Aug. 20, 1935. S. H. WILLISTON 2,012,152

METHOD OF ORIENTING WHIPSTOCKS

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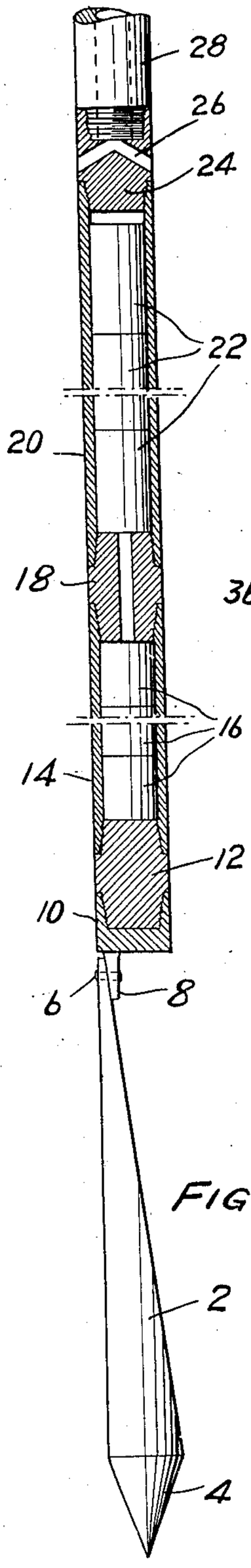

FIG. 1.

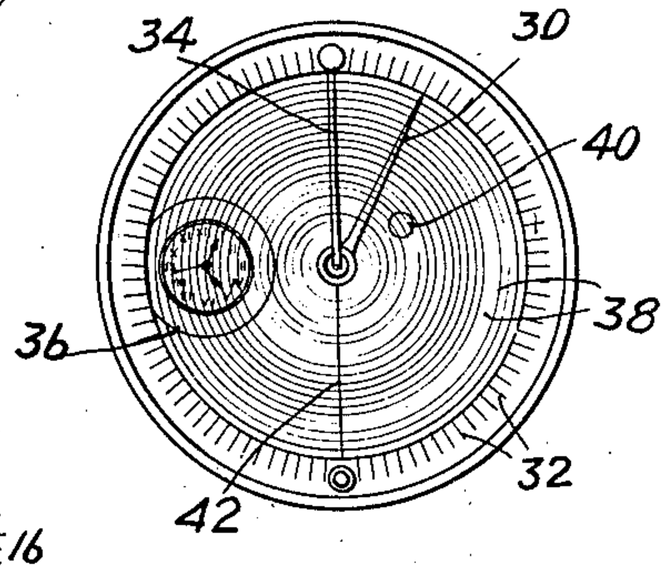

FIG. 2.

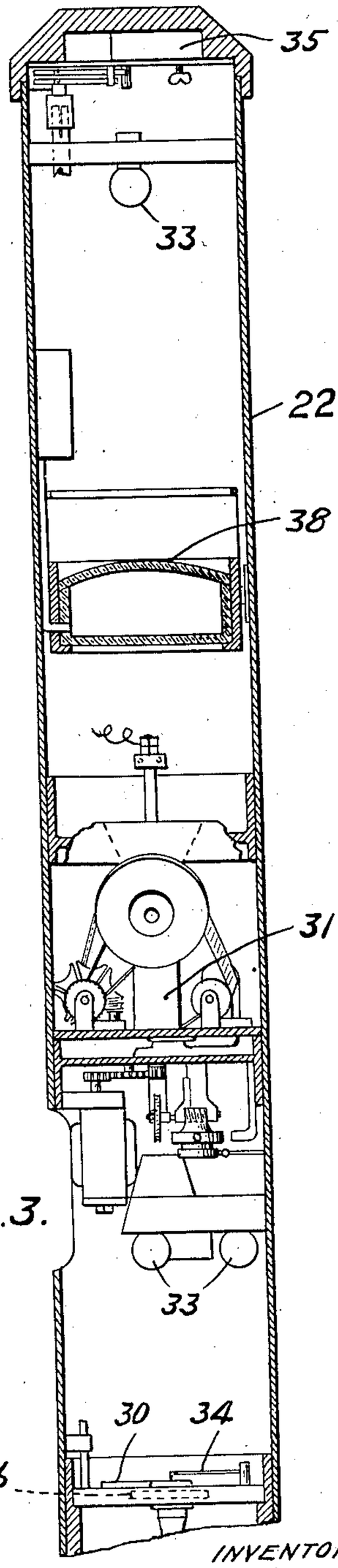

FIG. 3.

