United States Patent

Nicolas et al.

[15] **3,664,416**

[45] **May 23, 1972**

[54] WIRELINE WELL TOOL ANCHORING SYSTEM

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[22] Filed: **June 1, 1970**

[21] Appl. No.: **42,179**

[30] **Foreign Application Priority Data**

June 3, 1969 France 6918133

[52] **U.S. Cl.** **166/65**, 166/212

[51] **Int. Cl.** **E21b 23/00**

[58] **Field of Search** 166/120, 121, 122, 212, 207, 166/65

[56] **References Cited**

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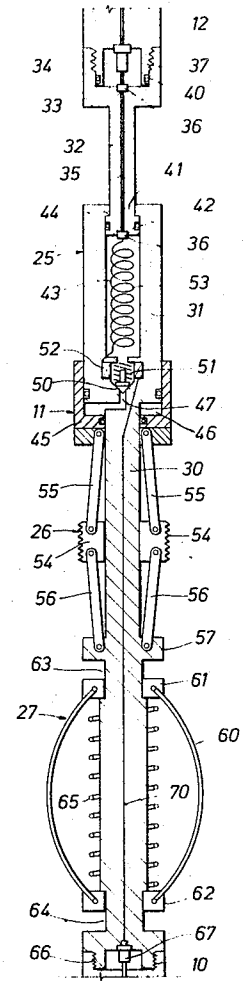
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[57] **ABSTRACT**

An illustrative embodiment of the present invention includes apparatus for use in anchoring a probe in a well bore. The apparatus includes a body member which is attached to the upper part of the probe. A ballast weight is telescopically mounted on the body member and is attached to the wireline cable for operating the device. Movement of the ballast weight is amplified by a force multiplying hydraulic system and utilized to spread anchoring means outwardly against the wall of the well bore. A surface-actuated solenoid control valve may be utilized to control the anchoring system.

