Jan. 22, 1935. T. L. LYNCH ET AL 1,988,741

INCLINATION INDICATING DEVICE FOR OIL WELLS

Filed July 7, 1930 2 Sheets-Sheet 1

Fig. 1.

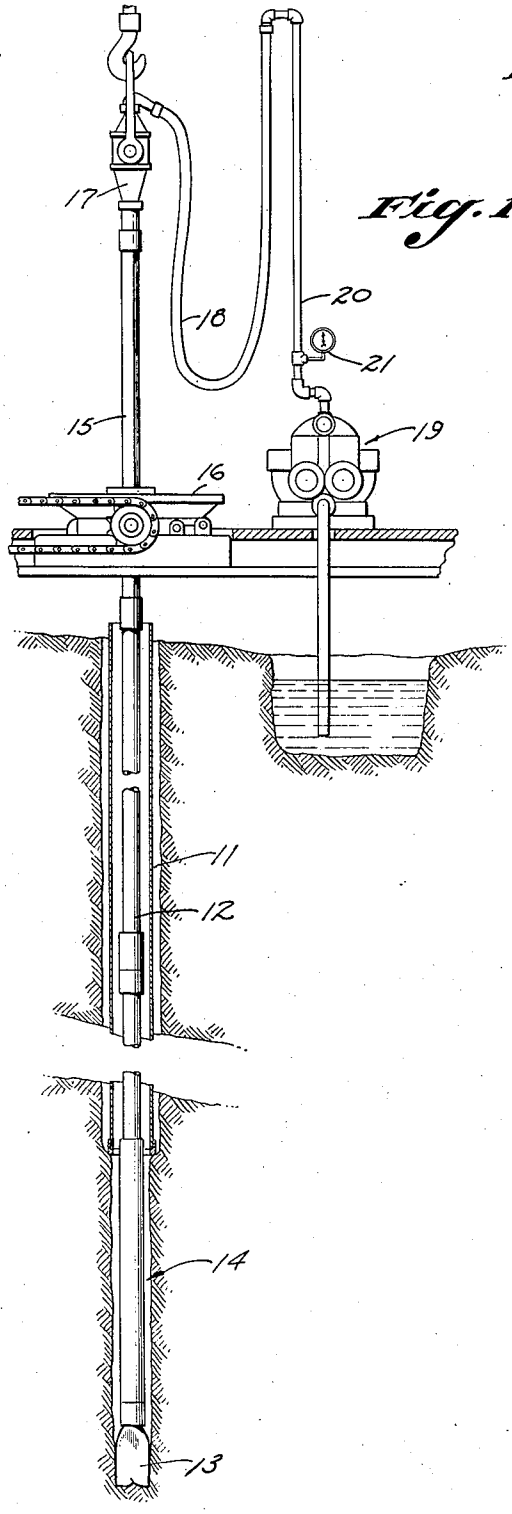
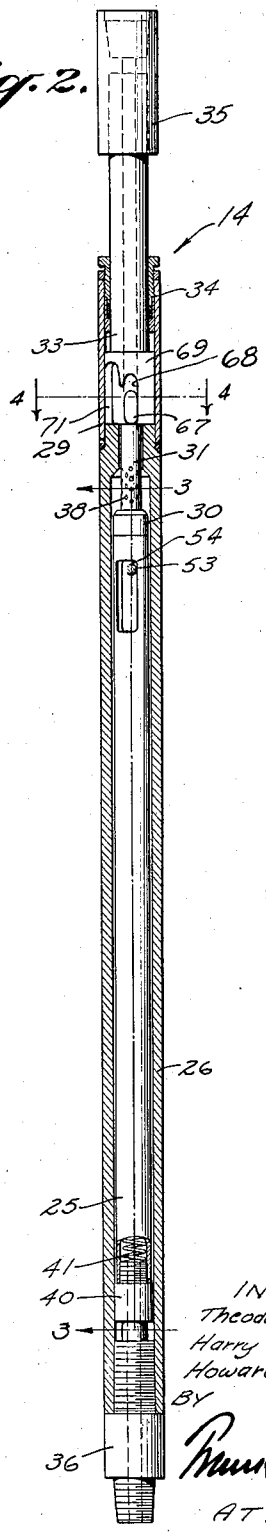


Fig. 2.



