

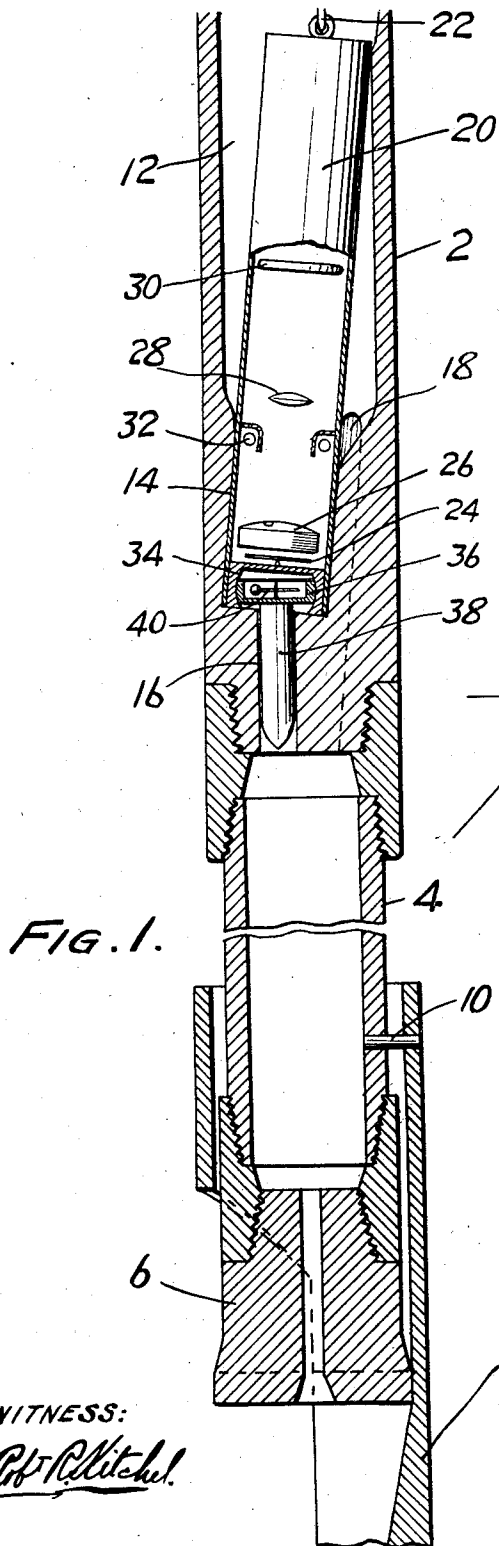
Jan. 16, 1940.

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2,187,367

METHOD AND APPARATUS FOR ORIENTING DRILL STEMS

Filed May 4, 1939



WITNESS:

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2,187,367

METHOD AND APPARATUS FOR ORIENTING
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Application May 4, 1939, Serial No. 271,743

8 Claims. (Cl. 255—1)

This invention relates to a method and apparatus for orienting drill stems, and, more specifically, to a method of directional drilling which has as part of its procedure the orientation of a drill stem.

10 The orientation of the lower portions of drill stems within bore holes is important for various purposes. For example, in setting of whipstocks or directional drilling tools the whipstock or other tool is lowered into the bore hole in an arbitrary position or perhaps with an attempt to get it in a predetermined position by so-called drill stem orientation. Orientation by the latter method is never absolutely certain because of the possibility that in lining up the drill stem lengths there may have occurred accumulation of errors which would result in substantial deviation of the tool from the assumed position. Accordingly, in either case it is desirable to check the orientation of the lowermost portion of the drill stem by means of a well surveying instrument. This may be accomplished in various fashions, for example, the inside of the lowermost portion of the drill stem may be provided with a key, adapted to engage a groove in a well surveying instrument, or vice versa, with the result that when the well surveying instrument is lowered within the drill stem it will be brought into a predetermined relationship with the stem. Alternatively, mechanical complications may be avoided by the use of the method and apparatus described in Hyer Patent 2,120,670, dated June 14, 1938.

In my prior application Serial No. 236,996, filed October 26, 1938, there is described another alternative method which avoids even the presence of a magnetic element in the drill stem, but utilizes a well surveying instrument which is adapted to give indications of its orientation with respect to the earth.

50 The present invention provides an improved method and apparatus for orienting the lower portion of a drill stem for any of the various purposes for which such orientation is usually practiced. Specifically, it avoids the presence of any magnetic or keying elements within the drill stem and does not require either precautions or special construction to permit a magnetic compass to respond to the field of the earth. It will become apparent in the following description that the improved method and apparatus is adapted for the general purposes described in my prior application mentioned above.

The various objects of the invention will become apparent from the following description,

read in conjunction with the accompanying drawing, in which:

Figure 1 is a diagrammatic sectional view of the lower portion of a drill stem together with a well surveying instrument cooperating therewith to indicate the orientation of the portion of the drill stem which is illustrated; and

Figure 2 is a perspective diagram illustrating the matters which must be taken into account in determining the orientation of the drill stem.

