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J. V. BOX ET AL
WELL SURVEYING DEVICE

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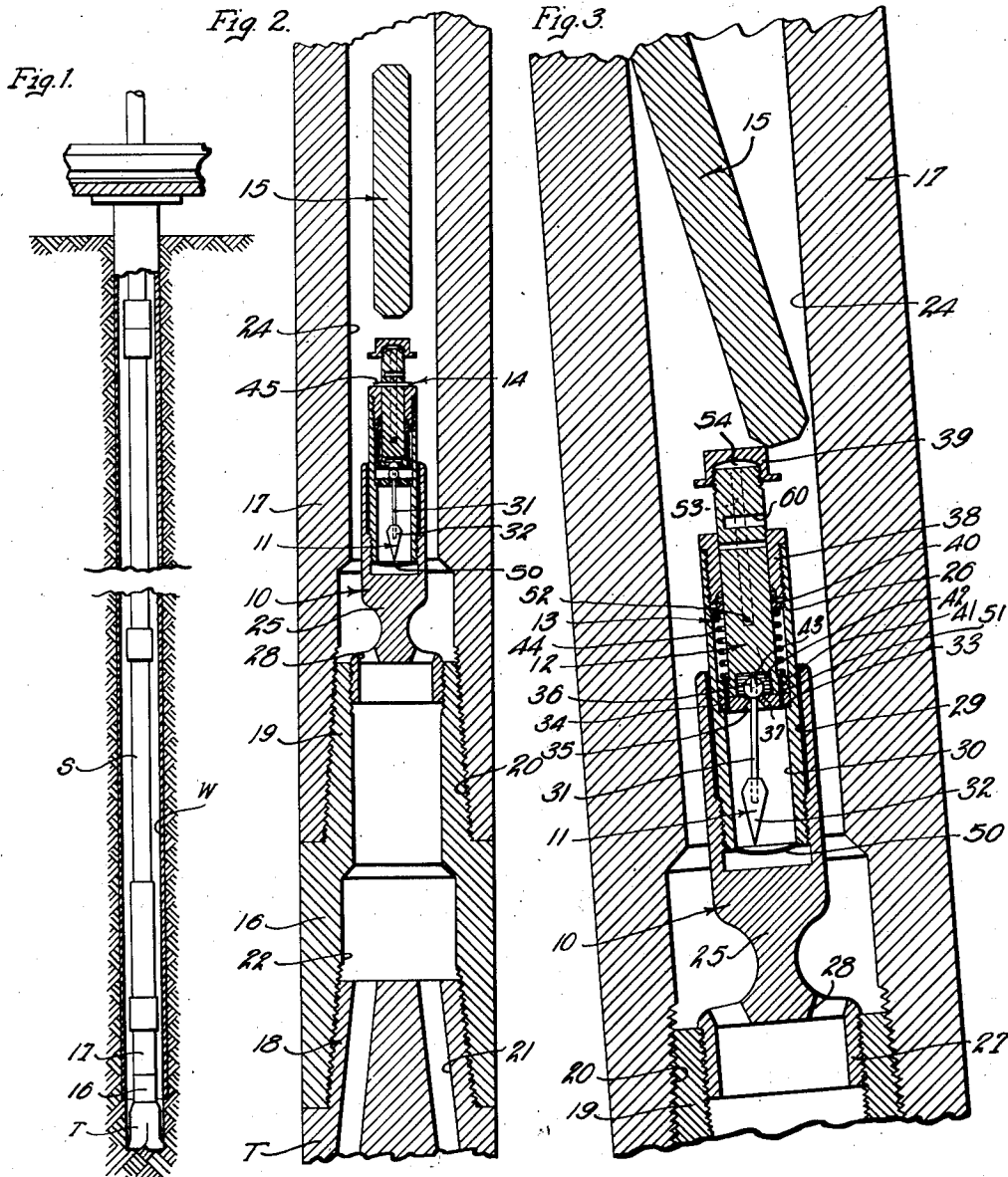
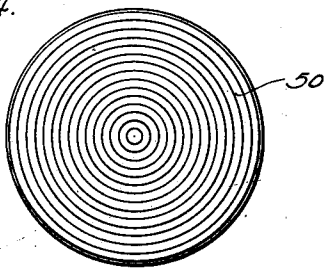


Fig. 4.



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WELL SURVEYING DEVICE

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This invention relates to a device for use in a well, and relates more particularly to a well surveying device.

