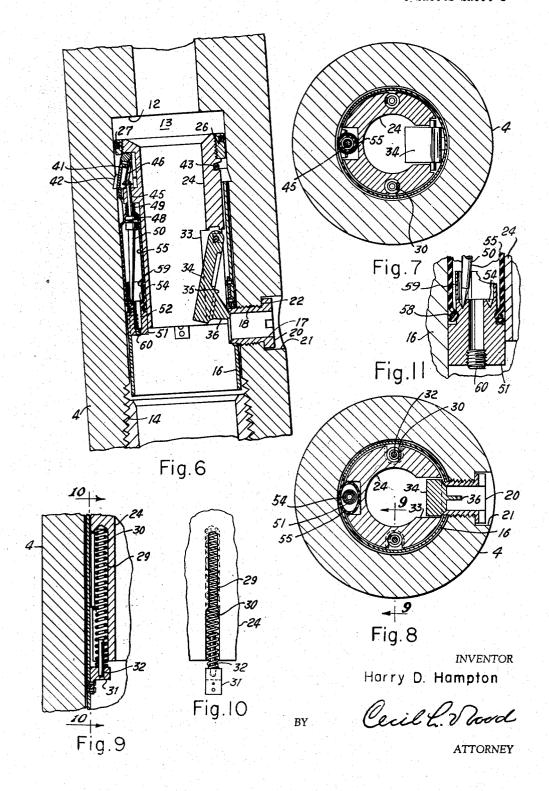
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WELL BORE INCLINOMETER

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WELL BORE INCLINOMETER

Harry D. Hampton, Wichita Falls, Tex. Application February 26, 1958, Serial No. 717,652 3 Claims. (Cl. 255-1)

This invention relates to a well bore inclinometer, and it concerns more particularly an instrument for use in 15 conjunction with oil well drilling rigs, to determine whether a well bore is inclined relative to the vertical

An object of the invention is to provide, in conjunction with an oil well drilling rig, means whereby any deviation of the well bore from the vertical plane may be detected by variations in the pump pressure on the circulating drilling fluid, as reflected by a pressure gauge at the surface.

Another object of the invention is to provide, in conjunction with an oil well drilling rig, a drill collar having incorporated therein means responsive to the inclination of the well bore, and including a valved opening in the side wall of the drill collar, whereby a portion of the circulating drilling fluid is bypassed relative to the drilling bit, and is discharged into the well bore thru the valved opening, upon deviation of the well bore from the vertical plane, to thereby reduce the pressure of the circulating fluid as discharged from the bit while maintaining constant the circulation of fluid to and from the well.

A further object of the invention is to provide a well bore inclinometer of the type described in which the seating surfaces of the valved opening are positioned outside the normal path of the circulating drilling fluid, so that they are not subject to excessive wear due to

impingement of the fluid thereon.

Another object of the invention is to provide a well bore inclinometer of the type described which is characterized by substantially unobstructed flow of the drilling fluid circulated thru it at all times, whereby the drilling fluid may be introduced into the well at a constant rate, as desired. This is an important consideration for the reason that the weight of the drilling fluid ordinarily is relied on to off-set gas pressures in the well, thereby 50 reducing the danger of blow-outs.

Another object of the invention is to provide a well bore inclinometer of the type described comprising a drill collar having an internally enlarged portion and a side opening communicating with the internally enlarged portion, a sleeve received in the internally enlarged portion and capable of limited longitudinal movement relative thereto, a valve member pivotally connected to the sleeve for seating engagement with the opening when the sleeve is in its lowermost position, spring means biasing the sleeve upwardly relative to the drill collar whereby the valve member is disengaged from the opening, a cam surface on the valve member for engagement with the inner wall of the drill collar whereby the valve member is inclined downwardly and radially inwardly relative to the drill collar upon disengagement of the valve member from the opening, the arrangement being such that the sleeve is normally moved downwardly, against the action of the spring means, by the action of the circulating drilling fluid on the valve member, whereby the valve member is seated in the opening, and latching means responsive to the inclination of the well bore ca-

pable of securing the sleeve in its uppermost position upon deviation of the well bore from the vertical plane.

Another object of the invention is to provide a well bore inclinometer of the type described in which the latching means includes a latch pivotally connected to the sleeve and movable radially outwardly relative thereto, a detent for the latch comprising a V-shaped annular groove formed in the inner wall of the drill collar, a rod carried by the sleeve and capable of limited reciprocal movement relative thereto, a pendulum pivotally connected at its upper end to the rod, spring means biasing the rod downwardly relative to the sleeve, an abutment carried by the drill collar and positioned below the pendulum for engagement with the pendulum to limit its downward movement relative to the drill collar upon deviation of the well bore from the vertical plane, and a cam surface on the latch for engagement by the upper end of the rod, upon upward movement of the pendulum and the rod relative to the sleeve, whereby the latch is urged radially outwardly for engagement with the detent.

