April 11, 1933. W. I. McLAUGHLIN ET AL 1,903,512

INSTRUMENT FOR RECORDING INCLINATION

Filed Nov. 3, 1930 3 Sheets-Sheet 1

Fig. 1.

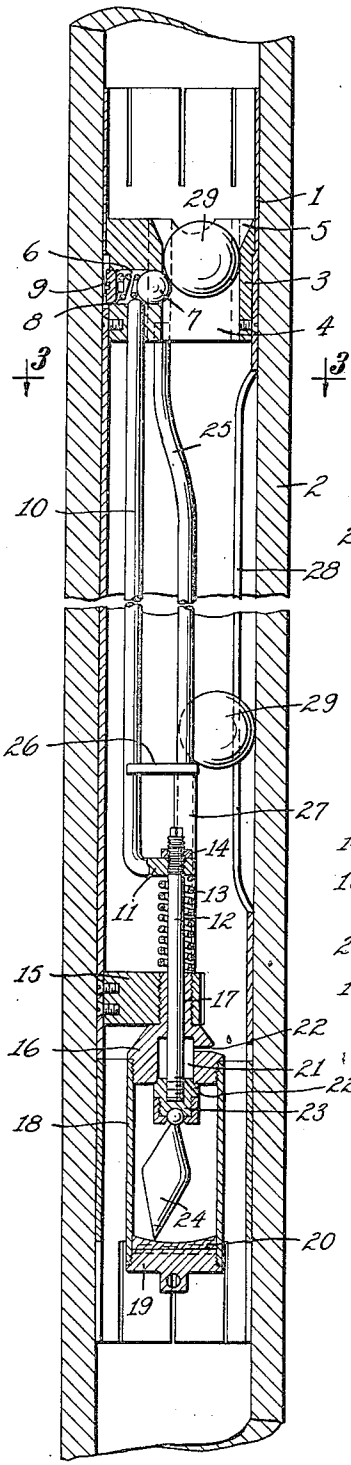



Fig. 2.

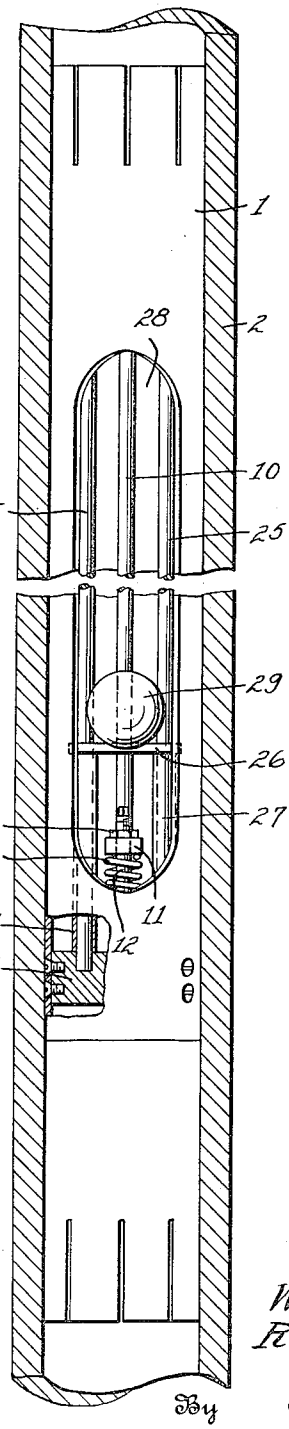



Fig. 4.

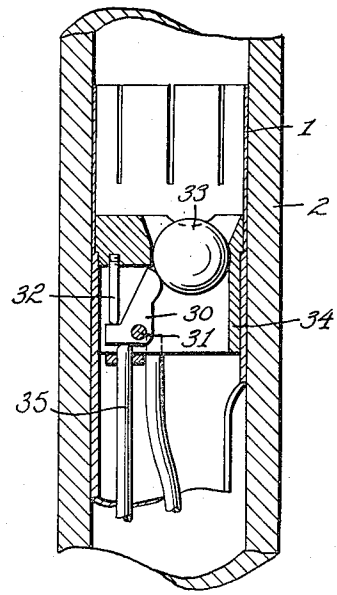
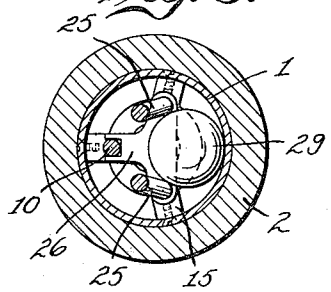



Fig. 3.

