A. F. L. BELL.

CLINOMETER FOR WELL BORES.

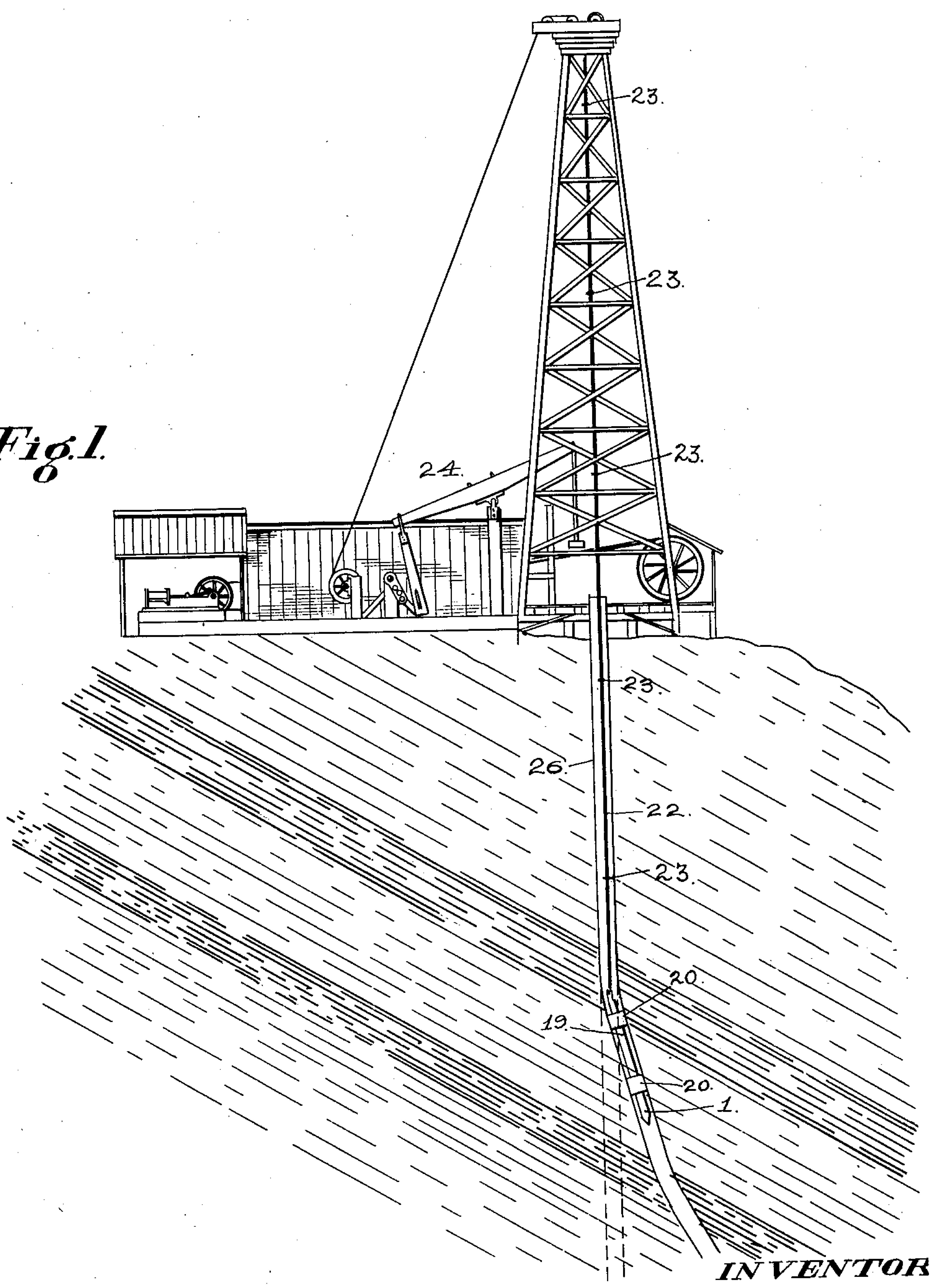
APPLICATION FILED JAN. 15, 1908.

959,912.

Patented May 31, 1910.

3 SHEETS—SHEET 1.

Fig.1.



WITNESSES.

Arthur L. Slee.

N. A. Acker

INVENTOR

Arthur F. L. Bell

by Wm. F. Booth

his Attorney.