8 Claims, 3 Drawing Figures



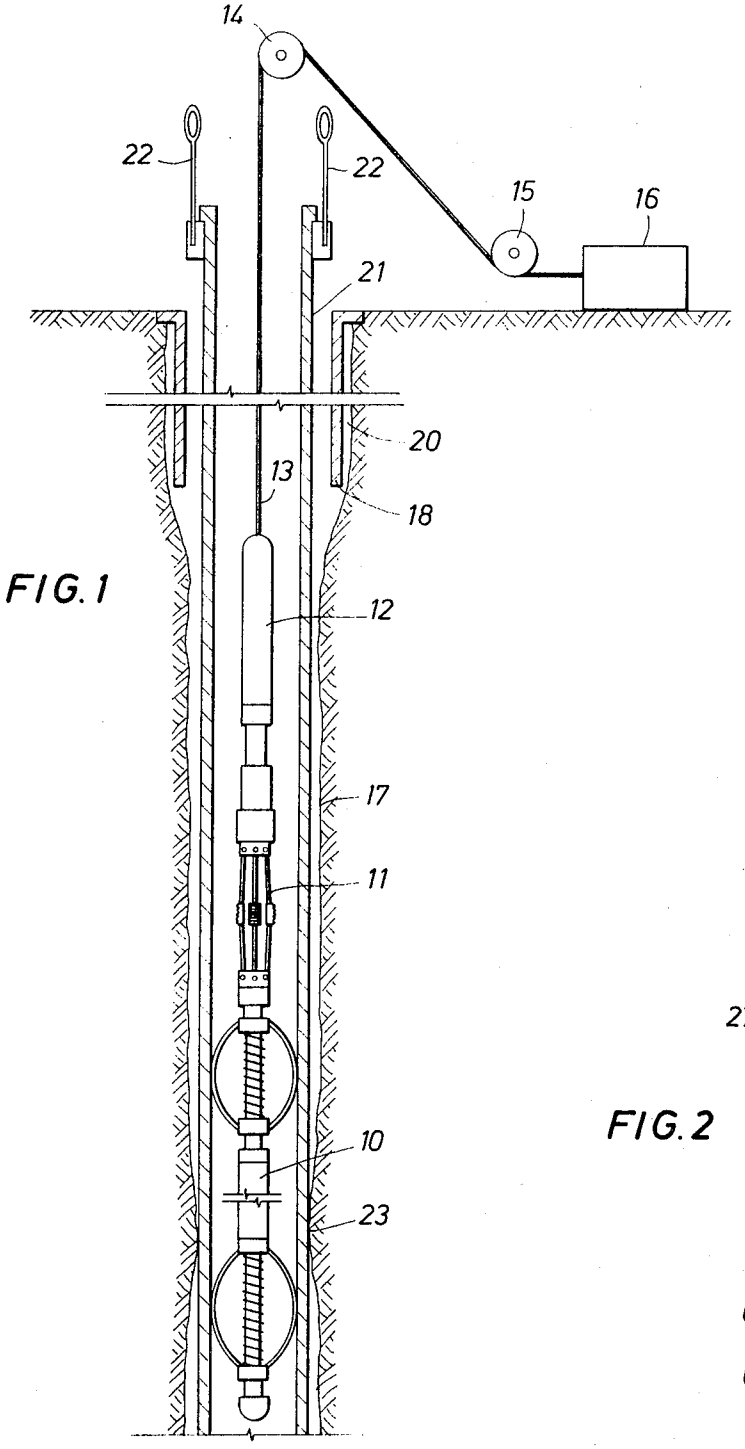


FIG. 1

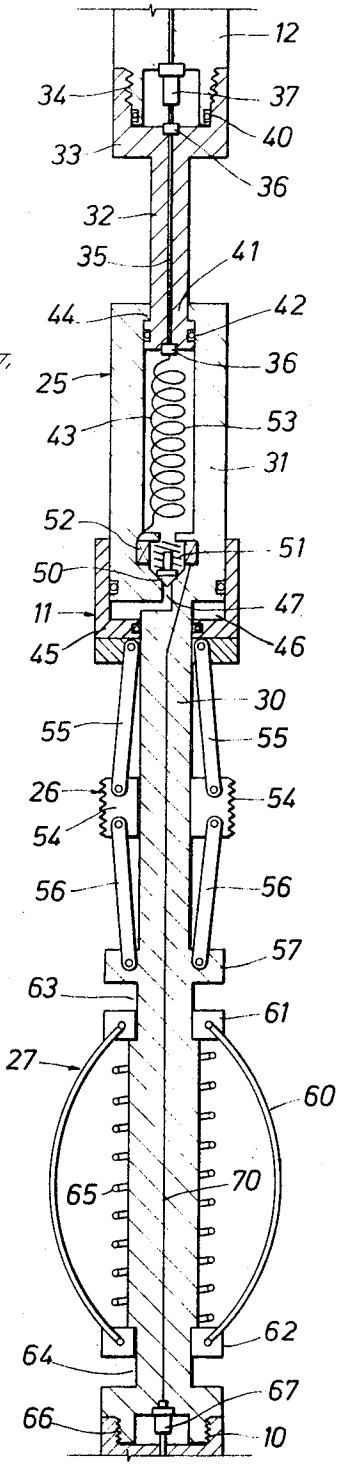


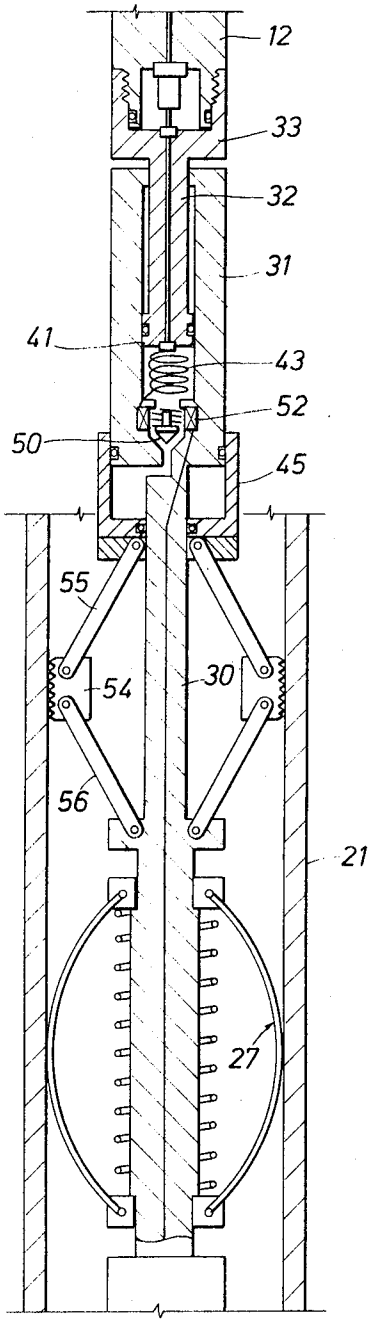
FIG. 2

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FIG. 3



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WIRELINE WELL TOOL ANCHORING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to well tools and more particularly to an anchoring system permitting a wireline measuring probe to be temporarily secured at a desirable depth in a well bore.

In modern oil exploration it has become common practice to make measurements in a well bore by means of various measuring instruments or probes which may be suspended by wireline into the well. Certain types of these measurements require the probe be rigidly attached at some point interior to the well at a depth which may be predetermined. In addition, such measurements may require the tool be repositioned to other points in the well bore where it again can be anchored in a rigid manner with respect to the well while the measurement is made. For example, well fluid sampling apparatus, fluid flow meters or fluid analyzers used in production logging may require this type of anchoring and/or movement through the well bore. Moreover, in the case of offshore wells drilled from floating barges or ships the movement of the waves is sometimes transmitted through the cable to the underground probe. Accordingly, this cable movement requires that the underground apparatus be anchored against the wall of the well bore while a measurement is being made rather than simply attempting to stop the movement of the cable at the surface.

There are a large number of prior art well tool anchoring systems. In particular, expandable slip type anchoring systems used in anchoring well plugs or packers in position in a cased borehole are particularly numerous. The energy required for setting such anchoring devices may be applied by the weight of a drill string in the case of tubing or in the case of a wireline device this energy may be stored in the apparatus itself. Such stored setting energy can come from a compressed spring, a set of weights or from the expanding gases produced by an explosive charge. In this latter case, the apparatus may usually only be anchored at one point in the well bore per trip because once the apparatus is anchored and disengaged it must be brought to the surface to recondition the energy storage system.

