United States Patent [19]

Grable et al.

[11] **3,807,902**

[45] **Apr. 30, 1974**

[54] **CONTROL OF WELL FLUID LEVEL**

[75] Inventors: **Donovan B. Grable**, Long Beach; **Bill C. Laney**, Torrance, both of Calif.

[73] Assignees: **Donovan B. Grable**, Long Beach; **Bill C. Laney**, Torrance, both of, Calif.

[22] Filed: **July 17, 1972**

[21] Appl. No.: **272,549**

[52] **U.S. Cl.** **417/46**
[51] **Int. Cl.** **F04b 49/00**
[58] **Field of Search** 417/36, 38, 12, 362, 53, 417/46, 47

[56] **References Cited**

UNITED STATES PATENTS

2,180,400	11/1939	Coborly	417/46
1,957,320	5/1934	Coborly	417/12
3,075,466	1/1963	Agnew et al.	417/12
3,225,697	12/1965	Brown	417/38
3,516,762	6/1970	Grable	417/362

Primary Examiner—William L. Freeh
Attorney, Agent, or Firm—William W. Haefliger

[57] **ABSTRACT**

The rate of the displacement of a main drive effecting stroking of a sub-surface well pump is automatically controlled in response to changes in the level of a sub-surface column of well fluid to be pumped, and one objective is to reduce the power required to operate the main drive.

15 Claims, 4 Drawing Figures

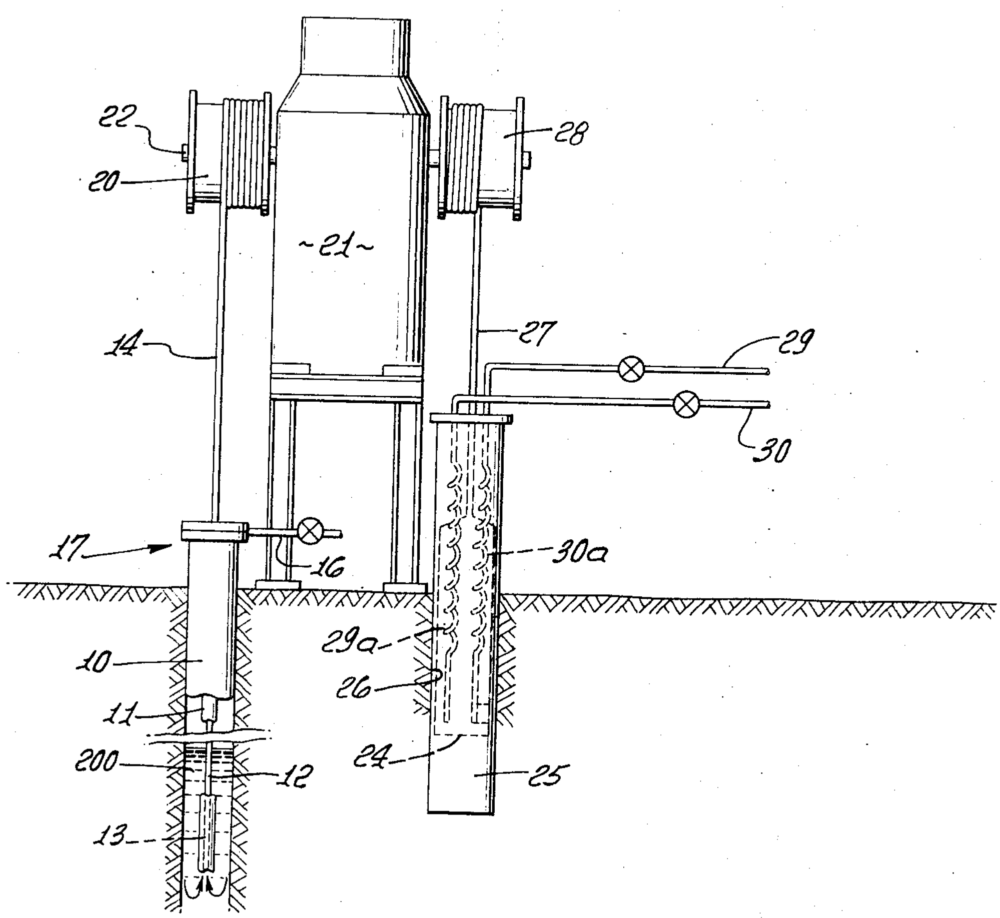


FIG. 1.