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INCLINATION INDICATING DEVICE FOR OIL WELLS

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Fig. 3.

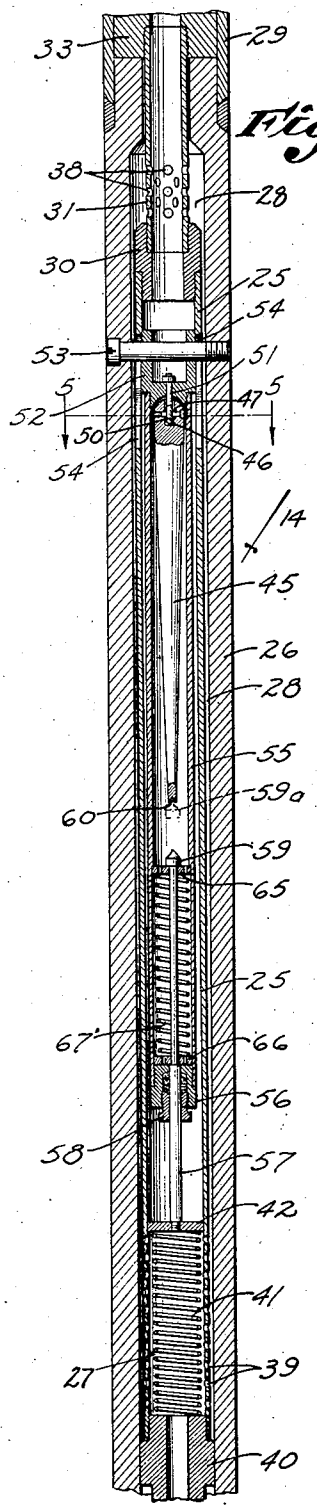


Fig. 4.

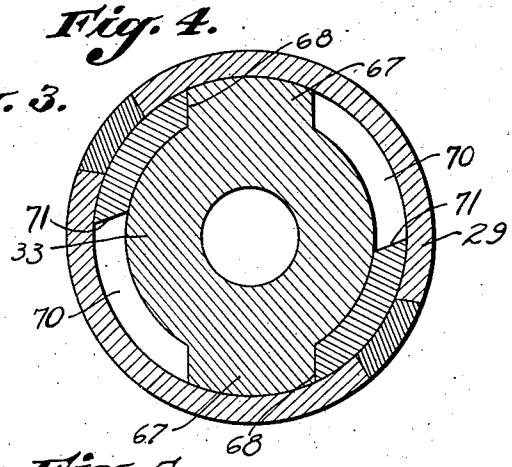


Fig. 5.

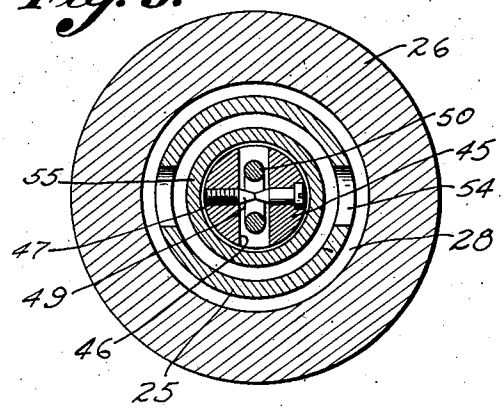
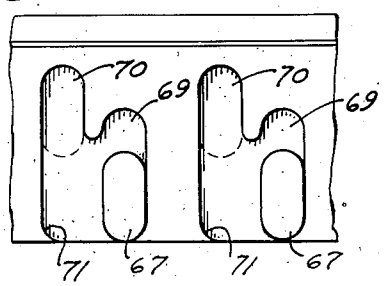


Fig. 6.



