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[54] **WELL TOOL ANCHORING SYSTEM**

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[58] **Field of Search** 166/65, 104, 120, 212

[56] **References Cited**

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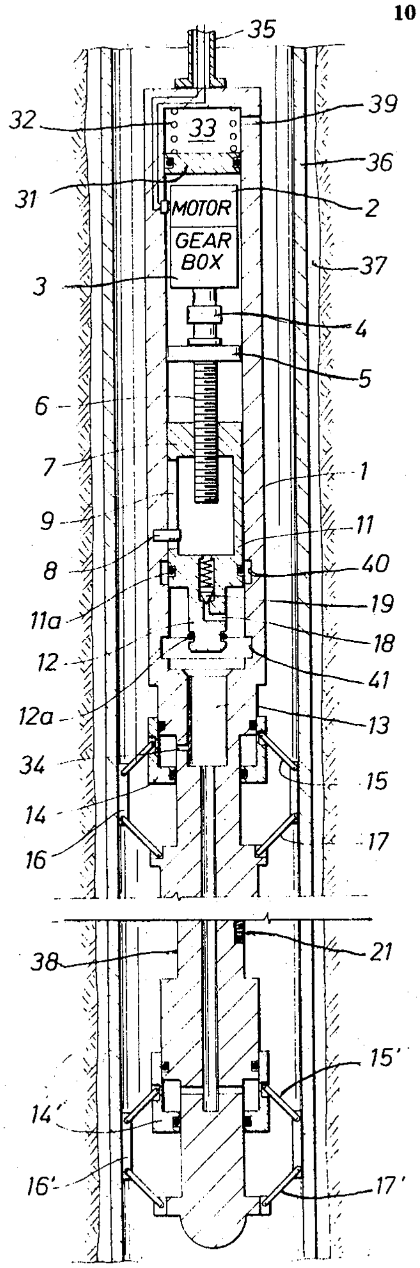
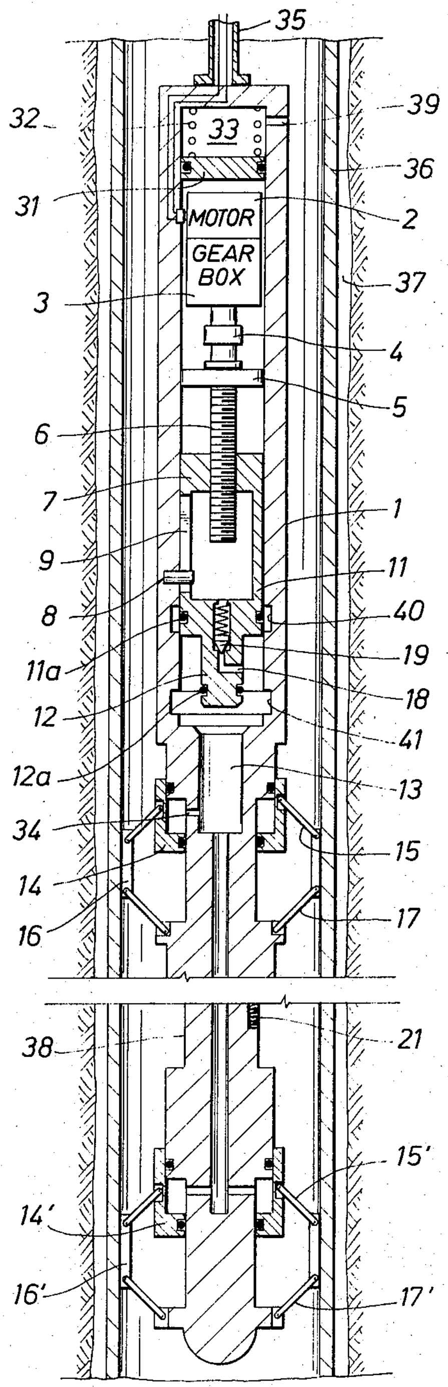
[57] **ABSTRACT**