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3 SHEETS—SHEET 2.

Fig. 3.

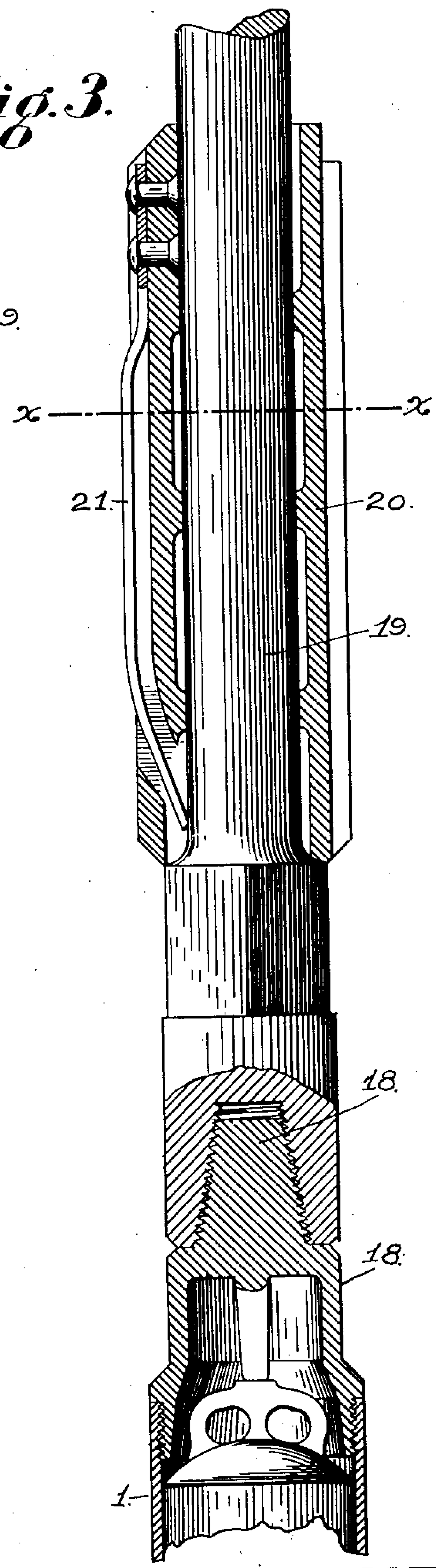

Fig. 2.

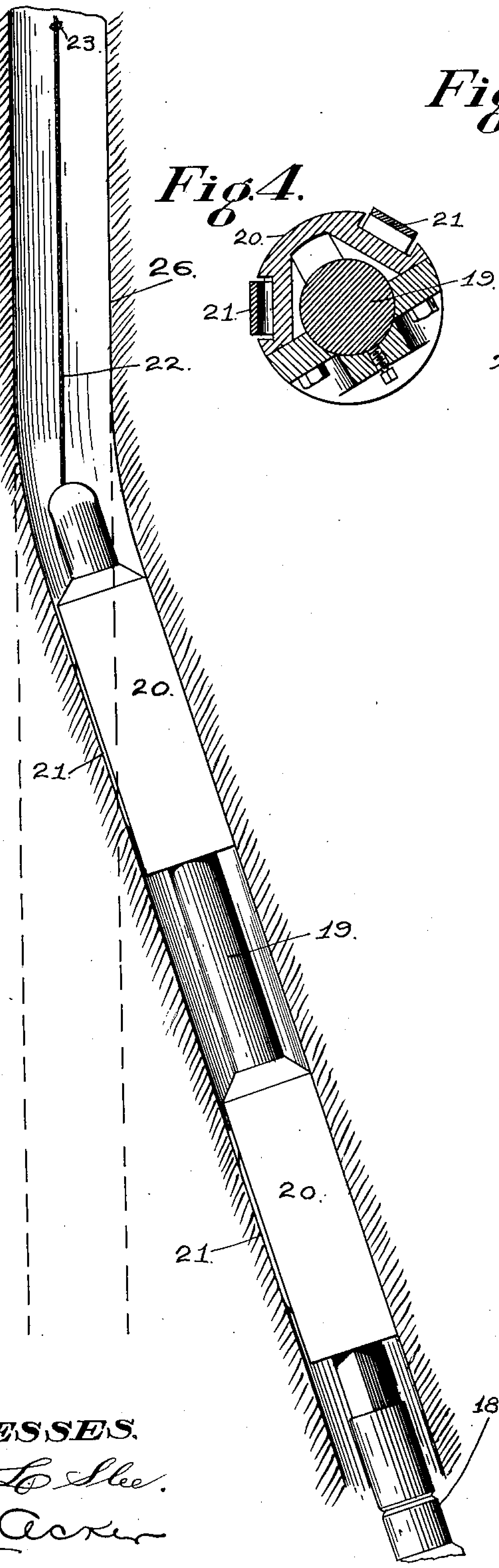

Fig. 4.