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UNITED STATES PATENT OFFICE

1,988,741

INCLINATION INDICATING DEVICE FOR OIL WELLS

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Application July 7, 1930, Serial No. 466,126

20 Claims. (Cl. 33—205)

This invention has to do in a general way with well drilling equipment and is more particularly related to devices for indicating to the operator of such equipment at any predetermined time whether or not the bit whereby the well is being drilled, is following a vertical course. The invention is especially adapted for use in connection with rotary drilling equipment. As is well known to those familiar with the art, such equipment consists in a general way of a string of pipe or tubing known as the drill stem, the lower end of which carries a drill bit and the upper end of which is provided with a squared section of tubing known as the Kelly, whereby the drill stem is rotated through the medium of a rotary table. The upper end of the Kelly carries what is known as a swivel circulating head through which pressure fluid ordinarily known as rotary mud is delivered to the drill stem from any suitable source of supply.

It is also well known to those familiar with the art that considerable difficulty has been experienced in the practice of rotary drilling operations in maintaing a vertical bore hole. Numerour operators have initiated the practice of surveying the hole from time to time as it is being drilled and the usual procedure followed in making a survey of this nature necessitates the withdrawal of the drill stem and its associated parts and entails the use of a special instrument which must be lowered into the well by means of special apparatus, such instrument being designed to produce a permanent record of the direction and degree of the inclination of the well at all points throughout the length of the survey.

It is the primary object of this invention to produce an indicating instrument which may be embodied in the drill stem and is preferably positioned at a point adjacent the drill bit. It is not the purpose of the device contemplated by this invention to produce a permanent record of the degree and direction of the inclination of the drill stem as it progresses downwardly into the ground, but it is rather the purpose of this invention to produce a device whereby the operator may at any predetermined time determine whether or not the drill stem is standing vertical.

It is a further object of this invention to produce a device of the class described wherein the indication of verticality is evidenced through an increase in pressure in the circulating fluid. This object is accomplished by providing the instrument with a valve which is associated with gravity actuated means designed to obstruct the flow of fluid through the device when the drill stem is vertical. The operation of the device is of course optional, so that under normal conditions while the drill bit is being advanced into the well, there is no obstruction in the path of the circulating fluid.

As inferred above, the preferred form of our invention embodies a device in which the flow of circulating fluid is obstructed when the well is vertical. It is to be understood, however, that by a comparatively simple alteration in the arrangement of the parts embodying the device contemplated by the invention, the obstruction in fluid and the increase in pressure may be obtained when the drill stem is inclined from the vertical.

It is a further object of this invention to produce a novel type of valve mechanism which is perculiarly adapted for use in connection with a device of the character contemplated by this invention. Such valve mechanism consists in a general way of a coil spring which is interposed in the path of flow of the fluid so that the fluid must necessarily flow between the coils in the spring. The closing action of the valve is obtained simply by compressing the spring and the expansion of the spring to its normal position is, of course, effective to provide an open passage for the flow of circulating fluid.

The device contemplated by this invention is of simple form and construction, it requires no additional apparatus on the derrick floor, since the usual gauge employed in indicating pump pressure on the circulating fluid provides means for indicating the results obtained at the bottom of the hole.

In the operation of rotary drilling equipment the flow of fluid through the bit itself may at times be obstructed by the accumulation or balling up of cuttings about the bit, and under these circumstances an increase in pressure when the device was used would not necessarily indicate that the well was vertical. We have, therefore, provided the device contemplated by this invention with means for locking the instrument against operation so that when the drill stem is raised, (this being the procedure followed to effect a closure of the valve if the well is vertical), the valve is held against closing movement. Under these circumstances, the circulating fluid is permitted to flow through the valve, and if an increase in pressure is observed, it is known that such increase is due to some cause other than the valve mechanism and the operator must then remove the obstruction causing the increase in pressure and again use the instrument without locking same to determine whether or not the well is vertical.