During the course of drilling a deep well, for example, an oil or gas well, the well bore often becomes crooked and out of vertical alignment. This deviation of the well bore from the true vertical is often caused by strata or formation which is inclined or dipped so that it causes the drilling tools to be deflected from their proper course. For numerous reasons it is desirable to drill a well as straight and as truly vertical as possible. The present invention relates to a device for indicating and recording the inclination of the drilling string and, more particularly, the drilling tool, during the course of drilling a well. It has been found difficult to provide a device that may be employed with the standard drilling equipment and, during normal drilling operations, that will accurately indicate or record the inclination of the well bore or the drilling tool.

It is a general object of the present invention to provide a simple, practical, and effective device for indicating and recording the extent of inclination of a well bore and/or a well drilling tool.

It is another object of the invention to provide a well surveying device of the character mentioned that may be used during the usual course of well drilling operations and with standard equipment.

Another object of the invention is to provide a device for indicating the extent of inclination of a well bore or a well drilling tool within a well bore that may be mounted in a string of drill pipe carrying the drilling tool and that may be operated or tripped to record the inclination of the drilling tool at any suitable time, for example, prior to the removal of the drilling tool from the well for repair or replacement.

It is a further object of the invention to provide a well surveying device of the character mentioned that does not interfere with the free circulation of fluid through the drilling string.

It is another object of the invention to provide a surveying device of the character men-

tioned that may be easily and quickly read to determine the inclination of the drilling tool.

A further object of the invention is to provide a well surveying device of the character mentioned that is simple and sturdy in construction and that cannot be collapsed by the fluid or hydrostatic pressures within a well bore.

Other objects and features of our invention will be best and more fully understood from the following detailed description of a typical form and application of the invention, throughout which description reference is had to the accompanying drawing, in which:

Fig. 1 is a sectional view of a typical well bore illustrating the device provided by the present invention mounted in an operating string extending into the well. Fig. 2 is an enlarged longitudinal detailed sectional view of a portion of the drilling string and of the device provided by this invention, showing the parts in the unactuated position. Fig. 3 is an enlarged longitudinal detailed sectional view of the device in an inclined position and with the parts in the actuated position, and Fig. 4 is an enlarged elevation of the graduated dial or gauge embodied in the invention.

The device provided by the present invention is intended primarily for use in connection with the rotary method of well drilling, and in Fig. 1 of the drawing we have shown the device carried by a string S of drill pipe extending through a well bore W. A typical fish tail bit T is carried at the lower end of the operating string S and is in engagement with the formation at the bottom of the well bore W. The surveying device is adapted to be used in connection with various types of bits and drilling tools, and it is to be understood that the invention is not to be taken as restricted for use in connection with the particular type of drilling tool illustrated in the drawing.

The present invention includes, generally, a body 10 adapted to be mounted in the drilling string S, a pendulum or plumb bob 11 mounted for oscillation in the body 10, a

plunger 12 operable to a position where it sets the plumb bob 11 against movement, means 13 for operating the plunger 12, releasable or frangible means 14 normally holding the plunger 12 against movement, and a trip pin 15 adapted to be dropped through the operating string S to release the means 14.

The body 10 is intended to be arranged in or mounted in the fluid passage of the operating string S. In accordance with the broader principles of the invention, the body 10 may be mounted on or in any suitable member of the operating string, and at any suitable point. In practice, it is desirable to mount the body 10 in the operating string at a point adjacent or immediately above the drilling tool T so that the device, when operated, will record the position or inclination of the drilling tool. In the preferred form of the invention illustrated in the drawing, the body 10 is carried by a sub 16 arranged between the drilling tool T and a drill collar 17. The sub 16 may be screw threaded on a tapered pin 18 at the upper end of the drilling tool T and may have a pin 19 at its upper end, screw threaded into a socket 20 in the lower end of the drill collar 17. The pin 18 of the drilling tool is illustrated as having fluid passages 21 communicating with the interior or fluid passage 22 of the sub 16. The sub 16 and the drill collar 17 may be of standard construction. The body 10 may be carried by the pin 19 of the sub 16 so that it is disposed within the bore or fluid passage 24 of the drill collar 17.

In the preferred form of the invention, the body 10 is sectional, having a main or lower section 25, and an upper section 26. The lower section 25 is provided, at its lower end, with a projection or pin 27 which may be screw threaded into the upper end of the fluid passage 22 of the sub 16. The section 25 projects upwardly from the pin 19, and spaced fluid passages or ports 28 are provided in the section 25 to pass fluid from the interior of the drill collar 17 to the fluid passage 22 of the sub 16. The lower body section 25 may be comparatively long, and a central longitudinal chamber or opening 29 is provided in its upper end.