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3 SHEETS—SHEET 3.

Fig. 5.

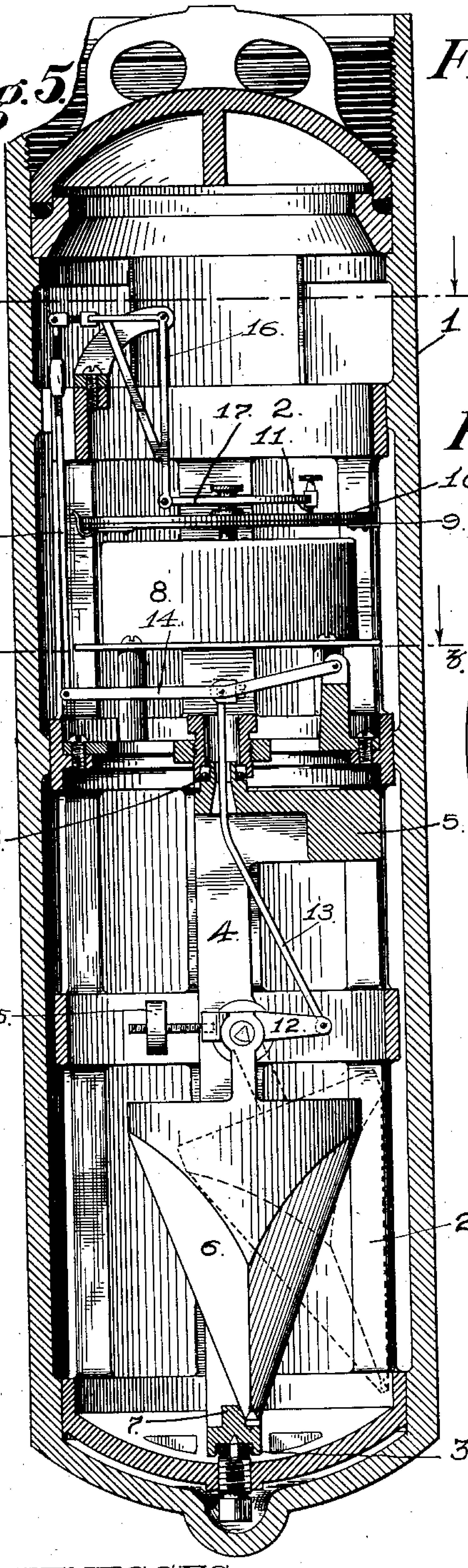


Fig. 6.