10 Referring first to Figure 1, there is illustrated diagrammatically therein the lower portion of a drill stem comprising at 2 a sub forming a portion of the drill stem and adapted to receive and position in predetermined fashion a well surveying instrument. Below this and connected through it to the tubular member 4 may be a bit indicated at 6. Connected to this assembly by a rivet 10 or the like, which may be readily sheared off, is a whipstock 8. The whipstock and drilling tool are illustrated merely as examples, since it will be evident that the invention is applicable to the orientation of a drill stem for any of many purposes and in connection with the use of various tools, for example, for purposes of directional drilling, oriented coring, side wall sampling or the like. It will be evident that directional drilling may be accomplished through the use of a bent drill stem as described in my prior application and in Ragland Patent 2,114,476, dated April 19, 1938.

20 In the vicinity of the portion of the drill stem which is to be oriented, a sub such as indicated at 2 may be provided with an enlarged bore indicated at 12 communicating with a socket bore 14 making a predetermined angle with the axis of the bore hole and adapted to align at such angle a well surveying instrument such as indicated at 20. Reference is here made to the arrangement of the socket 14 at a predetermined angle relative to the bore hole. If the drill stem is straight this angle is, of course, the same as the angle of the socket with respect to the axis of the drill stem. Such would not be the case, however, if there was used a bent drill stem as disclosed in the Ragland patent.

40 In the assembly of the device the socket 14 has an angular position in the drill stem assembly which is predetermined relative to the tool or other element carried by the drill stem. For simplicity it will be assumed in the following description that the socket inclines downwardly toward the direction in which a whipstock 8 faces. Any predetermined relationship is, of course, equally usable.

Extending beyond the socket 14 is a bore 16, which is parallel with the axis of the bore hole (or with the axis of the drill stem if the drill stem is straight).

5 Since mud circulation is desirably maintained at all times, it is preferable to bypass the socket 14 and bore 16 by one or more grooves indicated at 18 which, as will be evident, will permit seating of a surveying instrument without interruption of the circulation of mud.

10 The surveying instrument 20 which is adapted to be lowered and raised by means of a wire line 22, or lowered or raised in any other suitable fashion, for example, by the use of catchers, 15 comprises a pivoted magnetic compass 24, having contrastingly marked or shaped poles, immediately above which there is located a transparent level 26 or other suitable means such as a pendulum for indicating inclination with respect to the vertical. A record of the inclination indicating means and the compass 24 may be made photographically by projection by lens system 28 upon a sensitized member 30, illumination being provided by lamps 32, which are lighted at the proper time under control of clockwork mechanism. Such instruments for photographic recording are well known, and the operation need not be described in greater detail.

At the lower end of the well surveying instrument there is provided a spherical socket member indicated at 34 adapted to receive the spherical head 36 of a plunger 38 adapted to closely fit the bore 16. Within this head there is pivoted a powerful magnet 40 which is weighted at one end so that that end will occupy the lowermost position whenever the member 38 is tilted from the vertical. The well surveying instrument is enclosed in a casing of non-magnetic type at least at its lowermost portion designed to withstand the pressures encountered in the bore hole. The chamber in the spherical head 36 is also closed to prevent the entrance of mud to the pivoted magnet 40. While the elements in the vicinity of the magnet and compass should be non-magnetic, the sub 2 may be made of steel if desired. The only requirement is that the magnet 40 and compass 24 be sufficiently close together that the compass will align itself with the magnet and that magnetic materials be sufficiently remote from these elements to prevent any misaligning.

15 In the operation of the method, assume that the assembly just described is located in a portion of a bore hole of which the inclination and direction of inclination is known. The well surveying instrument is lowered within the drill stem to a position within the socket 14 and with the member 38 in the bore 16. The azimuthal position of the instrument may be quite arbitrary and the universal connection afforded by the ball and socket joint will permit the attainment of the position just described. Through the usual timing means a photographic record is then made. This record will show the inclination of the surveying instrument with respect to the vertical and the position of the compass 24 with respect to the direction of deviation of the bubble. The compass 24 will be in the direction of maximum inclination of the bore hole with respect to the vertical inasmuch as the weighted end of the magnet 40 will lie in lowermost position. The well surveying instrument is then removed from the hole, the record developed and calculations made.

20 The calculations and significance of the records made will be best appreciated by consider-

ing Figure 2. At OM there is indicated the vertical direction, north being indicated by the arrow N. OP is the direction of the bore hole determined from a previous survey.

The angle of inclination of the socket 14 with respect to the axis of the bore hole is known, and consequently it will be known that the well surveying instrument must lie in the direction of one of the straight line elements of a cone having a vertex angle twice the inclination of the angle of deviation of the socket from the axis of the bore hole. The intersection of such a cone with the horizontal plane is indicated by the ellipse Q.