The upper body section 26 is an elongated tubular member and is provided to encase or carry the pendulum 11 and the plunger 12. The section 26 extends into the opening 29 and its lower end is detachably screw threaded into the opening 29 adjacent its lower end or bottom. In the preferred form of the invention, the body section 26 projects upwardly from the upper end of the section 25 and is centrally arranged in the fluid passage 24 of the drill collar 17. The body 10 is of considerably less diameter than the fluid passage 24, so that the circulation fluid is free to pass through the drill collar 17.

The pendulum or plumb bob 11 is normally centrally and vertically disposed within the lower portion of the opening 30 of the body section 26. The plumb bob is normally carried for free oscillation and includes a stem 31 and a pointed weight or head 32 on the lower end of the stem 31, of bronze or other non-magnetic material. A carrier or seat 33 is arranged in the opening 30 to carry or support the plumb bob 11. The seat 33 may be in the nature of a circular disc supported on a shoulder 34 in the opening 30. The plumb bob stem 31 extends through a central vertical opening 35 in the seat 33. A ball or spherical enlargement 36 is provided on the upper end of the stem 31 to seat on a suitable bearing ring 37 on the upper side of the seat 33. The ball 36 is carried on the ring 37 so that the plumb bob 11 is normally free to swing or oscillate. The lower portion of the opening 35 may be outwardly flared to permit free oscillation of the plumb bob.

The plunger 12 is slidably carried by the upper body section 26. The plunger 12 is slidably supported and guided by a guide bushing 38 screw threaded into the upper end of the opening 30. In accordance with the invention, the plunger 12 projects upwardly from the upper end of the body 10, and a cap 39 may be provided on the upper end of the plunger. A suitable packing gland 40 may be provided on the lower end of the bushing 38 to seal with the plunger 12. The lower end of the plunger 12 is normally held spaced above the ball 36 by the means 14, and an annular flange 41 may be provided on the lower end of the plunger to slidably engage the walls of the opening 30. A transverse opening 60 may be provided in the plunger 12 at a point above the upper end of the bushing 38 to receive a suitable tool for the handling of the plunger.

The plunger 12 is operable by the means 13 to a position where it engages the ball 36 to hold the plumb bob 11 against movement, and the invention provides improved means on the plunger for engaging and gripping the ball 36 when the plunger is operated. A body 42 of resilient material is arranged in a central socket in the lower end of the plunger 12. The body 42 may be formed of rubber or a suitable rubber composition. A substantially semi-spherical socket 43 is provided in the lower side of the resilient material 42 to receive the ball 36 when the plunger 12 is operated to the down position. In accordance with the preferred form of the invention, the socket 43 is of slightly less diameter than the ball 36 and is proportioned so that the ball fits tightly in it when the plunger is in the down or operated position.

The means 13, for operating the plunger 12 to the down position where the ball 36 is held and clamped in the socket 43, is in the

nature of a spring means within the opening 30. The means 13 includes a helical spring 44 surrounding the plunger 12. The spring 44 is arranged under compression between the packing gland 40 and the shoulder 41, so that it normally tends to operate the plunger 12 downwardly.

The means 14 for normally holding the plunger 12 in the up position against the action of the spring 12, where the plumb bob is free to swing, is broken or released upon the cap 30 being engaged or struck by the trip pin 15 or other object dropped through the operating string S. The means 14 includes a shear pin 45 arranged through a transverse opening in the plunger 12. The shear pin projects from the opposite sides of the plunger 12 and seats against the upper end of the bushing 38. The shear pin is such that it is sheared off or broken when the cap 39 is struck by the trip pin 15 or other object dropped through the operating string S. In accordance with the invention, the shear pin 45 is positioned so that it normally retains the plunger against movement in a position where its lower end is spaced above the ball 36 and is made sufficiently strong to resist the action of the spring 44 until the plunger is struck by the trip pin 15.

The trip pin 15 is intended to be lowered or dropped into the operating string S to engage the cap 39 to impart a downward blow to the plunger 12 and break the shear pin 45. The trip pin 15 may be of any suitable shape and size. In the case illustrated in the drawing, the pin 15 is an elongated member having beveled corners, and is adapted to readily pass through the operating string S.

It will be apparent how the shear pin 45 will be broken when the pin 15 strikes the cap 39, and how the spring 44 will forcibly operate the plunger 12 downwardly so that the resilient material 42 engages and grips the ball 36 to hold the plumb bob 11 against movement.