A further object of the invention is to provide a well bore inclinometer of the type described in which the latching means is positioned exteriorly of the sleeve, out of the path of the circulating drilling fluid, and the pendulum is positively shielded from the drilling fluid so that the action of the pendulum is not affected by the weight and viscosity of the drilling fluid or its rate of flow.

The invention will be readily understood by referring to the following description and the accompanying draw-

ing, in which:

Figure 1 is a diagrammatic elevational view of an oil well drilling rig;

Figure 2 is an exploded perspective view of an inclinometer embodying the invention, showing the parts thereof, exclusive of the drill collar, in their relative position before assembling;

Figure 3 is a fragmentary sectional elevational view, taken on the lines 3-3 of Figure 4, of the adjacent ends of a drill collar and an adjoining coupling, the drill collar having a well bore inclinometer as shown in Figure 2 incorporated therein, showing the inclinometer in its assembled position, as it appears before commencing the circulation of drilling fluid through the device;

Figure 4 is a sectional plan view taken on the lines

4 of Figure 3;

Figure 5 is a view similar to Figure 3, showing the inclinometer as it appears when positioned vertically in a well bore, after commencing the circulation of drilling fluid through the device;

Figure 6 is a view similar to Figures 3 and 5, showing the inclinometer as it appears when positioned in a well bore which is inclined relative to the vertical plane, after commencing the circulation of drilling fluid through the device;

Figure 7 is a sectional plan view taken on the lines -7 of Figure 3;

Figure 8 is a sectional plan view taken on the lines 8-8 of Figure 5;

Figure 9 is a sectional elevational view taken on the lines 9—9 of Figure 8;

Figure 10 is a sectional elevational view taken on the lines 10—10 of Figure 9; and

Figure 11 is a fragmentary sectional elevational view, on an enlarged scale, of a portion of the apparatus.

Referring to Figure 1 of the drawing, the numeral 1. designates generally a conventional oil well drilling rig. The numeral 2 indicates a well in the process of being drilled. The drill pipe 3 has a plurality of drill collars 4 connected thereto and forming a downward extension thereof. A drilling bit 5 is connected to the lowermost drill collar 4 by a coupling 6. A mud pump 7 has a

suction line 8 which leads to a reservoir (not shown), and a discharge line 9 which communicates with the drill pipe 3 through a swivel connection 10. A pressure gauge 11 is operatively connected to the discharge line 9.

As shown in Figures 2 to 10 of the drawing, the lower- 5 most drill collar 4 is enlarged internally adjacent its lower end to form a downwardly facing internal shoulder 12 and a cylindrical chamber 13 positioned below the shoulder 12. The lower end of the drill collar 4 is internally threaded, as at 14, below the chamber 13, for engagement 10 inwardly, by engagement of the lug 36 with the wear by the externally threaded upper end of the coupling 6, plate 37. The body 24 is urged upwardly by the action whereby the drill collar 4 is connected to the drilling

An inclinometer embodying the invention, which is designated generally by the numeral 15, is received in 15 the chamber 13 and is secured therein as hereinafter described. The inclinometer 15 includes an open ended cylindrical shell 16, which has an outside diameter corresponding to the inside diameter of the chamber 13 and is removably inserted therein.

An opening 17, which is formed in the shell 16, is aligned with a corresponding opening 18 which is formed in the drill collar 4. A tubular closure member 19, which is inserted in the aligned openings 17 and 18, is threaded externally for engagement with the opening 18, 25 which is correspondingly threaded.

The tubular closure member 19 has a circular head 20 for engagement by a wrench. The head 20 of the tubular closure member 19 is received in a corresponding recess 21, which comprises an enlargement of the 30 opening 18 and forms an outwardly facing internal shoulder 22 for engagement by the head 20. The inner end of the tubular closure member 19 is beveled internally,

as at 23, for use as hereinafter described.

An open ended cylindrical body 24, which has an out- 35 side diameter corresponding to the inside diameter of the shell 16, is received telescopically therein. In its lowermost position, as shown in Fig. 5, the ends of the body 24 are spaced above the corresponding ends of the shell 16.

The upper end of the body 24 is threaded externally, as at 25, for engagement by an internally threaded ring 26. The ring 26 has an outside diameter corresponding to the inside diameter of the chamber 13. A peripheral groove 27 is formed in the ring 26 for engagement by a resilient O ring 28.