The record of the inclination indicating member such as the level 26 will show the inclination of the well surveying instrument with respect to the vertical. Assume this angle to be b , the angle of the bore hole with respect to the vertical being a . Then it will be known that the direction taken by the well surveying instrument will be OU or OV which, on the diagram are lines forming the angle b with the vertical and passing from O through points on the ellipse Q.

25 With this information only, an indeterminateness would result. If the whipstock or other tool was aligned angularly as assumed with respect to the direction of slope of the well surveying instrument it might face in either the direction Y or the direction Y'.

The record of the position of the compass 24, however, will solve this indefiniteness. The compass 24 will indicate the direction PM, i. e., the plane in which the bore hole slopes or, in other words, at points U and V the directions UT and VT'. The bubble or other inclination indicating means will indicate the direction UM or VM' indicated by the lines S and S' respectively. It will be evident, therefore, that the side of the bubble on which the compass lies will indicate whether the point U or the point V represents the point indicative of the direction of slope of the well surveying instrument. It will be noted that the line UM is clockwise with respect to UT, while the line VM is counter-clockwise with respect to VT'. From the relationship of the bubble to the compass, therefore, it will be apparent whether Y or Y' is the direction of orientation of the whipstock or other tool.

While the magnet 40 which indicates the direction of slope of the bore hole may be lowered with the instrument as part thereof as indicated in Figure 1, it will be evident that this compass may be permanently secured at the bottom of the socket 14 within the drill stem with its axis parallel to the axis of the bore hole, so that when the instrument is located in the socket its compass will be forced to align itself with the magnet which will indicate the direction of slope of the hole.

It will be evident that various modifications of the invention may be made within its scope.

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

1. The method of determining the orientation of a portion of a drill stem within a bore hole comprising determining the slope of a bore hole at the location where such determination is to be made, lowering into the bore hole a hollow drill stem which, at the portion which is positioned at the location where such determination is to be made, is arranged to position a well surveying instrument at a known angle of deviation from the axis of the hole, causing to be made by an instrument so positioned a record of the inclination

of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, and removing the instrument from the drill stem.

2. The method of determining the orientation of a portion of a drill stem within a bore hole comprising determining the slope and direction of slope of a bore hole at the location where such determination is to be made, lowering into the bore hole a hollow drill stem which, at the portion which is positioned at the location where such determination is to be made, is arranged to position a well surveying instrument at a known angle of deviation from the axis of the hole, causing to be made by an instrument so positioned a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, and removing the instrument from the drill stem.

3. The method of determining the orientation of a portion of a drill stem within a bore hole comprising determining the slope of a bore hole at the location where such determination is to be made, lowering into the bore hole a hollow drill stem which, at the portion which is positioned at the location where such determination is to be made, is arranged to position a well surveying instrument at a known angle of deviation from the axis of the hole, and is provided with means defining the direction of the axis of the hole, causing to be made by an instrument so positioned a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, and removing the instrument from the drill stem.

4. The method of determining the orientation of a portion of a drill stem within a bore hole comprising determining the slope and direction of slope of a bore hole at the location where such determination is to be made, lowering into the bore hole a hollow drill stem which, at the portion which is positioned at the location where such determination is to be made, is arranged to position a well surveying instrument at a known angle of deviation from the axis of the hole, and is provided with means defining the direction of the axis of the hole, causing to be made by an instrument so positioned a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, and removing the instrument from the drill stem.

5. Means for determining the orientation of

a portion of a drill stem within a bore hole comprising means in the drill stem for positioning a well surveying instrument at a known angle of deviation from the axis of the hole at the location where such determination is to be made, and a well surveying instrument arranged to be so positioned and provided with means to make a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical.

6. Means for determining the orientation of a portion of a drill stem within a bore hole comprising means in the drill stem for positioning a well surveying instrument at a known angle of deviation from the axis of the hole at the location where such determination is to be made, and a well surveying instrument arranged to be so positioned and provided with means to make a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, said last means comprising a device cooperating with means in the drill stem defining the direction of the axis of the hole.

7. Means for determining the orientation of a portion of a drill stem within a bore hole comprising means in the drill stem for positioning a well surveying instrument at a known angle of deviation from the axis of the hole at the location where such determination is to be made, and a well surveying instrument arranged to be so positioned and provided with means to make a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the vertical, said last means comprising a magnetic compass arranged to respond to a magnetic element arranged to define the direction of inclination of the bore hole with respect to the vertical.

8. Means for determining the orientation of a portion of a drill stem within a bore hole comprising means in the drill stem for positioning a well surveying instrument at a known angle of deviation from the axis of the hole at the location where such determination is to be made, and a well surveying instrument arranged to be so positioned and provided with means to make a record of the inclination of the instrument with respect to the vertical and of the relationship of said inclination to the direction of inclination of the bore hole with respect to the vertical, said last means comprising a magnetic compass and a magnetic element arranged to define the direction of inclination of the bore hole with respect to the vertical.

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