WITNESS:
Robt. R. Kitchel.

INVENTOR
Samuel H. Williston
BY
Busser & Harding
ATTORNEYS.

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METHOD OF ORIENTING WHIPSTOCKS

Samuel H. Williston, Aberdeen, Wash., assignor to Sperry-Sun Well Surveying Company, Philadelphia, Pa., a corporation of Delaware

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4 Claims. (Cl. 255—1)

This invention relates to the drilling of wells and has particular reference to a method of checking the orientation of a whipstock designed to guide a drill in a definite direction as is necessary, for example, in straightening a crooked well. As is well known, many wells, particularly those produced by rotary drilling, deviate very considerably from the vertical at even moderate distances below the surface, such deviations being apparently due to lack of uniformity in the soil through which the drill is passing and being particularly noticeable in the case of rotary drilling since the rotation of the drill stem appears to promote the production of a tortuous hole. If a bore hole deviates to a substantial degree from the vertical it may entirely miss the locality which is believed to contain oil. Once a bore hole begins to deviate from the vertical little can be done in the way of control of the drilling from the surface to cause it to become straight. Accordingly, it is the practice to insert within the bore hole a whipstock having a guiding surface at an angle with the axis of the bore hole to direct the drill in the desired direction to reach its objective. Obviously, it is necessary to properly orient the whipstock and check the orientation to insure that a proper correction of the direction of the bore hole will be made.

The orientation of a whipstock necessarily involves a knowledge of the path of a bore hole so that a preliminary survey must be made to find the direction and position of the lower end of the hole.

Various methods of orienting whipstocks are known, a typical one being described in the transactions of the Institute of Mining and Metallurgy (1911–1912, pages 481 to 489). Carrying out any of the known processes is quite difficult by reason of the various manipulations involved, so that they are impractical.

In the process described in the above publication, the whipstock is lowered on the end of a drill stem, being secured to the drill stem by means of soft metal rivets which can be sheared off to eventually leave the whipstock in position. Where the bore hole does not have an excessively tortuous path, the whipstock may be positioned by drill stem orientation, the corrections for tortuosity being in certain cases negligible in comparison with the errors arising in the alignment and orientation of the drill stem sections. Whether or not the effects of tortuosity must be calculated can be determined, or sometimes inferred without calculation, from a consideration of the path of the hole as determined by a preliminary survey.

It is the object of the present invention to provide means to check the position of the set whipstock, this being effected by including within the length of the drill stem at its lower end a surveying instrument capable of indicating accurately the azimuthal position of the whipstock while the whipstock is being lowered and set. The whipstock is oriented by the setting of the drill stem while in the same operation its position is checked by a reliable instrument. The necessity for accuracy even within wide permissible ranges substantially requires that the well surveying instrument used should be of gyroscopic character, and the records made photographically.

Other objects of the invention will be apparent from the following description read in conjunction with the accompanying drawing in which:

Fig. 1 is a sectional view showing the assembly of the drill stem, well surveying instrument and whipstock prior to setting;

Fig. 2 is a plan view of the type of photographic record made by the surveying instrument; and

Fig. 3 is a sectional view showing the relationship of various parts of the surveying instrument.

In carrying out the improved method, it is first necessary to make a complete directional survey of the bore hole. This must be done by the use of some instrument which is not in itself affected by errors due to tortuosity, namely, an instrument which contains within itself an element for correctly indicating the azimuth. It may be pointed out that if the survey was made by drill stem orientation, the tortuosity errors would be cumulative. In accordance with the present invention, however, the only tortuosity errors are those which may arise in the setting of the whipstock itself. The errors are thereby minimized particularly since surveys made by drill stem orientation are likely to have large errors due to inaccuracies in aligning the various sections of the stem.