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INSTRUMENT FOR RECORDING INCLINATION

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Fig. 5.

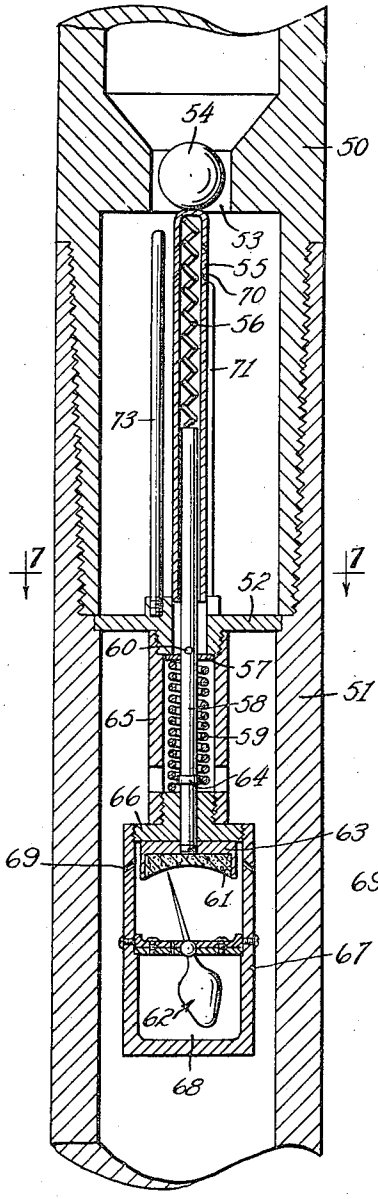
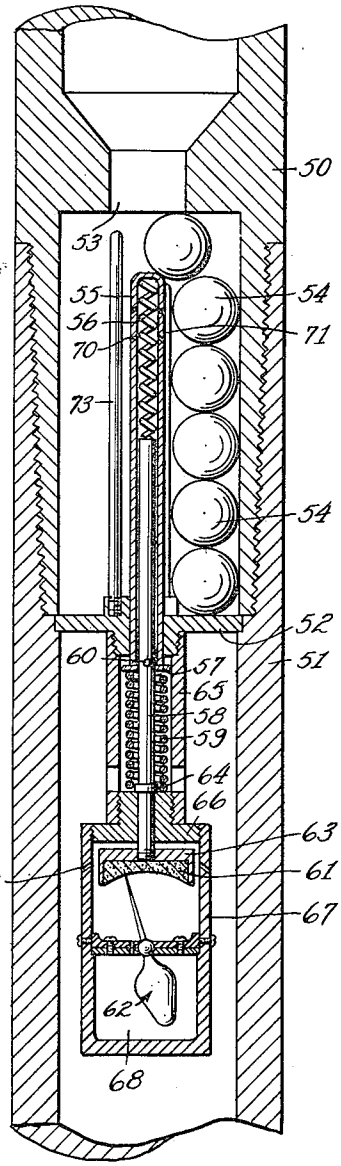



Fig. 6.



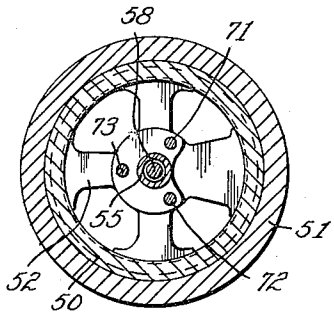




Fig. 7.