The details in the construction of a preferred form of our invention, together with other objects attending its production, will be best understood from the following description of the accompanying drawings, which are chosen for illustrative purposes only, and in which—

Fig. 1 is a diagrammatic view illustrating in a general way a rotary well drilling organization

of the type in connection with which this invention is adapted for use;

Fig. 2 is a sectional elevation, partly an outside view showing the general arrangement of the parts in a preferred form of device contemplated by this invention;

Fig. 3 is an enlarged partial sectional elevation taken in a plane represented by the line 3—3 in Fig. 2;

Fig. 4 is a transverse section taken in a plane represented by the line 4—4 in Fig. 2;

Fig. 5 is a plan section taken in a plane represented by the line 5—5 in Fig. 3; and

Fig. 6 is a developed outside elevational view showing a preferred form of locking mechanism which is used in the device contemplated by this invention.

More particularly describing the invention as herein illustrated, reference numeral 11 indicates a bore hole in which a drill stem or drill pipe 12 is suspended. The lower end of the drill pipe 12 carries a bit, indicated by reference numeral 13, and reference numeral 14 indicates the gravity actuated fluid obstructing valve contemplated by this invention. The upper end portion of the drill stem 12 is provided with a Kelly 15 which extends through a Kelly bushing provided in a rotary table 16. The upper end of the Kelly carries a swivel head 17 into which circulating fluid is delivered through a hose 18 from a fluid circulating pump 19. The pump 19 is connected to the hose 18 through a stand pipe 20 and the pumping system is provided with a pressure gauge indicated by reference numeral 21.

The details in the construction of the device contemplated by this invention are best illustrated in Figs. 2 to 6, inclusive, where the device is shown as comprising a telescoping body 14, such body including an inner tubular element or part 25 and an outer tubular part 26. These parts are so shaped and so arranged with respect to each other as to form an inner chamber 27 and an outer chamber 28. The upper end portion of the outer tube 26 is attached to a sleeve or cylinder member 29 and the upper end portion of the inner tube 25 contains a bushing 30 which is attached to a connecting tube 31, such connecting tube having its upper end portion secured in the lower end of a tubular core member 33. The core member 33 extends upwardly through a packing gland 34 provided in the top of the sleeve or cylinder member 29 and has its upper end secured to a sub 35 which in turn is attached to a section of the drill stem 12. The lower end portion of the outer tube or barrel 26 receives a sub 36 which may be attached to another section of the drill stem 12 or may be secured directly to the bit 13.

The circulating fluid coming from the drill pipe is delivered downwardly through the tubular core 33 into the connecting tube 31, from which it passes through apertures 38 into the outer chamber 28. The fluid from the outer chamber 28 is delivered into the lower end portion of the inner chamber 27 through a series of apertures 39 which are provided in the lower end of the inner tube 25.

Reference numeral 40 indicates a tubular plunger which is secured to the lower end portion of the inner tube 25 and is in fluid tight sliding engagement with the interior of the barrel 26. Reference numeral 41 indicates a coil spring which rests upon the upper inner end portion of the plunger 40 in the lower end of the inner tube 25. This coil spring 41 is associated with a spring control plunger 42 and in combination with the spring control plunger constitutes a valve mechanism which is employed for the purpose of obstructing the flow of fluid from the outer chamber 28 into the lower end portion of the inner chamber 27. It will be observed that so long as the spring 41 is in its normal expanded position the circulating fluid flows freely between the coils of the spring into the lower end portion of the inner chamber and downwardly through the tubular plunger 40 into the lower end of the drill string or into the bit as the case may be. When the coil spring is compressed either by moving the plunger 42 downwardly toward the plunger 40, or by holding the plunger 42 stationary and raising the plunger 40 upwardly, such compression is effective to close the spaces between the coils of the spring, thereby obstructing the flow of fluid through the drill pipe, such obstruction of flow being effective to increase the fluid pressure in the drill pipe which is evidenced upon the gauge 21, thereby indicating to the operator that the well is either vertical or inclined from the vertical, depending upon the mechanism which is employed to bring about the compression of the spring.