Both gyroscopic and magnetic instruments would satisfy the requirement for avoidance of errors due to tortuosity, but the only type of instrument which is fully reliable, is a gyroscopic one due to the errors caused in magnetic readings by mineral deposits or the presence of magnetic bodies artificially present in the bore hole. An accurate survey with no errors due to tortuosity or magnetism may be made by the type of instrument described in the patent to Williston and Nichols No. 1,960,038, dated May 22, 1934. This instrument photographically records the positions of a gyroscope and a bubble at short intervals of time corresponding to relatively short

distances along the path of a bore hole. Such instrument may be lowered either on a wire line or a drill stem for the purpose of making the initial survey.

Following the determination of the path of the bore hole the position which the whipstock must assume to secure straight drilling or a desired deviation will, of course, be known. There is then lowered into the bore hole at the bottom of a drill stem an assembly of the type indicated in Fig. 1. This comprises a whipstock 2, which is shown as provided with a chisel-shaped lower end 4. The showing of this type of whipstock is to be understood to be conventional, since the whipstock may be of any well known type involving, for example, an automatic arrangement designed to engage and hold the bottom of the whipstock at the position of a joint in a casing. The whipstock may also be of the type designed to be secured in place by cementing. The type of whipstock here illustrated, provided with a chisel-shaped lower end, would be held in place by being forced into the soil at the bottom of the bore hole.

The whipstock is secured by means of a soft metal rivet or pin 6 to an extension 8 of a setting tool 10, which is coupled by means of a sub 12 to the outer casing 14 of a battery container, which is indicated as filled with a suitable number of batteries 16. This casing is in turn connected by a coupling 18 to the outer casing 20 of a surveying instrument of the type described in the above mentioned Williston and Nichols patent. This surveying instrument comprises three parts indicated at 22, including a gyroscope, a timepiece and a box level, which are arranged to be simultaneously photographed by the use of a motion picture camera making successive exposures at suitably timed intervals.

Above the surveying instrument there is provided a coupling 24 provided with mud passages 26, to which coupling there is secured the lowermost section 28 of the drill stem on which the apparatus is lowered.

The details of the well surveying instrument corresponding to that of the Williston and Nichols patent are indicated in Fig. 3, and also on the record illustrated in Fig. 2. The vertical gimbal ring of a gyroscope carries a pointer 30 which moves adjacent a scale 32. Current is led into the gyroscope by means of a lead 34 which extends in a plane above that of movement of the pointer 30. Located adjacent the scale 32 is a watch 36 which serves to indicate permanently on the records the times at which exposures are made. A camera 31 is located above the gyroscope and serves not only to take pictures of the gyroscope pointer and the adjacent pieces of apparatus, but also makes simultaneous exposures of a box level, indicated at 38, provided with concentric lines on its transparent cover, in contact with which there moves a bubble 40 serving to indicate the inclination of the device. Lamps 33 are provided to furnish illumination of the parts for the production of exposures. Movements of the film of the camera and the illumination are controlled by means of a mechanism indicated at 35, which serves to prevent the formation of an excessive number of exposures in the relatively long interval involved in lowering and locating the whipstock.

The surveying instrument is oriented into a known position relative to the whipstock so that, from the readings obtained in the instrument, the final position of the whipstock will be accurately known. Either a line 42 inscribed on the cover glass of the level 38, or the electrical lead 34 may be used as the zero of reference of the scale 32, or the scale itself may be suitably marked with a zero indication. Whatever this indication may be, it is brought into position bearing a definite relationship to the inclined face of the whipstock. It will be understood, of course, that the box level occupies a fixed angular position in the casing relative to the gyroscope scale. The mark 42 inscribed on the cover of the level is desirable since, while the lead 34 is generally visible, it is to some extent out of focus, being disposed in a plane above that in which the pointer 30 moves.

The box level forms an integral part of the surveying instrument to which reference has been made. It will be obvious, however, that the indications of the box level are not necessary to the carrying out of the method herein described. It is, however, convenient to have this check upon the inclination of the bore hole at the position where the whipstock is set.

The various sections of the drill stem are lined up relative to each other and the surveying instrument and whipstock by the usual process involving the alignment of successive fourbles relative to each other. This may be effected by the well known procedure of attaching targets to the bottoms and tops of the fourbles and sighting these targets, successively moving them upwardly in steps as the drill stem is lowered by fourble lengths. The drill stem may be turned to secure proper alignment or, alternatively, the misalignment may be noted and correction made. The process may be carried out either by sighting targets attached to the fourble lengths, or by clamping to the fourble lengths telescopes or other sighting instruments directed toward fixed distant objects. This method of orientation of the various lengths to secure a known alignment throughout the entire length of the drill stem is well known and the specific steps involved need not be described herein in detail. It is the same procedure as is frequently followed in making well surveys.