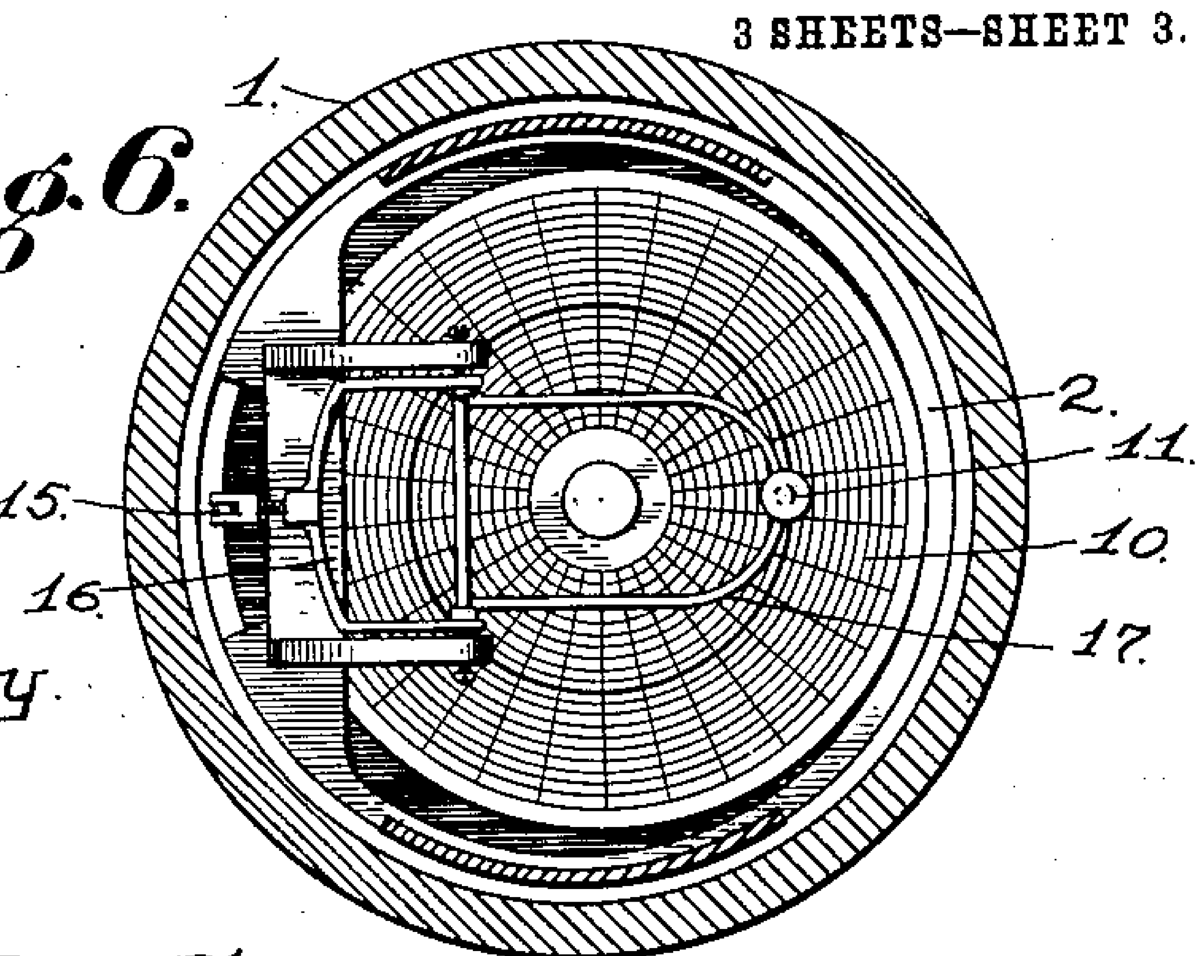


Fig. 7.