In other prior art well tool anchoring systems the setting energy is furnished by a hydraulic pump which may be supplied with electric current from the surface via the wireline or cable which is used to suspend the tool in the well bore. However, such systems have the disadvantage of requiring complicated hydraulic equipment and electrical pump motors which increase the cost of the probe and complicate its operation by the addition of large numbers of moving parts.

One type of apparatus used in making measurements in a well bore which requires frequent and rapid movement from one location to another in the borehole is a so-called stuckpoint indicator device. Such devices are used to locate the point in the borehole at which casing or tubing is stuck, usually due to a pressure differential. For this operation the stuckpoint indicator is placed at different depths in the well bore and anchored to the interior surface of the tubing or casing. The casing or tubing is then twisted or stretched by powerful engines at the surface of the earth and the elastic deformation of the pipe at the depth at which the stuckpoint indicator is placed is measured. If the indicator is above the stuck or "free" point of the pipe, such elastic deformation will be noted. If on the other hand, the stuckpoint indicator is located below the point at which the pipe or tubing is stuck in the well bore no elastic deformation will be noted. Accordingly, it is necessary to move the stuckpoint indicator tool to various locations in the well bore and to anchor it at each location in order to make the measurements of the elastic deformation of the tubing.

Such measurements are usually made by means of a strain gauge sensing element which detects the relative motion between the upper end of the measuring instrument and the lower end of the measuring instrument which is caused by the elastic deformation of the tubing string when placed under either longitudinal tension force or rotational torsion force from the surface. Therefore, a convenient and rapidly engageable and disengageable anchoring system is very desirable for use with a stuckpoint indicator tool. Moreover, this anchoring system must be of small enough diameter to pass through drill pipe or tubing strings and the disengagement and movement of the stuckpoint indicator apparatus must be convenient and rapid.

Accordingly, an object of the present invention is to provide a relatively simple and economical system for anchoring a probe operated by a wireline in a well bore, the system not requiring the input of the energy from an external source.