The present invention provides an improved gauge 50 whereby the position of the plumb bob 11 may be quickly and accurately determined or read. The gauge 50 is a circular disc made of a suitable transparent material and is adapted to be arranged on the lower end of the body section 26. In practice, the gauge 50 may not be applied to the device until after it has been withdrawn from the well and has been taken apart to ascertain the inclination of the well bore. The gauge 50 is spaced a short distance below the pointed lower end of the plumb bob 11 and may be dished or concave, as illustrated in the drawing. A plurality of spaced concentric circles are marked on the gauge 50. The exact position of the plumb bob 11 may be readily determined by unthreading or de-

taching the section 26 from the section 25 so that the plumb bob may be seen through the gauge 50.

The present invention provides means for equalizing the fluid pressures within the body 10 during operation of the device, and for preventing the device from being crushed by the excessive hydrostatic pressures encountered within a well bore. The opening 30 may be filled with a suitable liquid, say, an oil, and vertical openings 51 may be provided in the seat 33 and the flange 41 so that the upper end lower portions of the opening 30 are in communication, and so that the fluid trapped between the lower end of the plunger 12 and the gauge may be displaced upon downward movement of the plunger. A transverse vent opening 53 communicates with the opening 52 and extends to the upper end of the plunger. The lower side of the cap 39 may be relieved or provided with a chamber 54 which is in communication with the upper end of the opening 53. The body 10 may be filled with liquid when the device is assembled, and the opening 53, or a part of the opening 53, and the chamber 54 may be left empty, so that the liquid within the opening 30 may be displaced into the opening 53 and the chamber 54 when the plunger 12 is operated downwardly. The liquid or oil provided in the body 10 prevents the body from being crushed or collapsed by the high pressures within the well bore.

In employing the surveying device, it may be mounted on a sub 16, or the like, in the manner described above, and lowered into a well in an operating string of drill pipe, or the like. In practice, the device may be mounted within the drilling string carrying a well drilling tool of any character and may be permitted to remain in the unactuated position until the drilling string is to be removed from the well for the replacing of the drilling tool. When it is desired to trip or actuate the device, the drilling string S is permitted to remain stationary. The trip pin 15 or any other suitable object may then be dropped through the operating string S so that it will strike the cap 39 and cause the shear pin 45 to be broken. Upon the breaking of the shear pin 45, the spring 44 forcibly shifts the plunger 12 downwardly so that the resilient material 42 grips the ball 36 and tightly holds it within the socket 43. It will be apparent how the spring 44 acts to retain the plunger 12 in a position where the plumb bob 11 is held against movement after actuation of the device. After the operating string is removed from the well bore, the upper section 26 of the body may be unthreaded or detached from the lower section 25 and the extent of inclination of the plumb bob 11 may be readily ascertained by applying the gauge 50 to the lower end of the section 26.

It is to be noted that the present invention provides a well surveying device that is particularly simple in construction and operation. The device may be employed during normal drilling operations and does not necessitate the lowering of a special string of tools into the well to take a survey. The device does not interfere with the free circulation of fluid through the operating string and does not depend upon the varying or controlling of the pressure on the circulating fluid for its operation or control. The device is also quicker to operate than the "acid bottle type of well surveying device," as no time is lost in waiting for the acid of an "acid bottle" to etch the glass.

Having described only a typical preferred form of our invention, we do not wish to limit ourselves to the specific details set forth, but wish to reserve to ourselves any changes or variations that may appear to those skilled in the art or fall within the scope of the following claims:

Having described our invention, we claim:

1. A well surveying device of the character described, including a body adapted to be mounted within an operating string, a plumb bob mounted in the body for oscillation, a plunger slidable in the body operable to a position where it holds the plumb against oscillation, means for operating the plunger to the said position, frangible means normally holding the plunger against operation to said position, and gravity actuated means for fracturing the frangible means to release the plunger for movement to the position where it holds the plumb bob.

2. A well surveying device, including a tubular body adapted to be mounted in an operating string, a plumb bob mounted in the body for oscillation, a plunger slidable in the body and projecting from the body, the plunger being operable to a position where it holds the plumb bob against oscillation, frangible means normally holding the plunger against movement releasable by fracturing upon the projecting portion of the plunger's being struck by an object passed through the operating string, an object adapted to be passed into the string to fall therethrough to strike the projecting portion of the plunger to fracture the frangible means and means for operating the plunger to the position where it holds the plumb bob against movement upon the release of the last-mentioned means.