An illustrative embodiment of the invention includes upper and lower anchoring members for temporarily securing a well tool in a well bore. The upper and lower anchoring members are pivotally supported from the central body member of the tool and respectively coupled to upper and lower movable slide blocks or driven pistons. The slide blocks are, in turn, moved by a two phase hydraulic transmission system whose pressure is controlled by a movable driving piston having two different cross sectional piston areas. The driving piston's motion is provided by a reversible electric motor via a gear box and threaded driving screw. This arrangement provides for low pressure fast moving initial deployment of the anchoring means followed by subsequent high pressure, low displacement anchoring force.

10 Claims, 1 Drawing Figure





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WELL TOOL ANCHORING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to well tools and more particularly to anchoring systems permitting a wireline measuring probe to be temporarily secured at a desired 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 a wireline into the well. Certain types of these measurements require the probe to be firmly anchored in the well at a depth which may be predetermined. In addition, such measurements may require the tool to be re-positioned to other points in the well bore where it again may be anchored in a rigid manner with respect to the well while the measurement is being 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, extendible 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 an anchoring device may be applied by the weight of the drill string in the case of tubing or, in the case of a wireline operated device, this energy may be stored in the apparatus itself in some form. Such stored setting energy may come from a compressed spring or a set of weights carried above the main body of the well tool or from expanding gases produced by an explosive charge. In the 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.

One type of apparatus used in making measurements in a well bore which requires the frequent and relatively rapid movement from one location to another in the borehole is a so-called freepoint or stuckpoint indicator device. Such devices are used to locate the point in the borehole which a tubing string or casing string is stuck, usually due to a pressure differential between the borehole fluid and the surrounding formations. 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 in question. The casing or tubing is then twisted or stretched by powerful engines at the surface 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 stuckpoint or freepoint of the pipe, 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 such location. The tubing or casing deformations are then made and the measurements of such thereby obtained.

Such measurements are usually made by the means of a strain gauge sensing element which detects 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 forces 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 a small enough diameter to pass through drill pipe or tubing strings and the disengagement and movement of the stuckpoint indicator anchoring apparatus must be convenient and rapid.

Accordingly, it is an object of the present invention to provide an easily engageable and disengageable stuckpoint indicator anchoring system.

Another object of the present invention is to provide a well tool anchoring system which may be used to anchor a measuring tool at longitudinally spaced apart locations in such a manner that the elastic deformation of the pipe between the anchoring locations may be measured.

A still further object of the present invention is to provide an electrically operable well tool anchoring system.

Briefly, in accordance with the objects of the present invention, a system for anchoring a stuckpoint indicator or other well probe operated by a wireline in a well bore is provided. Wall engaging anchoring means are cooperatively arranged on a tool body and adapted for lateral movement from the body member of the probe. A reversible electric motor drive mechanism which may be remotely controlled from the surface is coupled by a hydraulic system to the anchoring means and cooperatively arranged to transform the first phase of the driving motion into a relatively rapid extension of the anchoring means. During a second phase of the driving displacement, the continuing motion of the drive mechanism is employed to impose a greatly increased anchoring force on the anchoring means.

The invention may be better understood upon consideration of the following description of a particular embodiment of the anchoring system in connection with the appended drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

The single drawing represents a partial schematic view in longitudinal section of an anchoring system associated with a stuckpoint indicator tool.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, a stuckpoint indicator equipped with upper and lower anchoring devices is suspended by a cable **35** inside a tubing string **36** extending within a borehole **37**. The anchoring system of the stuckpoint indicator comprises a housing **1** or hollow body member which is filled with hydraulic fluid **13**. At the interior portion of the upper end of the body member is an electric motor **2** which is supplied with surface originated electrical power from conductors coming down a cable member **35**. The motor **2** is capable of reversal depending, for example, upon the polarity of the voltage applied thereto. The electric motor **2** drives a planetary reduction gear **3** whose rotary motion is coupled via an Oldham coupling **4** to a square thread screw member **6**. A thrust bearing **5** supports the axial forces acting on this assembly and serves to relieve undue stresses on gear upon planetary gear box **3** or electric motor **2**.