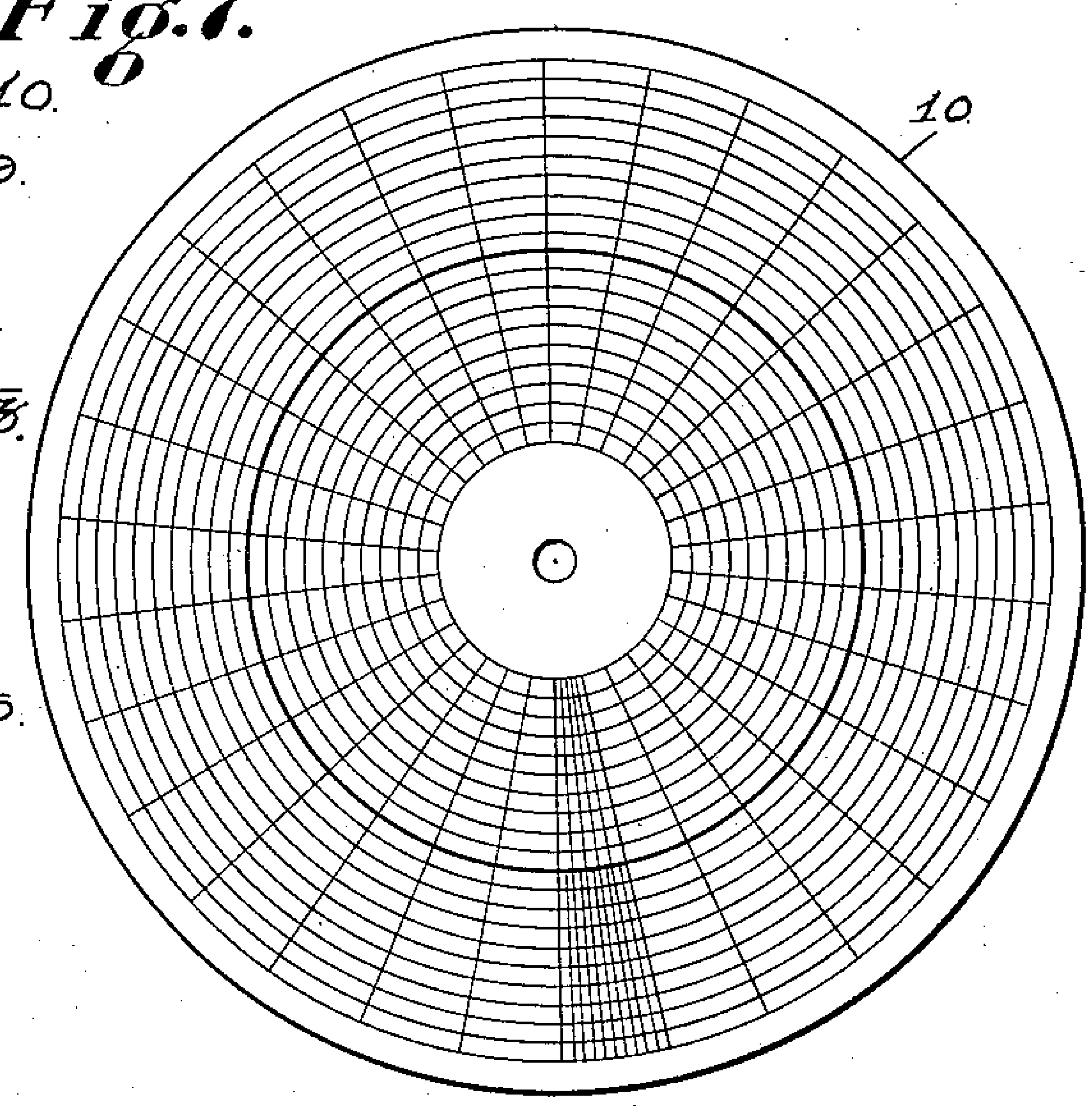
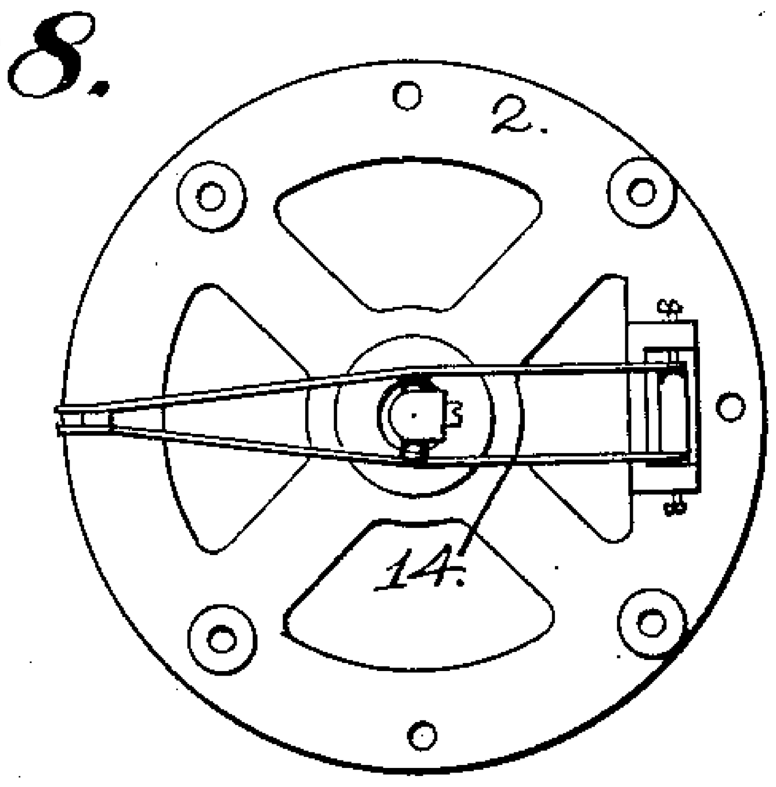


Fig. 8.



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his Attorney

UNITED STATES PATENT OFFICE.