The body 24 has a relatively thick wall, and a pair of diametrically opposed longitudinal grooves 29 are formed in the exterior surface thereof, beginning at its lower end, for engagement by the upper ends of a pair of compression springs 30. The lower ends of the 50 grooves 29 are U shaped in transverse section, whereby the springs 30 may be readily inserted therein, while the upper ends of the grooves 29 form substantially cylindrical sockets for retention of the adjacent ends of the

A pair of diametrically opposed brackets 31, which are attached to the inner wall of the shell 16, each have an upstanding pin 32 connected thereto for engagement with the lower end of one of the springs 30, whereby the body 24 is yieldably supported within the shell 16.

A slot 33 is formed in the wall of the body 24, beginning at its lower end. The slot 33 is aligned circumferentially with the tubular closure member 19, the inner end of which is received therein when the body 24

is in its lowermost position, as shown in Fig. 5.

A flapper type valve 34 is received in the slot 33, and pivotally connected at its upper end to the sides thereof. The valve 34 has a beveled circular boss 35 adjacent its lower end which forms a seating surface for engagement with the internally beveled inner end 23 of the tubular 70 closure member 19.

A lug 36, which comprises an outward extension of the boss 35, has an outwardly and downwardly inclined upper edge which forms a cam surface for engagement with the inner wall of the shell 16, or alternatively, the 75

inner end of the tubular closure member 19, depending on the position of the body 24 relative to the shell 16.

A wear plate 37 is attached to the inner wall of the shell 16, immediately above the tubular closure member 19 and flush with the inner end thereof, for sliding engagement with the lug 36 upon movement of the body 24 longitudinally relative to the shell 16.

When the body 24 is in its uppermost position, as shown in Fig. 3, the valve 34 is inclined downwardly and radially of the springs 30. As the body 24 is advanced downwardly relative to the shell 16, the lug 36 is received in the inner end of the tubular closure member 19 whereby the valve 34 is disposed wholly within the slot 33 and the boss 35 is seated in the inner end 23 of the tubular closure member 19.

A longitudinal cavity 38 is formed in the exterior surface of the body 24, beginning at its lower end. The cavity 38 is positioned diametrically opposite the slot 33, and is spaced circumferentially relative to the grooves 29. An opening 39 is formed in the upper portion of the shell 16 opposite the cavity 38. A segmental cavity 40 is formed in the exterior surface of the body 24 near its upper end, above the cavity 38. The cavity 40 is spaced below the upper end of the body 24, and above the upper end of the cavity 38, and is positioned above the upper end of the shell 16.

A latch 41 is received in the cavity 40, and is pivotally connected to the body 24 as hereinafter described. An annular V-shaped groove 42 is formed in the inner wall of the drill collar 4 for use as a detent for the latch 41 to limit downward movement of the body 24 relative

to the drill collar 4.

The upper edge of the latch 41 is curved for pivotal engagement with the upper edge of the cavity 40. A tension spring 43, which is received in a peripheral groove 44 formed in the exterior surface of the body 24 and communicating with the cavity 40, is connected at its ends to opposite sides of the latch 41 above its lower edge. The spring 43, in conjunction with the curved upper edge of the latch 41, pivotally connects the latch 41 to the body 24 whereby the weight of the body 24 is supported by the latch 41 upon movement of the latch 41 radially outwardly for engagement with the groove 31.

A rod 45 is disposed vertically in a bore provided therefor in the body 24, between the upper end of the cavity 38 and the lower edge of the cavity 40. The rod 45 is capable of limited reciprocal movement relative to the body 24. A downwardly and radially outwardly curved cam plate 46 is attached to the inner side of the latch 41 for engagement by the upper end of the rod 45, which is pointed, upon downward movement of the body 24 relative to the rod 45, whereby the latch 41 is moved radially outwardly for engagement with the groove 42.

Enlargements 47 and 48 are formed on the upper and lower ends of the rod 45 for engagement with the lower edge of the cavity 40 and the upper end of the cavity 38, respectively, to limit the reciprocal movement of the rod 45 relative to the body 24. The rod 45 is biased downwardly relative to the body 24 by a compression spring 49, which surrounds the rod 45 and acts on the upper end of the cavity 38 and the enlarged lower end 48 of the rod 45.

A pendulum 50 is pivotally connected to the lower end of the rod 45 whereby it is suspended therefrom. A socket member 51, which is generally cylindrical and has a central bore 52 beginning at its upper end for engagement with the lower end of the pendulum 50 when the drill collar 4 is disposed vertically, is attached to the inner wall of the shell 16 below the pendulum 50. The peripheral surface of the socket member 51 extends through a slot 53 formed in the shell 16, below the opening 40 and communicating therewith. The upper end of the socket member 51 is of reduced diameter, and has a V-shaped annular groove 54 formed in the end face thereof for engagement with the lower end of the pendulum 50 when the drill collar 4 is inclined relative 5 to the vertical plane, to limit downward movement of the pendulum 50 and the rod 45, upon movement of the body 24 downwardly relative to the drill collar 4, whereby the latch 41 is acted on by the rod 45 to move the latch radially outwardly for engagement with the 10 groove 42.