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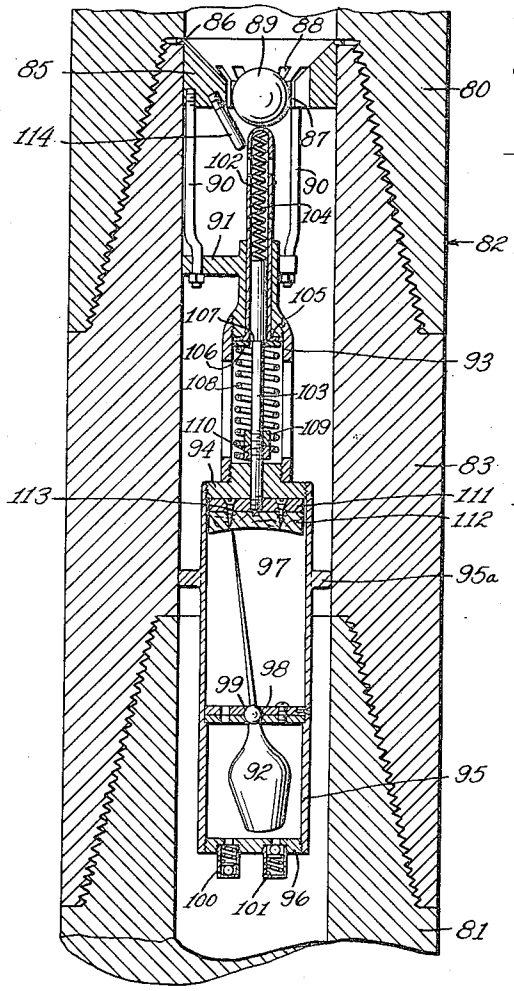


Fig. 8.

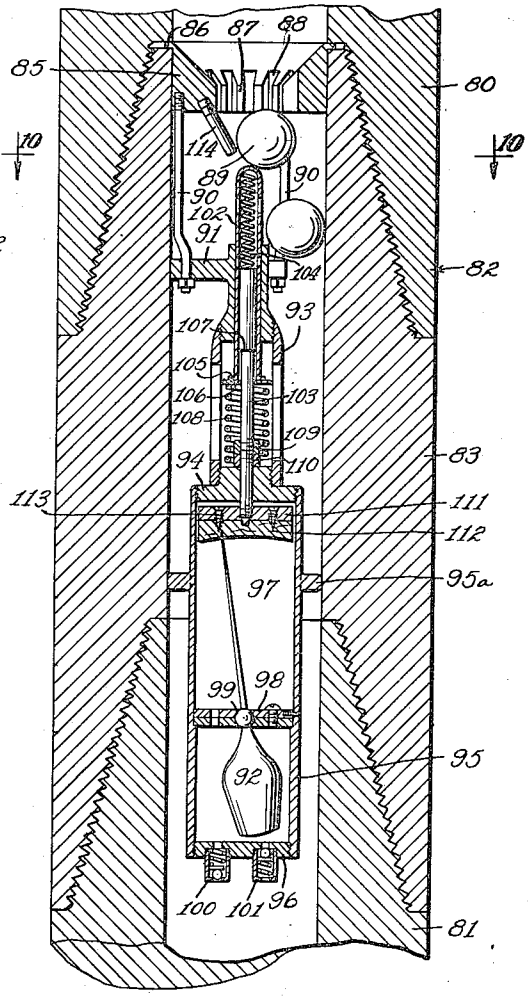


Fig. 9.

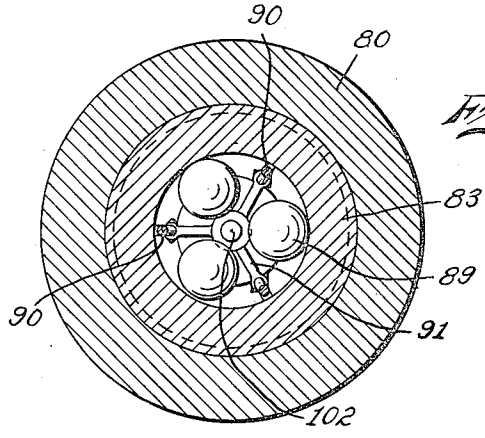


Fig. 10.

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# UNITED STATES PATENT OFFICE

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## INSTRUMENT FOR RECORDING INCLINATION

Application filed November 3, 1930. Serial No. 493,057.

This invention relates to an instrument for recording the inclination of the drill pipe during the drilling of oil wells, and more specifically relates to an instrument adapted to be mounted in the drill collar or pipe during the drilling operation and to be actuated by pumping a ball through the throat of the instrument.