The square thread screw member **6** is capable of driving a pressure-developing piston **7** longitudinally in either direction depending upon the direction of drive of the electric motor **2**. The piston **7** is provided on one side of its circumference with a slotted portion **9** which serves in cooperation with a lug **8** affixed to the wall of body member **1** to prevent rotational motion of the piston **7**. Piston **7** is further provided with an upper portion comprising a low pressure piston of large section **11** which is fitted with an O-ring **11*a***. The lower portion of the piston **7** comprises a high pressure piston of small section **12**. This high pressure piston portion is fitted with an O-ring **12*a***. These two pistons of different section may travel within a cooperatively sized bore **5** within the body member **1** and act via the hydraulic fluid **13** and port **34** on a longitudinally-movable slide block **14** slidably mounted on the tool. A second longitudinally-movable block **14'** located near the lower end of the tool is also acted on by the hydraulic fluid **13** as its pressure increases. The two slide blocks **14** and **14'** are also equipped with O-ring seals in the manner shown in the drawing for defining pressure-responsive surfaces on which the hydraulic fluid can act.

Considering only the upper slide block **14** (as the lower slide member **14'** is analogous) three sets of upper arms **15** situated, for example, 120° apart, about the circumference of the tool are provided. Arms **15** are cooperatively supported as for example by hinges or pivots from the slide block **14** at one end and are hinged on friction anchoring shoes **16** at their opposite end. Three corresponding lower arms **17** are similarly hinged to the shoes **16** on their one end and on their other end are pivoted or hinged at fixed points of the body member **1**. The lower slide block **14'** is associated in a similar manner to shoes **16'** which are equipped with corresponding hinged arms **15'** and **17'**. The wall engaging pad members or shoes **16** and **16'** may additionally be provided with external teeth or wickers (not shown) for engaging and anchoring the tool in a frictional manner to the interior surface of the tubing in which it is suspended. It will be appreciated, therefore, that the arrangement of the several linkages provides a toggling action upon downward movement of the slide blocks **14** and **14'**.

The body member **1** and the slide blocks **14** and **14'** have the same overall diameter so that in the folded position of the shoes **16** and **16'**, this diameter determines the overall diameter and hence the passage possibilities of the apparatus in the tubular space where it is to be admitted. Between the two sets of anchoring devices there is a connecting tube **38** (shown partially deleted) belonging to the stuckpoint indicator measurement portion of the tool. This tube could, for example, carry embedded strain gauges such as **21** which make it possible to detect elastic deformation of the tubing due to traction or stretching and twisting forces applied to it. The length of stroke of the driving piston **7** may be defined by stroke limitators such as microswitches (not shown) which cut off the electrical power to the motor **2** or simply by mechanical stops as represented by the ends of the groove **9**.

At the upper end of the body member or housing **1** a free piston **31** equipped with an O-ring seal is loaded by a compression spring **32**. This defines an upper chamber of variable volume **33** which communicates with the surrounding borehole fluid medium via a port **39**. This variable volume upper chamber permits the free expansion of the hydraulic fluid in the interior of the body member due to temperature changes. Moreover, this arrangement serves to balance the pressures on the inside and outside of the tool housing **1** permitting pressure balanced operation within the tool.

The larger diameter portion of the cooperatively shaped inner surface of the housing **1** in which the large sectional area **11** of the piston **7** moves is equipped with an internal circumferential annular groove **40** at the one end of the travel of the piston **7**. A lower annular groove **41** is similarly provided at the lower end of the travel of the piston. The role of these grooves will be more clearly seen subsequently. The smaller diameter portion **12** of the piston has an internal passage **18** connecting the hydraulic fluid filling the body member proper, with the lateral face of this piston. A hollow internal chamber in the piston **7** located above the seal **11***a* connects the passage **18** with the chamber via a preset pressure-relief valve **19**.