As pointed out above, this form of our invention is designed to effect an obstruction of flow and a consequent increase in head pressure when the instrument or the barrel 26 is vertical. The mechanism for effecting such indication is, as inferred above, actuated by gravity and consists of a pendulum which is arranged so as to hold the spring control plunger 42 against upward movement with the plunger 40 and the inner tube 25 when the barrel is in a vertical position. This pendulum is indicated by reference numeral 45 and is shown as having provided in its upper end a slot or notch 46 through which a transverse pin 47 extends. The pin 47 is recessed in its mid portion as indicated at 49 in Fig. 5 and provides a bearing which rests upon the lower surface of an eye 50 suspended by means of a stem 51 from a head member 52. The head member 52 has a sliding fit in the inner tube 25 and is held against movement relative to the barrel 26 by means of a transverse pin 53. The tube 25 is provided with a pair of aligned slots 54 which are positioned so as to permit movement of the tube 25 relative to the pin 53.

The pendulum 45 is enclosed within a pendulum housing 55 which is secured at its upper end to the head member 52 and has an apertured bottom plug 56 provided in its lower end portion. Reference numeral 57 indicates what will hereinafter be referred to as a valve control stem which is mounted on the valve control plunger 42 and extends upwardly through a packing gland 58 provided in the bottom plug 56 into the pendulum housing 55 where its upper end portion is provided with a tapered head 59 situated in alignment with a tapered recess 60 formed in the bottom of the pendulum when the pendulum is hanging vertical.

With regard to the means for suspending the pendulum 45, it will be noted that the pin and eye construction indicated at 47 and 50 respectively, forms a single point contact from which the pendulum is suspended, and it will also be observed that the notch 46 is of sufficient width to permit the pendulum's swinging through an arc in any direction which is great enough to permit the clearance of the pin 59 and the lower end of the pendulum 45 when the body 26 is in-

clined at a predetermined angle from the vertical. This angle is, of course, dependent upon the length of the pendulum and its relation with respect to the engagement member 59. In the preferred form of our invention we have constructed a device so that the pendulum will clear the engagement member 59 when the barrel is inclined one degree from the vertical.

It will be noted that in their normal positions the lower end of the pendulum and the upper end of the engagement member are spaced a substantial distance apart so as to permit the locking action referred to hereinabove, the operation of which will be hereinafter more specifically pointed out.

Reference numerals 65 and 66 indicate guide plates which are contained within the pendulum housing 55 and are yieldably held in spaced relation with each other by means of a coil spring 67', such spring being adapted to maintain the valve control plunger 42 in its normal position when the device is not in use.

As pointed out above, the device contemplated by this invention is adapted to be interposed in a drill string and to remain therein during the drilling operation. Since the body 14 is of a telescoping nature, it is necessary that it be provided with means for transmitting torque from the inner section thereof to its outer section. Such means are shown as comprising splines 67 which are formed on opposite sides of the lower end portion of the tubular core 33. These splines are adapted to engage shoulders 68 which are provided on the interior of the sleeve or cylinder section 29. The shoulders 68 may be formed by milling the interior of the section 29 to the proper shape, or they may be provided by means of segmental cylindrical plates which are welded or otherwise rigidly attached to the interior of the sleeve section 29, as indicated in Fig. 4. This latter form of construction is preferable in the device as shown and described above in that it makes possible a convenient manner of forming a lock for optionally holding the telescoping parts against expansion to a point at which the engagement member 59 will be brought into contact with the lower end of the pendulum 60. This lock is a modification of the well known bayonet joint and consists merely of a pair of offset recesses indicated in the development in Fig. 6 by reference numerals 69 and 70. It will be noted that the upper end portions of the lugs or splines 67 are rounded and that the upper end portions of the recesses 69 and 70 are likewise rounded so that when the device is locked, which is effected by rotating the drill stem clockwise and then raising the same, it is impossible to disengage the bayonet joint. It will also be seen that the recess 70 is considerably longer than the spline 67 which permits relative longitudinal movement between the parts to test for verticality of the hole.