In the drilling of oil wells the use of drill pipe and the forcing of a drilling fluid such as mud down through the drill pipe to wash out the cuttings is so common and so thoroughly understood by those skilled in the drilling art that further description is deemed unnecessary.

An instrument as described in these specifications and as illustrated in the accompanying drawings, as will be appreciated by those skilled in the art, is applicable for a great many different uses, but for the purpose of illustration will be described and illustrated as adapted to oil well surveying.

In drilling oil well bores it is desirable to drill a straight hole which will be perpendicular to the normal surface of the earth. However, in the course of drilling the well, the drilling tool is often deflected or, as is commonly termed, drifts from its true course. The driller can operate the drilling tool to bring the well bore back to its true course providing he knows the approximate locality of the drift. It is, therefore, the principal object of this invention to provide an instrument which may be mounted in the drill pipe and arranged whereby the instrument may be actuated to record the inclination of the drill pipe where and when deemed necessary.

To withdraw the drill pipe requires considerable time and labor and is therefore expensive and consequently the drill pipe is run as long as possible before being withdrawn and it is therefore important to provide an instrument which may be actuated a number of times to record the inclination of the drill pipe during a single run.

It is a further object of this invention to provide an instrument which may be actuated to record a plurality of readings during a single run of the drill pipe.

It is a further object of this invention to provide an instrument which, when mounted in the drill pipe, will not materially interfere with or stop the flow of the drilling fluid pumped through the drill pipe.

It is a further object of this invention to provide an instrument which will permit the normal filling and draining of the drill pipe during the running in and withdrawal of the drill pipe.

It is another object of this invention to provide an instrument which will permit the running in and the withdrawal of the drill pipe without causing the instrument to be actuated.

It is a further object of this invention to provide an instrument which may be actuated by dropping a ball into the drill pipe and thence pumping the ball through the throat of the instrument.

A further object of this invention is to provide a magazine for receiving and storing the balls which have been pumped through the throat of the instrument so that a plurality of readings may be taken during a single run of the drill pipe.

It is a further object of this invention to provide an instrument having an oil seal and pressure equalizing means for the plumb bob chamber.

Another object of this invention is to provide an instrument having a replaceable recording disc.

Further objects and advantages will appear in the specification and drawings.

This invention consists in the novel parts and combinations of parts to be described hereinafter, all of which contribute to produce an efficient and easily operated instrument for recording the inclination of a drill pipe.

A preferred embodiment of the invention is described in the following specification and illustrated in the drawings, while the full scope of the invention is pointed out in the appended claims.

In the drawings:

Figure 1 is a longitudinal sectional view of the invention illustrating the position of the parts as normally maintained and illustrat-

ing a ball entering the throat of the instrument to cause the instrument to actuate the plumb bob into recording engagement with the disc and also illustrates a ball which has passed through the throat and is supported in the ball magazine.

Figure 2 illustrates an elevational view of the instrument looking in the direction toward the ball magazine of Figure 1 and further illustrating a portion of the instrument in section.

Figure 3 is a sectional view substantially on the line 3—3 of Figure 1.

Figure 4 illustrates a modification of Figure 1.

Figure 5 illustrates a sectional view of a modified form of the invention and further illustrates the instrument being actuated by the ball passing through the throat of the instrument.

Figure 6 illustrates a view similar to Figure 5 illustrating the instrument actuated to record the inclination of the drill pipe and also a number of balls received and held by the ball magazine.

Figure 7 is a sectional view substantially on the line 7—7 of Figure 5.

Figure 8 is a further modified view of the invention illustrating a ball about to be forced through the throat of the instrument.

Figure 9 is a similar view of Figure 8 illustrating the ball as it is forced through the throat of the instrument causing the instrument to be actuated into recording engagement, and also illustrating a ball in the magazine.

Figure 10 is a sectional view substantially on line 10—10 of Figure 9.