In operation, the apparatus functions as follows. The tool is lowered or moved through the tubing string with the shoes **16** and **16'** in the retracted position. When the desired operating level is reached, the electric motor **2** is started in the desired direction to provide motive force for extending the shoes **16** and **16'** by a control panel at the surface (not shown). With the anchoring shoes **16** and **16'** in the retracted position, the seal **11***a* of the large upper portion **11** of the driving piston **7** is at the level of the upper recess **40** of the body member. This effectively bypasses the piston **11** and permits equalizing of the internal pressure and the external borehole pressure and further provides for any temperature expansion of the hydraulic fluid. Upon activation of the electric motor, its energy is coupled via planetary gear box **3** and Oldham coupler **4** to the screw shaft **6**. At first only the large piston **11** acts on the hydraulic fluid **13** once the seal **11***a* moves below the recess **40**. The low pressure which this initially creates is sufficient to overcome the friction of the slide blocks **14** and **14'** and the arms coupling the blocks to the anchoring shoes **16** and **16'**. Moreover, during this phase of the downward motion of the driving piston the pressure-relief valve **19** limits the maximum value of the hydraulic pressure which may be developed. This portion of the motion of the piston **7** in which the large diameter portion **11** is acting on the hydraulic fluid may be termed the approach phase. At the end of this phase, the seal **11***a* of the large diameter portion **11** of the piston **7** is located in the lower recess **41** of the body member thereby again effectively bypassing the piston permitting the equalizing of internal and external pressure. Continued downward motion of the piston due to further rotation of the threaded screw **6** causes engagement of the smaller diameter high pressure portion **12** of the piston **7** with its cooperatively chambered bore in the body member **1**. When this phase is reached, a high pressure is created in the hydraulic fluid below the piston and a high thrust force for anchoring firmly the shoes **16** and **16'** into frictional engagement with the internal wall of the tubing is provided.

By way of an example, typical dimensions might comprise a driving screw of 8-mm diameter with a pitch of 1.4 mm in a body member having an overall outer diameter of 36 mm and an inner diameter of 30 mm. Such a device is capable of being used in drill pipe or tubing of 44.4 mm inner diameter. By choosing the following hydraulic cross sectional areas:

for the large piston $S_1 = 4\ cm^2$
for the small piston $S_2 = 0.8\ cm^2$
for the slide blocks $S_3 = 5\ cm^2$.

The calibrated valve **19** is set to release, for example, at 10 kgf/cm^2. Under these conditions, one obtains during the approach phase a force of 50 kgf on the slide blocks and an anchoring force during the second phase of 500 kgf is produced on the same slide blocks. In anchoring the apparatus in a pipe 152.4 mm (6 inches) in diameter in the case where the rotation speed of the driving screw **6** is 40 rpm, a typical time required for the anchoring will be 1.5 minutes.

When it is desired to move the tool, the direction of travel of the electric motor **2** is simply reversed as, for example, by reversing the polarity of the voltage supplied thereto and the drive screw **6** withdraws the hydraulic driving piston **7** in the reverse sequence. This causes lowered internal hydraulic pressure. Thus, external borehole pressures acting on the slide blocks cause the hinged pad members to retract to their original position. Moreover, internal and external pressures are equalized at the same points in the piston travel as previously noted. This anchoring system makes it possible to achieve high anchoring forces with sufficient rapidity and with relatively large applications of anchoring force.

It will be appreciated by those skilled in the art that other embodiments may be suggested which differ only in detail from that disclosed in the above description. It is the aim therefore in the appended claims to cover all such changes and modifications coming within the true spirit and scope of the invention as may be made apparent to those skilled in the art.