ARTHUR F. L. BELL, OF SAN FRANCISCO, CALIFORNIA.

CLINOMETER FOR WELL-BORES.

959,912. Specification of Letters Patent. **Patented May 31, 1910.**

Application filed January 15, 1908. Serial No. 410,897.

To all whom it may concern:

Be it known that I, Arthur F. L. Bell, a citizen of the United States, residing at the city and county of San Francisco and State of California, have invented certain new and useful Improvements in Clinometers for Well-Bores, of which the following is a specification.

My invention relates to a clinometer to be used for the purpose of determining whether wells drilled or being drilled are vertical or have gone crooked. This latter often occurs when drilling through a stratified formation of unequal hardness, especially when it dips at a steep angle.

The simplest method of determining whether a well is going crooked is, if shallow, to drop a light down the well or reflect with a looking glass the rays of the sun. This is feasible only in very shallow and dry wells. For deep wells, which while drilling are nearly always full of water, there are no practical means known to me of determining when they are crooked, except from the sluggish action of the tools, or, in some cases, where they get so bad that the drilling stem will become bent in the hole, or, where casing is being inserted in the hole, the bending of the casing in its endeavor to follow the crooked hole will break it at the joints.

Often a hole will gradually become so crooked that the driller can notice it by the action of the tools. If a hole is straight when drilling, the drilling-line will work upward and downward without showing any apparent slacking of the line; but if the hole is crooked and the tools are rubbing on one side enough to prevent them from exercising their full weight in pulling down the drilling line, a slacking of the line becomes apparent on the downstroke; and if the hole is very crooked, the line will slacken so much as to cause a whipping of the line on the return stroke. In their endeavor to determine whether a hole is going straight or not, drillers will often resort to dropping the tool and drilling line at a rapid speed, then suddenly checking them and watching to see if the momentum of the tool on being checked will not tighten the line so that it will show an appreciable springing upward and downward in front of the operator. If the line does spring up and down to the proper degree, according to whether it is a manila cable or a steel line, the driller concludes that his well is straight. If the line remains dead, showing no spring, he concludes that there is something the matter with the hole. Another method of determining whether a hole is going crooked is that the drilling bit, if the hole is going crooked, does not turn properly in the hole, and will show an unsual undercutting on one side of the bit. The driller is constantly looking for this indication, and, if found, always concludes that the hole is going crooked. At other times a hole may not go so crooked as to show an appreciable difference in the drilling, but be enough to cause an unusual wear on the cable at the point where the hole commences to go crooked; and if there is casing in the well it will sometimes wear through the casing with the result that there is danger of ruining the hole or requiring the removal of the casing.

After a well has gone crooked, it is customary for the driller to fill up the hole with some very hard or tough material, to some supposed point where the crook had taken place, this point being absolutely a matter of supposition, as is too often proven by actual practice. The operator then commences to drill his well over again from the point to which he has filled it up, and if he has been correct in his supposition he often overcomes his difficulty and proceeds with the well successfully; but, it too often occurs that the driller, in his desire not to lose time, does not fill up his well far enough to get above the crook, and he re-drills his well only to find, after days, and possibly months of tedious work and loss of time and money, that the well is still crooked. He, therefore, re-fills the well to a point still higher than he did before, and it is again a matter of guesswork as to whether he has come far enough. I have known where a well has been filled three times before it was filled to a point above the original crook.

To overcome these difficulties is the object of my invention, and to this end, my invention consists in the novel recording clinometer apparatus which I shall now fully describe, by reference to the accompanying drawings in which—

Figure 1 is a general view, showing the device in a well-bore. Fig. 2 is an enlarged section of the well-bore at the point of deviation, showing the clinometer centering-connection in elevation. Fig. 3 is an enlarged section showing the lower part of the said centering-connection. Fig. 4 is a cross section on line $x—x$ of Fig. 3. Fig. 5 is a vertical section and elevation of the clinometer instrument proper. Fig. 6 is a section on line $y—y$ of Fig. 5. Fig. 7 is a plan of the recording plate of the clinometer. Fig. 8 is a plan, looking down on plane $z—z$, Fig. 5.