In the preferred embodiment of the invention as illustrated in the drawings and especially in Figures 1 to 4 inclusive, a suitable supporting tube 1 is provided. The supporting tube 1 may be of any suitable size for retaining the instrument and aligning the instrument within the inner bore of the drill pipe or collar indicated at 2. Suitably mounted in the upper end of the tube 1 is a plug member 3 having an opening or throat 4 passing therethrough. The throat 4 may be enlarged at its upper end as at 5 to permit the ready entrance of the ball to be later described. The plug 3 is provided with a horizontal bore 6 extending into the throat 4 and in which there is operatively mounted a ball 7. The ball 7 is urged toward the throat 4 and projects partially therein by means of a spring 8 which is retained by a plug 9. The ball 7 is prevented from being forced by spring 8 into throat 4 by any suitable means such as by slightly reducing the diameter of the end of horizontal bore 6 to a slightly smaller diameter than the diameter of the ball 7.

Projecting into the horizontal bore 6 is the actuating rod or member 10. The upper end of rod 10 is guided and slidably supported in plug 3 and at its lower end is flanged as at 11 and is suitably mounted upon the bob actuating plunger 12 and is normally maintained in its upper operative position by means of spring 13 and locked at a predetermined setting by means of the plunger nut 14.

Suitably secured to tube 1 is a bracket member 15. Screwed or otherwise secured to bracket member 15 is a plumb bob cylinder head 16. The plumb bob cylinder head 16 is provided with a guide bore 17 through which the plumb bob plunger 12 passes. The lower end of the cylinder head 16 is suitably screw-threaded to receive the plumb bob enclosing tube 18 which is sealed at its lower end by means of a suitable plug 19. The plug 19 is removable and has suitably mounted thereon a recording disc 20. The plumb bob cylinder head 16 is provided with an enlarged bore 21 adjacent the lower end of the guide bore 17 to form a fluid seal and pressure equalizing chamber and is provided with a pressure equalizing port 22.

The plumb bob plunger 12 is provided at its lower end with a ball and socket mounting 23 having an upper diameter substantially the same diameter of the enlarged bore 21 and a flange of larger diameter to prevent ball and socket mounting 23 from rising into the bore 21 further than a predetermined distance, as is clearly illustrated in Figure 1.

A plumb bob 24 is mounted in the ball and socket mounting 23 to permit the plumb bob 24 to swing freely in all directions when the plumb bob 24 is raised above and free from the concave recording surface of the recording disc 20.

As the instrument just described is to be actuated by pumping balls through throat 3, it is necessary to provide a suitable means or magazine for receiving the balls after they have been pumped through throat 4, and for this purpose there are provided two magazine rods 25 suitably mounted at their upper ends in plug 3 and at the lower ends in the brackets 15 and provided with a support member 26 positioned upon the rods 25 slightly above the plumb bob plunger 12 and held in such position by any suitable means such as the supporting tubes 27 which surround rods 25 and maintain the support 26 at position as illustrated in Figure 1.

Rod 25 and tube 27 are clearly illustrated in section in Figure 2 and illustrate one form of mounting rods 25 in bracket 15. A further view of this arrangement is illustrated in Figure 3. For convenience of handling and for removing the balls from the instrument after the instrument has been removed from the casing, there is provided an elongated slot 28.

The instrument as illustrated in Figures 1, 2 and 3 is mounted in the lower end of the drill pipe, or the drill collar adjacent the

drilling tool, and the drill pipe is then lowered into the well. The drilling fluid contained in the well is free to pass through the instrument to permit the drill pipe to fill during the lowering operation.

The drilling operation is carried on until the operator desires to take a reading to determine whether the well bore has drifted from its true course. To take a reading the operator drops a ball such as a ball 29 down through the interior of the drill pipe, the ball finally reaching and passing into the throat 4 of plug 3. The pumps which furnish the drilling fluid are then turned on and ball 29 is forced through throat 4 and as it passes through throat 4, is engaged by the rods 25 and is directed to the ball magazine as illustrated in Figures 1, 2 and especially Figure 3 and the ball 29 is maintained within the magazine until the drill pipe is withdrawn from the well and the instrument taken out of the drill pipe.

It will be noted from the arrangement of the instrument that the ball magazine is provided so that a number of balls may be forced through the instrument at different intervals during the drilling operation and are received and held by the ball magazine until the instrument is removed from the drill pipe.