I claim

1. A well tool anchoring system comprising:

a body member sized for passage through a tubing string;

at least two longitudinally spaced apart anchoring means cooperatively coupled to said body member in a manner to allow expansion thereof radially outward from a closed position into an anchoring position; and

means for expanding said anchoring means radially outwardly from said body member in two phases, an approach phase and an anchoring phase, said means including remotely controllable reversible drive means, means for coupling said drive means to a longitudinally movable hydraulic piston, said piston having a first hydraulic cross section active during said approach phase and a second hydraulic cross section active during said anchoring phase and means for converting longitudinal motion of said piston into radial motion of said anchoring means.

2. The apparatus of claim 1 and further including means for pressure balancing the interior portion of said body member with the borehole fluid when said anchoring means are in said closed position and during at least one portion of the radial outward movement of said anchoring means.

3. The apparatus of claim 1 wherein said means for converting longitudinal motion of said piston into radial motion of said anchoring means includes at least two cooperatively sized bores in said body member for interaction with said first and second hydraulic cross section of said piston to form a first hydraulic pressure chamber during said approach phase having a relatively larger diameter and operating at a relatively lower pressure and a second hydraulic pressure chamber during said anchoring phase having a relatively smaller diameter and operating at a relatively higher pressure and at least one longitudinally movable driven hydraulic piston responsive to the pressure in said first and second hydraulic pressure chambers and coupled to said anchoring means in such a manner that longitudinal motion of said driven piston causes radial motion of said anchoring means.

4. The apparatus of claim 1 wherein said means for coupling said drive means to said hydraulic piston includes gear box means for reducing the relative speed of said drive means and for amplifying the relative power of said drive means and two-way screw means engageable with a cooperatively threaded nut means integral with said hydraulic piston so that the motion of said piston is reversible in accordance with the reversal of said reversible drive means.

5. The apparatus of claim 4 wherein said reversible drive means comprises a reversible electric motor.

6. The apparatus of claim 1 and further including pressure relief valve means calibrated to allow a maximum hydraulic pressure to be reached during said approach phase before opening.

7. A well tool adapted for suspension in a well bore from a suspension cable and comprising:

a body;

wall-anchoring means on said body and including first piston means slidably mounted on said body, at least a pair of arms respectively having one end pivotally coupled to said first piston means and another end adapted for movement laterally in relation to a well bore wall upon longitudinal movement of said first piston means in relation to said body; and

anchor-actuating means including selectively operable motor means mounted on said body and having a rotatable shaft adapted for rotation upon operation of said motor means, hydraulic means including second piston means including a piston member movably disposed on said body and having a first enlarged portion and a second reduced portion respectively adapted for successive movement into first and second piston chambers upon movement of said second piston means on said body, conduit means fluidly coupling said piston chambers to said first piston means, and means coupling said piston member and said motor shaft and cooperatively arranged for moving said piston member upon rotation of said motor shaft.

8. A well tool adapted for suspension in a well bore from an electric cable and comprising:

a body;

wall-anchoring means on said body and including a first piston member slidably mounted on said body and defining therebetween a first piston chamber adapted to receive a pressured fluid for selectively moving said first piston member along said body, a plurality of first and second rigid links pivotally coupled to one another between said body and said first piston member; and

actuating means including a selectively operable electric motor having a rotatable shaft, a second piston chamber on said body and having an enlarged portion and a reduced portion, a second piston member slidably mounted on said body having an enlarged portion and a reduced portion respectively adapted for movement into said enlarged and reduced chamber portions upon movement of said second piston member, conduit means intercoupling said piston chambers, and motion-translating means intercoupling said motor shaft and said second piston member and adapted for selectively moving said second piston member upon rotation of said motor shaft.

9. The well tool of claim 8 further including: wall-engaging means operatively mounted on said rigid links and adapted for anchoring engagement with a well bore wall upon outward movement of said rigid links.

10. The well tool of claim 8 wherein said motor shaft is threaded and said motion-translating means include a nut coupled to said second piston member and cooperatively arranged on said threaded shaft for moving said second piston member into said second piston chamber upon operation of said electric motor.

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