As the whipstock is brought to its position, the surveying instrument continues to operate to record its actual position, the drill stem being turned to bring the whipstock into the calculated position. The timepiece will indicate those exposures which are made when the whipstock is finally in position by merely noting the time at which such position is attained on a watch at the surface synchronized with that within the instrument.

After the desired position of the whipstock is reached it is set and held in place by that method which is suitable for the particular whipstock being used. In the present instance, for example, the chisel-shaped lower end of the whipstock is forced into the soil at the bottom of the bore hole or into cement if the lower portion of the bore hole has been partially filled therewith. If another type of whipstock is used, securing of it in position is accomplished in the corresponding suitable fashion. The securing of the whipstock in place may initially be temporary, more permanent securing thereof being obtained by cementing.

Following permanent or temporary fixation of the whipstock, the drill stem is pressed downwardly with sufficient force to shear off the rivet or pin 6, leaving the whipstock free of the lower end of the drill stem, which is then withdrawn, bringing up the surveying instrument. The

records of the surveying instrument may then be examined to determine whether the whipstock actually has the proper position. Following the check of this position, drilling may be resumed in any of the usual fashions, for example, as described fully in the article referred to above.

Various details of manipulation need not be described here since they are well known and are brought out, for example, in said article. If the deflection is to take place not in the bottom of a bore hole but at some intermediate position for the purpose, for example, of forming branches, then the various procedures specified in the article may be used to secure the positioning of the whipstock at the proper location. For example, the bore hole may be plugged back to a given position by the lowering of old drill stem piping or the use of cement.

The advantages of this method are primarily in that it makes possible the checking of the setting of a whipstock in a convenient and rapid fashion. The direction of the setting of the whipstock is photographically recorded in one round trip of the drill stem. A considerable expense is saved by avoiding a second trip into the hole with a surveying instrument for the purpose of checking the orientation of the whipstock. This check is of great value since if the whipstock setting should happen to be improper for any reason correction may be made by the use of a double whipstock as in the process described in the publication mentioned above.

It will be clear that variations in the practice of the invention may be made without departing from its scope, as defined by the following claims.

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

1. The method of orienting a whipstock within a bore hole including lowering the whipstock into the bore hole, there being lowered with the whipstock an instrument arranged to indicate photographically the azimuthal position of the whipstock, the intrument being adjacent the whipstock and attached thereto; causing the whipstock to assume a predetermined position; photographically recording the azimuthal position of the whipstock in said predetermined position by means of said instrument; fixing the whipstock in such position; and then withdrawing the instrument.

2. The method of orienting a whipstock within a bore hole including lowering the whipstock into the bore hole by means of a sectional drill stem, the sections of which are lined up relatively to each other, there being lowered with the whipstock an instrument arranged to indicate photographically the azimuthal position of the whipstock, the instrument being adjacent the whipstock and attached thereto; turning the upper end of the drill stem to thereby bring the whipstock into a predetermined position; photographically recording the azimuthal position of the whipstock in said predetermined position by means of said instrument; fixing the whipstock in such position; and then withdrawing the instrument.

3. The method of orienting a whipstock within a bore hole including lowering the whipstock into the bore hole, there being lowered with the whipstock an instrument arranged to record the azimuthal position of the whipstock, the instrument being adjacent the whipstock and attached thereto; causing the whipstock to assume a predetermined position; recording the azimuthal position of the whipstock in said predetermined position by means of said instrument; fixing the whipstock in such position; and then withdrawing the instrument.

4. The method of orienting a whipstock within a bore-hole including lowering the whipstock into the bore-hole by means of a sectional drill stem; photographically recording the azimuthal position of the whipstock in its lowered position while it is secured to the drill stem by means of an instrument located adjacent the whipstock and bearing a determinable relationship thereto; and effecting fixation of the whipstock in desired position and withdrawal of the instrument.

SAMUEL H. WILLISTON.