It will be noted from Figure 1 that as ball 29 passes through the throat 4 of plug 3 the small ball 7 is engaged and forced inward so that ball 7 engages the upper end of the operating rod 10, thus forcing rod 10 downward against the action of spring 13 forcing the plumb bob plunger 12 downward which forces the plumb bob 24 into recording engagement with disc 20.

In order that the disc 20 may receive an impression from the plumb bob 24, the disc 20 may be made of wood, white metal, brass or other suitable material. After the ball 29 has passed beyond the range of the small ball 7, the spring 8 forces ball 7 to return to its initial position and spring 13 forces the plumb bob plunger 12 upward to withdraw the bob from the recording disc and also to carry the operating rod 10 back to its initial position.

The operation just described may be repeated a number of times, depending upon the capacity of the ball receiving magazine. When the drill pipe is removed from the well the drilling fluid contained in the drill pipe is permitted to drain through the instrument and upon removal of the instrument from the drill pipe or collar 2, the balls 29 contained in the magazine may be readily removed through the elongated slot 28.

In the modification of Figure 1, as shown in Figure 4, it will be noted that ball 7, spring 8 and plug 9 have been replaced by a bell crank lever 30 which is pivoted to plug 34 by means of a pin 31. A stop 32 is provided to normally hold bell crank lever 30 in the position indicated in Figure 4. The operation of the instrument having the modification operating mechanism as illustrated in Figure 4 is substantially the same as the operation just described for the instrument as illustrated in Figures 1, 2 and 3.

It will be noted in Figure 4 that ball 33 is just engaging the upper arm of bell crank lever 30 and will force the upper arm of bell crank lever 30 inward as the ball 33 is forced through plug member 34 and also the lower arm of the bell crank lever 30 engages and will actuate the operating rod 35, causing the operating rod 35 to actuate the plumb bob into recording engagement with the disc just as the operating rod 10 causes plumb bob 24 to engage disc 20 of Figure 1.

To insure the proper functioning of the plumb bob 24 of Figure 1, it is desirable that the plumb bob be mounted within a chamber which is filled with water, oil or other suitable fluid so that the drilling mud or fluid will not interfere with the proper functioning of the plumb bob 24. To accomplish this, it will be noted that plumb bob 24 is encased by means of plug 19, casing 18 and head 16. It is further necessary to equalize the pressure within the plumb bob chamber with the pressure of the drilling fluid surrounding the encasing structure. For this purpose there is provided through the head member 16 a pressure equalizing port 22 which communicates between the enlarged bore 21 of member 16 and the exterior of the encasing chamber. As the enlarged bore 21 is closed by means of the ball and socket joint member 23, an equalizing passage $22^a$ is provided through member 23.

When the instrument is assembled, the chamber in which the plumb bob is mounted is filled with a suitable fluid. The equalizing port 22, the enlarged bore 21 and equalizing passage $22^a$ are each filled with the same fluid, and by this structure the pressure within the plumb bob chamber is equalized with the pressure exterior thereof and the drilling fluid is prevented from working its way into the plumb bob chamber.

In the modified form of this invention as illustrated in Figures 5, 6 and 7, the instrument is mounted within the drill pipe or casing such as, for example, the drill collar 50 and drill pipe 51 by means of a flange member 52 mounted between the drill collar 50 and the drill pipe 51 and by which the instrument may be suitably supported.

It is preferable to provide the drill collar with a throat 53 to guide the operating ball 54 so that the ball 54 when pumped through the throat 53 will engage and force downward a tube member 55 which is normally held in the position illustrated in Figure 5 by means of a spring 56 and is supported and guided at its lower end by the flange

member 52 and when approximately at the lower end of its stroke, engages the washer 57 which is loosely mounted upon the plunger 58. The washer 57 is normally held in the position shown in Figure 5 by means of a suitable spring 59. Spring 59 normally urges washer 57 upward and into engagement with a pin or other suitable means 60 for engaging and moving the plunger 58 upward.

As previously stated, when the member 55 is forced downward by means of the ball 54, the lower end of the member 55 engages washer 57 and forces the washer downward against the pressure of spring 59, and it will be noted that the spring 56 which normally holds the member 55 in its upper position, also engages the upper end of plunger 58 so that when the member 55 is forced downward, spring 56 urges plunger 58 downward carrying the recording disc 61 into recording engagement with a pivotally mounted plumb bob 62.