Another object of the present invention is to provide a retractable well tool anchoring system which uses the weight of ballast as the energy source for operating a hydraulically powered anchoring means.

A still further object of the present invention is to provide an anchoring system for use with a stuckpoint indicator which is rapidly engageable and disengageable for this purpose.

Briefly, in accordance with the objects of the present invention a system for anchoring a stuckpoint indicator or other well probe operated by wireline in a well bore is provided. A set of anchoring arms are equipped with wall-engaging pad-type anchoring means designed to move radially outward and away from the body member of the probe. This motion is initiated by a telescopically mounted slide member which is movably mounted on the body member and operated by a mechanism activated by the force of a falling ballast weight. The movement of the ballast weight is applied to the telescopically mounted movable slide member by a force multiplying hydraulic transmission mechanism. Moreover, an electrically operated solenoid-type blocking valve is utilized to control the motion of the ballast weight by controlling the flow of the hydraulic fluid.

For a better understanding of the invention together with further objects and advantages thereof, reference may be made to the following detailed description and to the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view of a measuring probe equipped with an anchoring device according to the invention;

FIG. 2 is an enlarged section showing the anchoring device of FIG. 1 in the position for lowering the apparatus into the well bore; and

FIG. 3 is a section showing the anchoring device of FIG. 1 in the secured or anchored position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, apparatus for use in a well borehole consisting of a measuring instrument or probe **10**, an anchoring device **11**, and a ballast weight **12** is shown suspended at the end of a cable **13**. The cable **13** passes over two pulleys **14** and **15** and is wound or taken up on the usual type winch arrangement (not shown) of a surface unit **16**. It will be understood that the cable **13** contains one or more insulated conductors and is used both for applying electrical current or power to the downhole apparatus and for the transmission of data from the downhole probe to the surface equipment. The downhole equipment is suspended in the well bore **17** which has surface casing **18** held in place by cement layer **20**. A string of drill pipe **21** is supported in a derrick (not shown) by the arms **22** of an elevator. The drill string **21** is shown wedged or stuck in the well bore at a point **23** whose depth is to be determined. The probe **10** in this example is shown as a stuckpoint or freepoint indicator, however, it will be appreciated that the anchoring means **11** and the ballast weight **12** may be used with any other type of apparatus capable of carrying out measurements directly in the casing **18** or in open well bores **17**. In any case, the downhole apparatus is typically lowered to a given depth by means of the cable **13** and secured at this depth for the actual measurements by means of the anchoring system **11**.

Referring now to FIGS. 2 and 3, the anchoring system 11 is shown in more detail. This system may consist in general of a hydraulic section 25, an anchoring section 26, and a centering mechanism 27. This apparatus comprises a body member 30 whose lower end is attached to the probe 10 and whose upper end is shaped into a cylinder 31, in which a mandrel 32 can slide telescopically. The mandrel 32 comprises a head portion 33 which is limited in its downward travel in relation to the cylinder 31. A tapped hole 34 cut in the head 33 permits this head to be screwed on to the threaded lower end of the ballast weight 12. A conducting rod 35 mounted on insulating rings 36 crosses the mandrel 32 axially and fits into an insulated sleeve 37. The rod 35 is connected to a conductor of the cable 13. An O-ring 40 provides sealing between the ballast weight 12 and the head 33.

The lower part of the mandrel 32 terminates in a control piston 41 which is fitted with an O-ring 42. This piston as it moves downwardly compresses a hydraulic fluid 43 which fills the cylinder 31. The cylinder 31 has an annular stop 44 at its upper end which limits the upward stroke of the piston 41.

A second annular piston 45, of larger diameter than the first piston 41, is slidably mounted on the lower part of the cylinder 31. The annular piston 45 has a side wall which fits on the cylinder 31 and a base with a smaller bore diameter which fits on the middle part of the body member 30. The annular piston 45 thus defines a chamber 46 which is in fluid communication with the interior of the cylinder 31 via a fluid passageway 47. A solenoid valve 50 is located in the passage 47. Under the action of a spring 51 the solenoid valve 50 can close the passage 47 when placed in the rest position. The valve 50 may be opened by supplying an electrical current to the control winding of solenoid coil 52 which is connected to the end of the conducting rod 35 by an insulating helical spring 53. The working surface of the piston 45, it will be noted, can be made equal to several times the surface area of the control piston 41.