The procedure followed in taking a reading is to rotate the drill stem clock-wise a sufficient distance to bring the splines 67 into engagement with the shoulders 71. An upward force is then applied to the drill stem, such force being effective to raise the inner tube 25 by means of the tubular core 33 together with its associated parts, including the spring valve 41 and the spring control plunger 42, until the engagement member 59 occupies the dot and dash line position indicated by reference numeral 59*a* in Fig. 3. If the barrel 26 is vertical and the pendulum 45 and the engagement member 59 are in alignment, this last mentioned movement will bring the engagement member 59 into contact with the recess 60 in the lower end of the pendulum and the continued upward movement of the drill stem will force the plunger 40 upwardly toward the spring control plunger 42 which is being held stationary, such movement being effective to compress the spring 41, thereby obstructing the flow of fluid from the outer chamber 28 into the inner chamber 27 and consequently effecting an increase in pressure in the circulating fluid which is indicated on the gauge 21. If the well is inclined from the vertical one degree or more, the upward movement of the plunger 40 and its associated parts in the manner described above will continue beyond the position 59*a*, permitting the engagement member 59 to pass by the lower end of the pendulum 45, thus preventing the compression of the spring 41 and the consequent obstruction of flow. It will be apparent, therefore, that if no increase in pressure is observed when the drill stem is raised in the manner described above, the operator knows that the well is inclined from the vertical and may take the necessary precautions, well known to those familiar with the art, to straighten the same. If an increase in pressure has been observed, which in general practice results in shutting off the flow, and the operator wishes to check this reading to determine whether such increase in pressure is due to an obstruction in the bit or is due to the compression of the spring 41, it is merely necessary to lower the bit onto the bottom of the hole, rotate the same counter-clockwise until the splines occupy the position shown in Fig. 6 and again apply an upward force to the drill stem. It will be observed that the recess 69 is shorter than the recess 70 and that as a result the spline 67 moves upwardly a less distance than in the former operation. The spring 41 is slightly compressed in this operation, but not sufficiently to materially obstruct the flow of fluid. If, after such operation, no material increase in pressure is observed, the operator knows that there is a clear passage through the drill stem and the bit and this demonstrates conclusively that his previous reading indicates the well to be vertical. If a large increase in pressure is observed in this last described operation, the operator knows that the former increase in pressure may have been due either to the obstruction of flow caused by the spring 41 or that it may be due to some other obstruction in the drill bit or the drill pipe and he must take the necessary measures to determine whether or not the passage in the bit or the passage through the drill pipe is obstructed.

It will be apparent from the foregoing description that the device contemplated by this invention is of simple form and construction, that it does not require expert attention, nor does it entail the use of additional equipment on the derrick floor; there is no part subjected to excessive wear by the abrasive action of the circulating fluid; the pendulum is entirely enclosed and is protected from the action of the circulating fluid and the instrument may be used at any time during the drilling operation to indicate whether or not the well is following a vertical course.

It is to be understood that while we have herein described and illustrated one preferred form of our invention, the invention is not limited to the precise construction set forth above, but in-

cludes within its scope whatever changes fairly come within the spirit of the appended claims.

I claim as my invention:

1. In combination with a drill pipe and a fluid pressure system for forcing drilling fluid through said drill pipe: means for indicating whether or not said pipe is vertical by a pressure change in said fluid embodying: a telescoping body member in said pipe; a valve in said body member adapted to be opened and closed by the telescoping action thereof; and gravity actuated means in said body for controlling said valve.

2. In combination with a drill pipe and a fluid pressure system for forcing drilling fluid through said drill pipe: means for indicating whether or not said pipe is vertical by a pressure change in said fluid embodying: a telescoping body member in said pipe; a valve in said body member adapted to be opened and closed by the telescoping action thereof; gravity actuated means in said body for controlling said valve; and locking means for optionally holding said body against expansion.

3. In combination with a drill pipe and a fluid pressure system for forcing drilling fluid through said drill pipe; means for indicating whether or not said pipe is vertical by a pressure change in said fluid embodying: a telescoping body member in said pipe; a valve in said body member adapted to be opened and closed by the telescoping action thereof; and gravity actuated means in said body dependent upon the verticality of said body for controlling said valve.