To support the recording disc 61 upon the lower end of plunger 58 any suitable means such as the flange member 63 may be provided. To prevent the plunger 58 from being forced downward more than a predetermined amount, a collar 64 is suitably mounted thereon. Suitable means are provided for supporting the plumb bob to bracket member 52. These means may include a spacing tube 65 suitably secured at its upper end to bracket member 52 and supporting at its lower end a plumb bob chamber head 66 which supports the plumb bob encasing member 67. Suitably mounted in the plumb bob encasing member 67 is the pivotally mounted plumb bob 62.

By means of the structure just described, there is formed a plumb bob chamber 68 and to equalize the pressure therein there is provided one or more pressure equalizing passages 69. It may be also desirable to provide the member 55 with one or more pressure equalizing passages 70.

A ball magazine of any suitable type may be provided which, in the present case, comprises rods 71 and 72 and operates as illustrated in Figure 6 to hold the plurality of balls which have been forced through the instrument to actuate the instrument to record the inclination of the drill pipe. A rod 73 is suitably mounted in bracket 52 and extends upward adjacent the upper end of member 55 and assists in directing the balls 54 as they pass through the throat 53 to pass into the ball magazine.

Like in the instrument illustrated in Figures 1, 2 and 3, when it is desired to make a reading to determine whether the drill pipe has drifted from its true course, a ball 54 is dropped into the drill pipe and forced through throat 53 by the pressure of the drilling fluid. Ball 54, as it passes through throat 53, engages and forces member 55 downward compressing spring 56 until the lower end of member 55 engages washer 57 and forces washer downward as illustrated in Figure 6. As the tension of spring 59 is now exerted against the lower end of member 55 instead of against plunger 58, spring 56 will resiliently force plunger 58 downward carrying disc 61 into recording engagement with the pointed needle of the plumb bob. When ball 54 has passed into the ball magazine springs 56 and 59 return the parts to their initial position as illustrated in Figure 5, where disc 61 is free from the plumb bob needle.

In the modified form of this invention illustrated in Figures 8, 9 and 10 a different form of mounting is illustrated. Between the box 80 and pin 81 of a tool joint 82 is an intermediate member 83. A plug 85 is held by means of a flange 86 between box 80 and member 83 and is provided with a throat 87. The throat may be grooved as at 88 to permit a flow of drilling fluid past plug 85 when ball 89 is passing through throat 87. Suspended from plug 85 by suitable means such as rods 90 is a spider 91 which may have three arms as illustrated in Figure 10. The plumb bob 92 is suspended from spider 91 by means of spacing member 93, head 94, casing 95 and base 96. Head 94 and casing 95 have three or more spacing feet $95^a$ and base 96 forms a plumb bob chamber 97. Mounted in chamber 97 is a partition 98 to which bob 92 is pivotally mounted as at 99. Chamber 97 is arranged to be filled with water, oil or other fluid and base 96 is provided with pressure equalizing valves 100 and 101.

A tubular actuating member 102 is slidably mounted in spider 91 and extends to adjacent throat 97 and slidably mounted in the member 102 and slidably extending through head 94 is plunger rod 103.

Positioned within and acting against the upper end of tube 102 and against plunger 103 is spring 104. To prevent tube 102 from being forced beyond a predetermined limit by spring 103, the lower end of tube 102 is flanged as at 105 and abuts against the under side of spider 91. A washer 106 is slidably mounted on plunger 103 and is arranged to engage shoulder 107 of plunger 103 to permit spring 108 to resiliently retain plunger 103 in its upper position as illustrated in Figure 8.

To limit the downward movement of plunger 103 a suitable adjustable stop means may be provided such as lock nuts 109 and 110, screw-threaded upon plunger 103 and arranged to engage head 94.

A piston 111 is suitably secured to the lower end of plunger 103 and carries a concaved recording disc 112 of wood, white metal, brass or other suitable material.

Disc 112 may be removably secured to piston 111 by means of screws 113.