A tubular casing 55, which is formed of elastic material, is connected at its upper end to the rod 45, above the enlargement 48, and at its lower end to the upper end of the socket member 51, whereby it surrounds the 15 pendulum 50. The confined space within the casing 55 advantageously may be filled with liquid, such as oil.

The tubular casing 55 is internally flanged at its upper end, and has a restricted opening therein surrounding the rod 45. The flanged upper end of the casing 55 is 20 clamped between the enlargement 48 and a washer 56, which is disposed between the casing 55 and the spring 49. A peripheral groove 57 is formed in the upper end of the socket member 51 for engagement by a piece of wire 58, which is tied about the lower end of the casing 25 55 whereby the casing 55 is secured to the socket member 51.

An annulus 59, which comprises an upward extension of the socket member 51, surrounds the groove 54 and serves as a shield for engagement by the lower end of the pendulum 50, to prevent contact of the pendulum 50 with the casing 55.

A threaded plug 60 is inserted in a threaded opening provided therefor in the lower end of the socket member 51, and communicating with the bore 52, for use in filling the casing 55 with liquid and draining liquid therefrom.

In the operation of the device, the circulation of drilling fluid is interrupted momentarily, whereby the apparatus assumes the position shown in Fig. 3, after which circulation is resumed and the apparatus assumes one of the positions shown in Figs. 5 and 6, respectively, depending on whether the well bore 2 is inclined relative to the vertical plane.

As shown in Fig. 6, upon deviation of the well bore 2 45 from the vertical plane a portion of the circulating drilling fluid is bypassed around the drilling bit 5, and is discharged into the well bore 2 through the opening in the tubular closure member 19, whereby the pump pressure on the drilling fluid is reduced while the rate of 50 circulation thereof remains constant.

In assembling the device, the parts shown in Fig. 2 advantageously may be assembled as a unit, which is thereafter inserted bodily in the chamber 13 and secured therein by engagement of the tubular closure member 19 with the aligned openings 17 and 18 provided therefor in the shell 16 and the drill collar 4, respectively. The shell 16 may be temporarily pinned to the body 24 prior to insertion of the device in the chamber 13.

The invention may be modified in various ways without departing from the spirit and scope thereof. I claim

1. In combination with an oil well drilling rig, means for determining whether a well bore is inclined relative to the vertical plane, as reflected by variations in the pump pressure on the circulating drilling fluid, comprising a drill collar operatively connected to the drill pipe and having an internally enlarged portion and a side opening communicating with the internally enlarged portion, a sleeve received in the internally enlarged portion and capable of limited longitudinal movement relative thereto, a valve member pivotally connected to the sleeve for seating engagement with the opening when the sleeve is in its lowermost position, spring means biasing the sleeve upwardly relative to the drill collar whereby the valve member is disengaged from the opening, a cam surface on the valve member for engagement with the inner wall of the drill collar whereby the valve member is inclined downwardly and radially inwardly relative to the drill collar upon disengagement of the valve member from the opening, the arrangement being such that the sleeve is normally moved downwardly, against the action of the spring means, by the action of the circulating drilling fluid on the valve member, whereby the valve member is seated in the opening, and latching means responsive to the inclination of the well bore capable of securing the sleeve in its uppermost position upon deviation of the well bore from the vertical plane.

2. Apparatus as described in claim 1 in which the latching means includes a latch pivotally connected to the 30 sleeve and movable radially outwardly relative thereto, a detent for the latch comprising a V-shaped annular groove formed in the inner wall of the drill collar, a rod carried by the sleeve and capable of limited reciprocal movement relative thereto, a pendulum pivotally connected at its upper end to the rod, spring means biasing the rod downwardly relative to the sleeve, an abutment carried by the drill collar and positioned below the pendulum for engagement with the pendulum to limit its downward movement relative to the drill collar upon deviation of the well bore from the vertical plane, and a cam surface on the latch for engagement by the upper end of the rod, upon downward movement of the sleeve relative to the pendulum and the rod, whereby the latch is urged radially outwardly for engagement with the detent to limit the downward movement of the sleeve relative to the drill collar.

3. Apparatus as described in claim 2 in which the latching means is positioned exteriorly of the sleeve, outside the path of the circulating drilling fluid, and the pendulum is positively shielded from the drilling fluid so that the action of the pendulum is not affected by the weight and viscosity of the drilling fluid or its rate of flow.

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