Thrust shoes 54 are mounted on arms 55 and 56 which are hinged respectively on the annular piston 45 and on a peripheral projection 57 of the body member 30. Immediately under the projection 57 is mounted a centering mechanism 27 consisting of plural curved leaf springs 60 fixed by their ends to two rings 61 and 62 which may turn and slide into annular grooves 63 and 64 of the body member 30. An annular coil spring 65 may be mounted about the body member 30 between the two rings 61 and 62. The lower part of the body member 30 is provided with threads 66 which can be screwed into the upper end of the measuring probe 10. A connector 67 is connected via an insulated wire 70 to the control winding of solenoid 52. This insures the electrical continuity between the cable 13 and the measuring probe 10.

In operation, the apparatus is lowered into the well bore, the different elements of the anchoring device assuming the position shown in FIGS. 1 and 2. The solenoid valve 50 closes the passageway 47 and the annular piston 45 remains in its upper position holding the thrust shoes 54 in their inward position against the body member 30. When the apparatus has reached the desired depth, electrical current is supplied to the solenoid control coil 52 via the cable 13 thereby opening the solenoid valve 50. Cable tension is then slacked and, because of the friction between the drill pipe and the springs of the centering mechanism 27, a force opposing the lowering of the body member 30 is developed. The piston 41 thus moves downwardly into the cylinder 31 under the action of the ballast weight 12. The control piston 41 applies pressure to the hydraulic fluid 43 and this pressure is transmitted to the annular piston 45. The piston 45 thus slides downwardly in relation to the body member 30 and spreads the thrust shoes 54 outwardly and against the inner wall of the drill pipes 21, anchoring the tool in place. The apparatus is then in the position shown in FIG. 3. To disengage the anchoring system, it is only necessary to pull upwardly on the cable 13. The control piston 41 thus moves up in the cylinder 31 and moves the annular piston 45 which closes the shoes 54 to their inward position against the body member 30. If the solenoid-operated valve 50 is then placed in the closed position, the thrust shoes 54 will remain in closed position alongside the body member 30.

Designating the weight of the ballast weight as F_1, the cross-sectional area of the control piston s, and the cross-sectional area of the annular piston 45 as S, the downward force f applied on the piston 45 is given by Equation 1 as:

$$f = F_1 \cdot S/s \quad (1)$$

If the length of the arms 55 and 56 are chosen such that for drill pipes of the smallest diameter, these arms form an angle of at least 30° with the longitudinal axis of the body member 30. Then the lateral thrust force provided by the shoes 54 against the wall of the interior surface of the drill pipe will be:

$$f' \geq f/2 = F_1/2 \cdot S/s \quad (2)$$

A large coefficient of friction may be given to the surface of the shoes 54, for example, by providing teeth or wickers on these surfaces. It will be noted that there is no danger of wear of the surfaces since the shoes are not in contact with the walls of the drill pipe during the movement of the apparatus. Assuming that the coefficient of friction is equal to 0.5, which is very easily accomplished, the total weight of the apparatus including the ballast must be no greater than 0.5 times f' in order that the apparatus be securely anchored. The ballast weight may be chosen so that this total weight is equal to twice the weight of the ballast. In this case we would have:

$$2F_1 \leq 0.5f' \leq F_1/4 \cdot S/s \quad (3)$$

or

$$S/s \geq 8 \quad (4)$$

Even under these unfavorable conditions the ratio of the cross-sectional areas of pistons 45 and 41 need only be equal to 8. By using this system the size of the probe is no longer limited by the thrust force which can be exerted by the centering mechanism or springs 27. It is thus possible to use a stuckpoint indicator having a longer measuring base, thereby providing better sensitivity. One could, for example, combine two such anchoring devices each forming the anchor points of a stuckpoint tool on the drill pipe. No sliding will then be possible and the deformation of the drill pipe can be measured with greater accuracy then heretofore possible with tools whose size and weight were more limited.