In normal operation the plumb bob chamber is filled with a suitable fluid and then the

instrument is assembled into tool joint 82 and the drill pipe lowered into the well. The position of the parts are as illustrated in Figure 8 excepting that ball 89 is not positioned within throat 87. Throat 87 with grooves 88 permit the drilling fluid to enter and fill the drill pipe as the drill pipe is lowered and also permits the pumping of the drilling fluid past the instrument during the drilling operation. When the operator desires to take a reading the rotation of the drill pipe is stopped and a ball 89 is dropped into the drill pipe. The ball drops through the drilling fluid until it reaches throat 87. The pressure is applied to the drilling fluid which forces ball 89 through throat 87 causing ball 89 to engage and force downward the tube member 102; spring 104 is compressed and flange 105 of tube 102 engages and forces downward washer 106, relieving the tension of spring 108 from shoulder 107 of plunger 103 and thus permitting spring 104 to resiliently urge plunger 102 downward and consequently disc 112 carried by plunger 102 is forced into engagement with plumb bob 92. After ball 89 has passed into the ball magazine formed by rods 90 and spider 91, springs 104 and 108 return the parts to their initial position, moving disc 112 clear of bob 92.

To assist ball 89 into the magazine, guide rod 114 is secured into plug 85 and extends downward and toward tube member 102. In each of the instruments, after the record has been completed the drilling operation may be continued until a further reading is desired and then the operation above described is repeated.

In each of the instruments readings may be taken as often as desired during the drilling operation, it being only necessary to stop the rotation of the drill pipe to allow sufficient time for the plumb bob to seek its true vertical plane, dropping a ball into the drill pipe, and forcing the ball through the instrument into the ball magazine by fluid pressure. The rotation of the drill pipe may then be again started and drilling continued.

It is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and we do not wish to be limited in the practice of the invention, nor in the claims, to the particular embodiment set forth.

We claim:

1. An instrument for recording inclination including the combination of a plumb-bob and disc recording means, an actuating ball, means operable by said ball to actuate said bob and disc into recording engagement, and automatic means operable thereafter to actuate said bob and disc out of recording engagement.

2. An instrument for recording inclination including the combination of a plumb-bob and disc recording means, a plurality of actuating balls, means operable by said balls for actuating said bob and disc into recording engagement, means for actuating said bob and disc out of recording engagement, and a magazine means for receiving said balls.

3. An instrument for recording inclination including a recording means, an actuating ball, means operable by said ball to actuate said recording means into recording engagement, ball receiving means to remove said ball from engagement with said actuating means, and automatic means for thereafter actuating said recording means out of recording engagement.

4. An instrument for recording inclination including a plumb-bob and disc recording means, a plurality of actuating balls, means operable by said balls for resiliently actuating said recording means into recording engagement, means for guiding said balls out of engagement with said actuating means after said balls have operated said actuating means, and means for thereafter receiving and retaining said balls out of effective engagement with said actuating means.

5. An instrument for recording inclination including a supporting structure, a recording disc supported thereby, a plumb-bob, means for pivotally and slidably mounting said plumb-bob in said structure, means for normally and yieldingly retaining said bob out of engagement with said disc, a plurality of actuating balls, and means actuated by said balls for resiliently forcing said bob into recording engagement with said disc.

6. An instrument for recording inclination including a supporting structure, a recording disc supported by said structure, a plumb-bob, means for pivotally and slidably mounting said bob in said structure, means for yieldingly retaining said bob out of engagement with said disc, a plurality of actuating balls, means actuated by said balls for momentarily forcing said bob into recording engagement with said disc, and means for thereafter receiving said balls.

7. An instrument for recording inclination including a supporting structure having a throat, a plumb-bob operatively mounted in said structure, an operating plunger slidably mounted in said structure and having one end positioned adjacent said throat, a disc plunger slidably mounted in said structure, a recording disc mounted upon said disc plunger, a spring means resiliently connecting said plungers, a second spring means yieldingly acting through said disc plunger for holding said disc out of recording engagement with said bob, a plurality of actuating balls adapted to pass through said throat and to engage and actuate said operating plunger to thereby operate through said first spring means and said disc plunger

to resiliently force said disc into recording engagement with said bob, and a magazine for receiving said balls.

Signed at San Francisco this 29th day of October, 1930.

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