Referring, first, to Fig. 5, 1 is an exterior shell, in which, for the sake of greater protection and accuracy, the clinometer proper is hermetically sealed. Within this shell is removably fitted the skeleton frame 2 which carries the operative parts of the clinometer. In the frame 2 is pivoted, in a vertical axis, on suitable bearings 3 above and below, a freely swinging bracket 4, which by the arm 5 or other means is so counterweighted as to automatically swing around to adjust itself to any inclination of the shell in the well-bore, so that the pendulum, carried by it, may swing freely in one direction, to present its readings on the recording plate always in one direction, say from the outer edge of the plate toward the center. From this bracket 4 is hung, slightly off center, the pendulum 6 which is free to swing in one direction only, being limited in the other direction by a stop 7. The pendulum thus hung in the swinging bracket remains vertical under any deviation that the well-bore may take. In the upper part of the frame 2 is fixed a clock, represented by 8. Upon the clock arbor is carried a plate 9 which is caused to revolve by the clock mechanism, and said plate forms a seat for any suitable form of recording plate, dial or chart. One form, for example, is a glass plate 10, Figs. 6 and 7, the surface of which is permanently properly marked, and then smoked for each operation, so that a needle 11 may simply wipe off the soot with a minimum of friction and leave a distinct line upon the graduations of the recording plate. The needle 11 is operated by suitable connections from the pendulum. Those here shown are the crank arm 12 of the pendulum head, the link 13 from said crank arm, the compound lever 14 to which the link is connected, the link 15 connected with said compound lever, the bell-crank 16 and the bail-like arm 17 which carries the needle 11, Figs. 5 and 6.

It may be here noted that in Fig. 5 the pendulum is drawn in full lines in one extreme position, the clinometer being vertical; while, for simplicity of the drawing, the recording levers, cranks and needle are shown in their central positions.

In marking off the recording plate 10, I divide it, as shown in Fig. 7, into thirty radial lines each of which will represent the movement made in one minute by the plate; and, for further convenience I can subdivide the minute into multiples of ten, so as to be able to read the time of movement of the plate in fractions of a minute. In addition to the radial lines, I inscribe on the plate a series of equally spaced circles, the spaces between each circle representing the movement which will be covered by the needle 11 for each degree of angularity of the clinometer from the vertical. For convenience in reading I have assumed a total movement of twenty degrees for the clinometer with twenty circles on the recording plate.

The clinometer instrument proper is here shown as secured by a sub 18, Fig. 3, to the lower end of the drilling stem or sinker bar 19, around each end of which is fitted a bushing 20, Fig. 2, which fills the well-bore, thus providing a simple, practical and effective connection for centering the clinometer in said bore and holding it in the axis thereof at all times. The fit of the bushings 20 in the well-bore may be rendered accurate by means of springs 21 seated in their sides, Figs. 2, 3 and 4, which also by their frictional contact with the sides of the well bore, prevent the clinometer from revolving in the bore. The drilling cable 22 is secured to the top of the drilling stem or sinker bar 19, Fig. 2.

Any suitable means or measuring device may be employed to determine the location or depth of the clinometer instrument in the well-bore. One such means is that which I here show, and which consists, as seen in Fig. 1, of measuring off the cable 22 in specified distances, which may be indicated in any suitable way, as, for example, by winding on it a piece of twine or string, these measured distances being indicated at 23. In practice, these marks will be fifty feet apart, measurement commencing with the clinometer instrument. In Fig. 1, 24 indicates, generally, the surface structure and mechanism of a well-drilling plant. In Fig. 5, 25 is an adjustable balance weight for the pendulum.