3. A well surveying device, including a tubular body adapted to be mounted in an operating string, an object adapted to be passed through the operating string, a plumb bob mounted in the body for oscillation, a plunger slidable in the body and projecting from the body and engageable by said object, the plunger being operable to a position where it holds the plumb bob against oscilla-

tion, a shear pin normally holding the plunger against movement breakable upon the plunger's being struck by said object, and means for operating the plunger to the said position upon breaking of the shear pin.

4. A well surveying device, including a body adapted to be detachably mounted in an operating string, an object adapted to be passed through the operating string, a plumb bob mounted for oscillation in the body, a plunger slidable in the body and having a portion projecting from the body adapted to be struck by the object dropped through the operating string, means on the plunger for holding the plumb bob against oscillation upon operation of the plunger, and means normally holding the plunger against operation in a position where the plumb bob is free to oscillate and releasable upon the plunger being struck by the said object.

5. A well surveying device, including a body adapted to be detachably mounted in an operating string, an object adapted to be dropped through the operating string, a plumb bob mounted for oscillation in the body, a plunger slidable in the body and having a portion projecting from the body adapted to be struck by the object dropped through the operating string, means on the plunger for holding the plumb bob against oscillation upon operation of the plunger, means in the body for operating the plunger, and means holding the plunger against operation, including a frangible pin engaging the plunger and the body adapted to be broken upon the object striking the said portion of the plunger.

6. A well surveying device for use in connection with an operating string of drill pipe, including a body adapted to be mounted in the drilling string, a plumb bob in the body, a plunger carried by the body and projecting from the body and operable to a position where it prevents oscillation of the plumb bob, releasable means normally holding the plunger against movement in a position where the plumb bob is free to oscillate, and a trip pin adapted to be dropped through the string so that it strikes the plunger to release the releasable means by the force of its impact against the plunger.

7. A well surveying device for use in connection with an operating string of drill pipe, including a body adapted to be mounted in the drilling string, a plumb bob in the body, a plunger carried by the body and projecting from the body and operable to a position where it prevents oscillation of the plumb bob, means for operating the plunger to said position, releasable means normally holding the plunger against movement in a position where the plumb bob is free to oscillate, and a trip pin adapted to be dropped through the string so that it strikes the plunger to release

the releasable means by the force and impact of its blow against the plunger.

8. A well surveying device for use in an operating string carrying a drilling tool, including a sub to be mounted in the string adjacent the tool, a body in the sub including a lower section on the sub, and an upper tubular section detachably mounted on the lower section, a plumb bob in the lower section, a plunger slidable in the upper section to a position where it holds the plumb bob against movement, the plunger projecting from the body, means for operating the plunger to the said position, and releasable means normally holding the plunger against movement and adapted to be released upon a blow being applied to the plunger, and an object to be passed into the operating string to fall therethrough and strike the plunger to release the releasable means by the force of its impact against the plunger.

9. A well surveying device of the character described, including a body adapted to be mounted in an operating string, a plumb bob mounted within the body, a plunger carried by the body operable to a position where it holds the plumb bob against oscillation, the plunger projecting from the upper end of the body, means normally tending to operate the plunger to the said position, including a spring in the body acting between the body and the plunger, a shear pin on the plunger and engaging the body normally holding the plunger against movement, and an object adapted to be passed into the operating string to fall therethrough to strike the plunger and break the shear pin by its impact with the plunger.

10. A well surveying device, including a

body adapted to be mounted in an operating string, the body having a chamber, a plumb bob mounted within the chamber, and including a stem and a ball on the stem, means swivelly supporting the ball, a plunger slidable in the chamber and projecting from the body, a body of yielding resilient material on the plunger having a socket adapted to co-operate with the ball to hold the plumb bob against movement, means for operating the plunger to a position where the plumb bob is held against movement, and releasable means normally holding the plunger against movement in a position where the ball is free of the socket and releasable upon a blow being applied to the plunger.

11. A well surveying device, including a body adapted to be mounted in an operating string, the body having a chamber, a plumb bob mounted within the chamber, and including a stem and a ball on the stem, means swivelly supporting the ball, a plunger slidable in the chamber closing an end of the chamber and projecting from the body, a body of yielding resilient material on the plunger having a socket adapted to co-operate with the ball to hold the plumb bob against movement, means for operating the plunger to a position where the plumb bob is held against movement, means whereby fluid may be displaced from the chamber when the plunger is operated, and releasable means normally holding the plunger against movement in a position where the ball is free of the socket releasable upon a blow being applied to the plunger.

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