In the embodiment described above the thrust shoes 54 were shown on mounted hinged arms. The shoes 54 may be eliminated if desired, thus using the arms 55 to bear directly on the wall of the well bore or casing. The arms can then open with a sufficiently large angle to buttress against the drill pipe permitting a larger weight to be supported. In the case where the inner diameter of the drill pipe is very small, the arm system may be replaced by a flexible compressible sleeve member whose external surface can be provided, for example, with a tungsten carbide coating to provide a large coefficient of friction. This sleeve can then be compressed by the piston 45 so as to expand radially and be brought to bear against the inner surface of the drill pipe or tubing. If desired, a further force multiplying system, preferably of hydraulic design, could also be incorporated into this anchoring system.

While a specific embodiment of the invention has been shown and described, it will be understood by those skilled in the art that certain modifications and variations both in form and detail can occur without departing from the basic concepts of the invention. All such modifications and variations therefore are intended to be included within the spirit and scope of the present invention as defined in the appended claims.

What is claimed is:

1. An anchoring system for use with a wireline well tool comprising: a body sized for passage in a well bore and adapted for coupling to a well tool; weight means vertically slidably mounted on said body; wall-engaging anchoring means pivotally coupled to said body and adapted to move outwardly in relation to said body member; force-multiplying hydraulic means coupled between said weight means and said anchoring means and adapted for transmitting forces developed by movement of said weight means to said anchor-

ing means, whereby a vertical movement of said weight means in relation to said body causes an outward movement of said anchoring means in relation to said body; and selectively operable valve means for deactivating said hydraulic means.

2. The apparatus of claim 8 wherein said hydraulic means include: a first chamber closed by a control piston of relatively small cross-sectional area and coupled to said weight means and joined by a fluid passage to a second chamber closed by a slave piston of relatively larger cross-sectional area and coupled to said anchoring means; and wherein said selectively operable valve means include a solenoid-operated valve disposed in said fluid passage between said chambers and adapted for selectively opening and closing said fluid passage.

3. The apparatus of claim 2 wherein the ratio of cross-sectional areas of said slave piston and said control piston is chosen to be greater than 8 so that the weight of said weight means is of the same order of magnitude as the weight of a well tool attached to said body.

4. The apparatus of claim 2 further including: spring means operable to hold said solenoid-operated valve normally closed, the force constant of said spring being chosen so that said solenoid-operated valve will open when the pressure of a hydraulic fluid in said second chamber exceeds that of a hydraulic fluid in said first chamber.

5. A well tool adapted for suspension in a well bore from a suspension cable and comprising: a body; ballast means adapted for connection to a suspension cable and slidably mounted on said body for upward and downward movements thereon in response to corresponding movements of a suspension cable coupled to said ballast means; anchoring means operatively arranged on said body and including at least one wall-engaging member movably coupled to said body and adapted for lateral movements back and forth in relation to said body; and hydraulic means cooperatively interconnecting said wall-engaging member and said ballast means and adapted for selectively moving said wall-engaging member into and out of anchoring engagement with a well bore wall in response to said upward and downward movements of said ballast means relative to said body.

6. The well tool of claim 5 wherein said hydraulic means include: first and second piston means respectively arranged in first and second piston chambers and coupled to said ballast means and to said wall-engaging member, and fluid passage means interconnecting said first and second piston chambers; and further including selectively operable valve means adapted for controlling fluid communication through said fluid passage means in response to signals from the surface to selectively activate and deactivate said hydraulic means.

7. The well tool of claim 5 wherein said hydraulic means include: a first piston chamber slidably receiving a first piston member and operatively arranged between said ballast means and said body for developing increased hydraulic pressures upon downward movement of said ballast means in relation to said body, a second piston chamber slidably receiving a second piston member and operatively arranged between said body and said wall-engaging member for extending said wall-engaging member outwardly in response to increased hydraulic pressures in said second piston chamber, and a fluid conduit interconnecting said piston chambers.

8. The well tool of claim 7 further including: a solenoid-actuated valve cooperatively arranged in said fluid conduit and adapted for controlling fluid communication therethrough in response to electrical signals transmitted from the surface by way of a suspension cable connected to said ballast means.

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