To operate my invention, I proceed as follows:—Having first spaced the suspending cable 22 to the desired measurements, as indicated at 23, and having attached to the drilling stem or sinker bar 19, the proper sized bushings 20, to keep the clinometer central to the axis of the well at all times and prevent it from turning in the well-bore, I attach the clinometer by a suitable sub 18 to the lower end of the stem or sinker-bar. Just before thus attaching the clinometer, I start the clock 8 in the instrument, by any suitable means, at an exact time noted on a stop-watch in the hands of the operator. The clock and the watch, starting at the same instant, thus indicate the same space of time. I then proceed to lower the clinometer in the well 26, and as it enters I record the time of entrance on a previously prepared charted sheet in the hands of the operator. As the first measuring string 23 on the cable passes a given point on the surface, I again register the time from the stop-watch on a charted line which represents the depth at which the clinometer is at the first string reading; and I repeat this recording of time as each string record on the cable passes said given point, until the bottom of the well is reached. At that time, if the half hour, which may be assumed to be required to revolve the recording plate 10, has not expired, I can let the clinometer stand until it has expired, or I can draw it back to the surface, the records on the plate not being counted after the moment it reached the bottom. As soon as the clinometer is landed at the surface, I disconnect it, remove the recording plate and examine it to see whether the needle point has remained on a given circle, which would represent zero or an absolutely vertical position of the clinometer. If the needle point has remained on that line for the complete circle of the plate 10, I know that the well is absolutely straight; but if I see the needle point has been scratching across the face of the plate as the latter revolved, it will represent a crooked line crossing the subdivisions of time on said plate. One familiar with the instrument can thus tell exactly the angle at which the clinometer stood at each space of time shown by the recording plate, and by referring to the charted sheet in his hands, he can readily determine at what depth in the well each one of these deviations from the vertical occurred, and this reading can be transferred to a sheet of paper to show the exact deviation from the vertical for the entire depth of the well.

If it be found, by looking at the resultant records, that the well has a marked deviation from the vertical at any given point, and it is desired that this point should be more accurately determined than it is when the depth of the well—which might be 4000 feet or more—had been measured over a space of only thirty minutes or less, the operation can be repeated by substituting a new smoked recording plate in the clinometer, rewinding the clock and starting it again at a given time. Assuming that the deviation in the well was shown to be about 1000 feet in the first record, the clinometer could be dropped to 950 feet, and, from there on, by accurate measurement, could be lowered one foot, say every four or five seconds, exact record of the time being kept, as above explained, and the entire space of thirty minutes could be consumed on a few feet of the hole. As soon as the location of the deviation had been known to be passed by the clinometer, the instrument could be brought to the surface without allowing it to go again to the bottom of the well, and the recording plate then removed. On account of the measurements being taken over a much longer space of time, the plate would show more accurately the exact location of the deviation; in fact, if it were desired, it could be done so accurately as to indicate within a small fraction of a foot. It would also be desirable to transfer the readings to the separate sheet which contained the first record taken. In this way, the operator would know exactly where the well had gone crooked and could make his arrangements to straighten the hole from that point down, without having to waste valuable time trying to ascertain the exact point at which the well had gone crooked.

The advantage of fitting the operative parts of the clinometer in a frame which is itself removably fitted within an outer shell, in addition to the accuracy resulting from thus hermetically sealing them up, is that in transportation, the inner frame with all its relatively delicate mechanism, can be removed and carried by the owner as personal baggage or in some other way insuring its safety, while the outer shell and other parts of the apparatus can be otherwise shipped to their destination, as they will stand rough handling.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is—

1. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording a continuous diagram of its readings, means for suspending it in the well-bore, and means for determining its location therein.

2. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording a continuous diagram of the times of its readings, means for suspending said instrument in the well-bore, and means for measuring the depth of the instrument therein.

3. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording a continuous diagram of the times of its readings, and a suspending device for said instrument measured off into distances.

4. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording its readings; a connection therewith for frictionally contacting with the wall of the well bore to prevent the instrument from revolving therein; and means for suspending said instrument in the well-bore.

5. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording its readings, means for suspending

it in the well-bore, and flexible means for centering it therein, and preventing it from revolving.

6. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer instrument having means for recording its readings, a bushing in connection therewith to fill the well-bore and hold said instrument central therein a friction device on said bushing to prevent it from axially turning and to keep the instrument from revolving in said bore, and means for suspending said instrument in said bore.

7. A clinometer for well-bores comprising a frame, a freely swinging bracket pivoted therein, a pendulum hung in said bracket, a clock in said frame, a recording surface driven by the clock, graduated as to time and angles of deviation, a marker operating in continuous contact on said surface, and connections from the pendulum to operate the marker.

8. An apparatus for testing the deviation of well-bores from a vertical, comprising a clinometer device embracing a pendulum, a constantly moving recording surface graduated as to times and angles of deviation, a marker in continuous contact with said surface, and connections from the pendulum to operate the marker, means for centering said clinometer device in the well-bore, means for preventing said clinometer device from revolving in the well-bore, means for suspending it in said bore, and means for measuring the suspending means to determine the location of the clinometer device in the well-bore.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ARTHUR F. L. BELL.

Witnesses:

N. A. ACKER,

D. B. RICHARDS.