4. For use in combination with a drill pipe and a fluid pressure system, a device for indicating whether or not said pipe is vertical by pressure change in said fluid pressure system embodying: a tubular body; a tubular plunger in said body; a tubular plunger rod having its lower end portion attached to said plunger and having its upper end portion connected to said drill pipe, said rod being shaped so as to form an outer chamber and an inner chamber in said body; means for delivering pressure fluid from said drill pipe into said outer chamber; valve means for controllably delivering pressure fluid from said outer chamber into said plunger; and gravity actuated means dependent upon the verticality of said body for controlling said valve.

5. For use in combination with a drill pipe and a fluid pressure system, a device for indicating whether or not said pipe is vertical by pressure change in said fluid pressure system embodying: a tubular body; a tubular plunger in said body; a tubular plunger rod having its lower end portion attached to said plunger and having its upper end portion connected to said drill pipe, said rod being shaped so as to form an outer chamber and an inner chamber in said body with apertures in said rod connecting said chambers; means for delivering pressure fluid from said drill pipe into said outer chamber; valve means for controllably delivering pressure fluid from said outer chamber into said plunger; and gravity actuated means dependent upon the verticality of said body for controlling said valve, said valve comprising a coil spring associated with said apertures in said tubular plunger rod.

6. For use in combination with a drill pipe and a fluid pressure system, a device for indicating whether or not said pipe is vertical by pressure change in said fluid pressure system embodying: a tubular body; a tubular plunger in said body; a tubular plunger rod having its lower end portion attached to said plunger and having its upper end portion connected to said drill pipe, said rod being shaped so as to form an outer chamber and an inner chamber in said body with apertures in said rod connecting said chambers; means for delivering pressure fluid from said drill pipe into said outer chamber; valve means for controllably delivering pressure fluid from said outer chamber into said plunger, said valve comprising a coil spring associated with said apertures in said tubular plunger rod, a valve control plunger for compressing said spring during longitudinal movement of said tubular plunger in said body; and gravity actuated means dependent upon the verticality of said body for governing the movement of said valve control plunger.

7. For use in combination with a drill pipe and a fluid pressure system, a device for indicating whether or not said pipe is vertical by pressure change in said fluid pressure system embodying: a tubular body; a tubular plunger in said body; a tubular plunger rod having its lower end portion attached to said plunger and having its upper end portion connected to said drill pipe, said rod being shaped so as to form an outer chamber and an inner chamber in said body with apertures in said rod connecting said chambers; means for delivering pressure fluid from said drill pipe into said outer chamber; valve means for controllably delivering pressure fluid from said outer chamber into said plunger, said valve comprising a coil spring associated with said apertures in said tubular plunger rod, a valve control plunger for compressing said spring during longitudinal movement of said plunger in said body; a stem on said valve control plunger; and gravity actuated means dependent upon the verticality of said body and adapted to engage said stem for governing the movement of said valve control plunger.

8. For use in combination with a drill pipe and a fluid pressure system, a device for indicating whether or not said pipe is vertical by pressure change in said fluid pressure system embodying: a tubular body; a tubular plunger in said body; a tubular plunger rod having its lower end portion attached to said plunger and having its upper end portion connected to said drill pipe, said rod being shaped so as to form an outer chamber and an inner chamber in said body with apertures in said rod connecting said chambers; means for delivering pressure fluid from said drill pipe into said outer chamber; valve means for controllably delivering pressure fluid from said outer chamber into said plunger, said valve comprising a coil spring associated with said apertures in said tubular plunger rod, a valve control plunger for compressing said spring during longitudinal movement of said plunger in said body, a stem on said valve control plunger; and a pendulum suspended in said body and adapted to engage said stem when said body is vertical for compressing said spring, thereby closing said valve during an upward movement of said plunger in said body.

9. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber; and gravity actuated means for governing the operation of said valve.

10. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber; and gravity actuated means for closing said valve during relative longitudinal movement of said telescoping parts when said body is vertical.

11. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber; and gravity actuated means for closing said valve during relative longitudinal movement of said telescoping parts when said body is vertical, said gravity actuated means being arranged so that said valve remains open if the body is inclined from the vertical.

12. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber with apertures in the inner telescoping part connecting said chambers; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber, said valve comprising a coil spring associated with said apertures; and gravity actuated means for governing the operation of said valve.

13. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber with apertures in the inner telescoping part connecting said chambers; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber, said valve comprising a coil spring associated with said apertures, a spring control plunger in said inner telescoping part, an upwardly projecting stem on said control plunger; and gravity actuated means arranged so as to engage said stem and compress said spring during a relative longitudinal movement of said telescoping parts when said body is vertical.

14. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber with apertures in the inner telescoping part connecting said chambers; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber, said valve comprising a coil spring associated with said apertures, a spring control plunger in said inner telescoping part, an upwardly projecting stem on said control plunger; and a pendulum suspended in said body so as to engage said stem and compress said spring during relative longitudinal movement of telescoping parts when said body is vertical.

15. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber; and gravity actuated means dependent upon relative longitudinal movement of said telescoping parts for governing the operation of said valve.

16. A device adapted for interposition in a pressure line for obstructing the flow of fluid therethrough when said line is vertical embodying: a body composed of relatively movable telescoping parts forming an inner and an outer chamber; means for delivering fluid into the outer chamber; valve means for controllably admitting fluid from the outer chamber into the inner chamber; gravity actuated means dependent upon relative longitudinal movement of said telescoping parts for governing the operation of said valve; and means for optionally locking said telescoping parts so as to permit the operation of said valve when an expanding force is applied to said telescoping body.

17. For use in combination with a drill pipe and a fluid circulating system, means for obstructing the flow of fluid therethrough when said pipe is vertical embodying: a body comprising two telescoping tubes arranged so as to form an inner chamber and an outer chamber; means for attaching the upper end of the inner tube to a section of said drill pipe; means for attaching the lower end of the outer tube to a section of said drill pipe; means for delivering circulating fluid from said drill pipe to said outer chamber, said inner tube being provided with apertures to admit fluid from said outer chamber into said inner chamber; a coil spring and plunger organization in said inner tube arranged so as to obstruct the flow of fluid into said inner chamber when said spring is compressed; and gravity controlled means for compressing said spring during relative longitudinal movement of said telescoping parts when said pipe is vertical.

18. For use in combination with a pressure line, means for optionally obstructing the flow of fluid therethrough when said line is vertical, embodying: a coil spring positioned in the path of flow and arranged so that the fluid must flow between the coils of said spring; and gravity controlled means for compressing said spring when said pipe is vertical.

19. For use in combination with a pressure line, means for obstructing the flow of fluid therethrough to indicate the verticality of said line embodying: a coil spring positioned in the path of flow so that the fluid must flow between the coils thereof; means for compressing said spring; and gravity actuated means for controlling said spring compressing means.

20. For use in combination with a pressure line, means for obstructing the flow of fluid therethrough to indicate the verticality of said line embodying: a coil spring positioned in the path of flow so that the fluid must flow between the coils thereof; means comprising relatively movable parts for compressing said spring; and gravity actuated means for controlling said spring compressing means.

THEODORE L. LYNCH.
HARRY L. RILLING.
HOWARD A. REDFIELD.

CERTIFICATE OF CORRECTION.

Patent No. 1,988,741. January 22, 1935.

THEODORE L. LYNCH, HARRY L. RILLING, and HOWARD A. REDFIELD.

It is hereby certified that the above numbered patent was erroneously issued to "Harry R. Staples, of Los Angeles, California," as assignee of the entire interest in said invention whereas said patent should have been issued to Theodore L. Lynch, Harry L. Rilling and Harry R. Staples, of Los Angeles, California, said Staples being assignee of the entire undivided interest of said Howard A. Redfield, as shown by the records of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of March, A D. 1935.

Leslie Frazer

(Seal) Acting Commissioner of Patents.