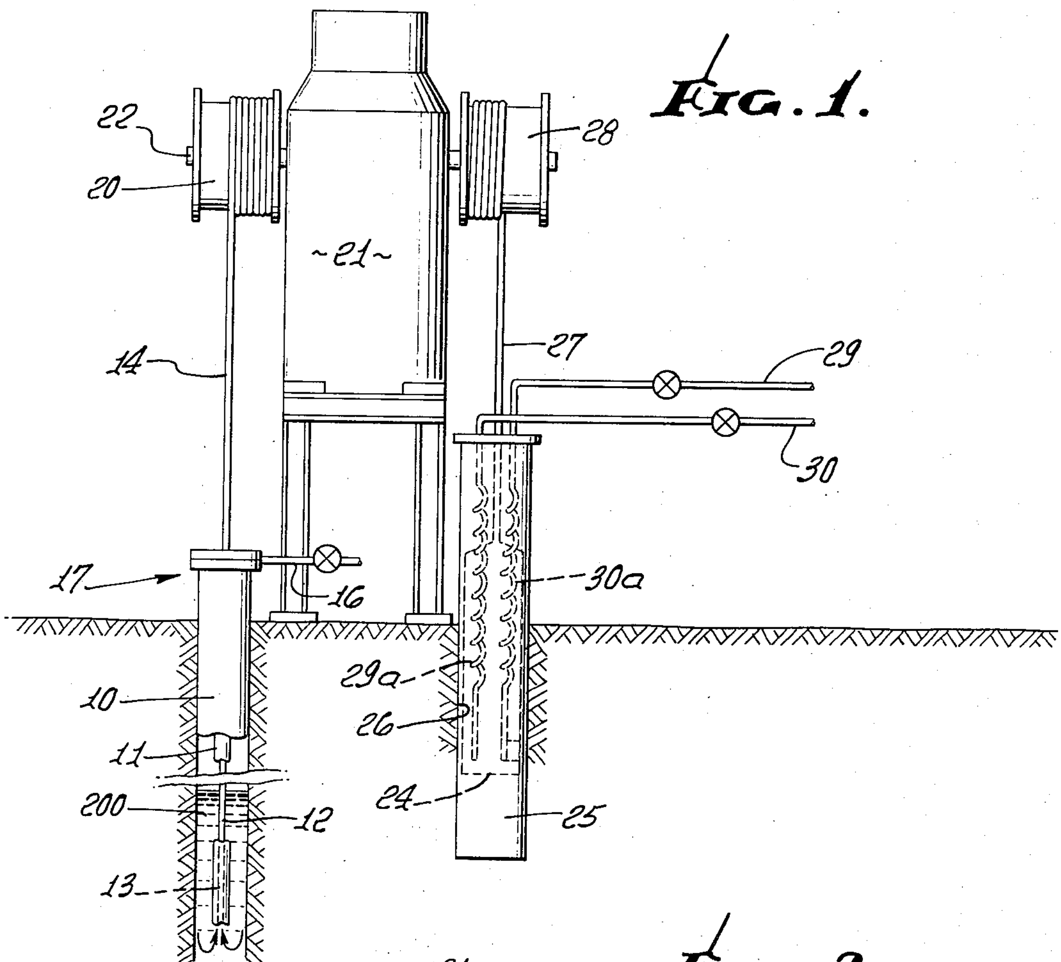


FIG. 3.

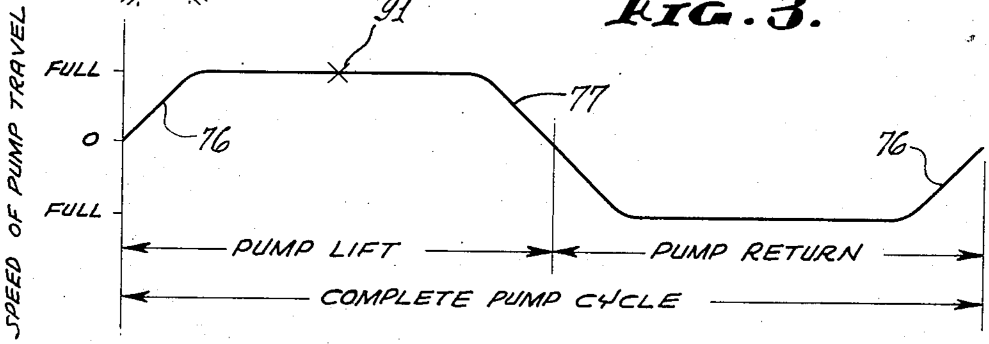
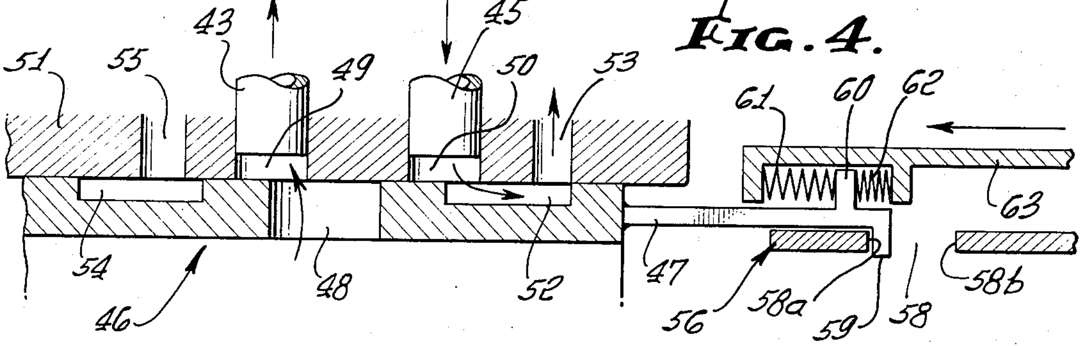


FIG. 4.



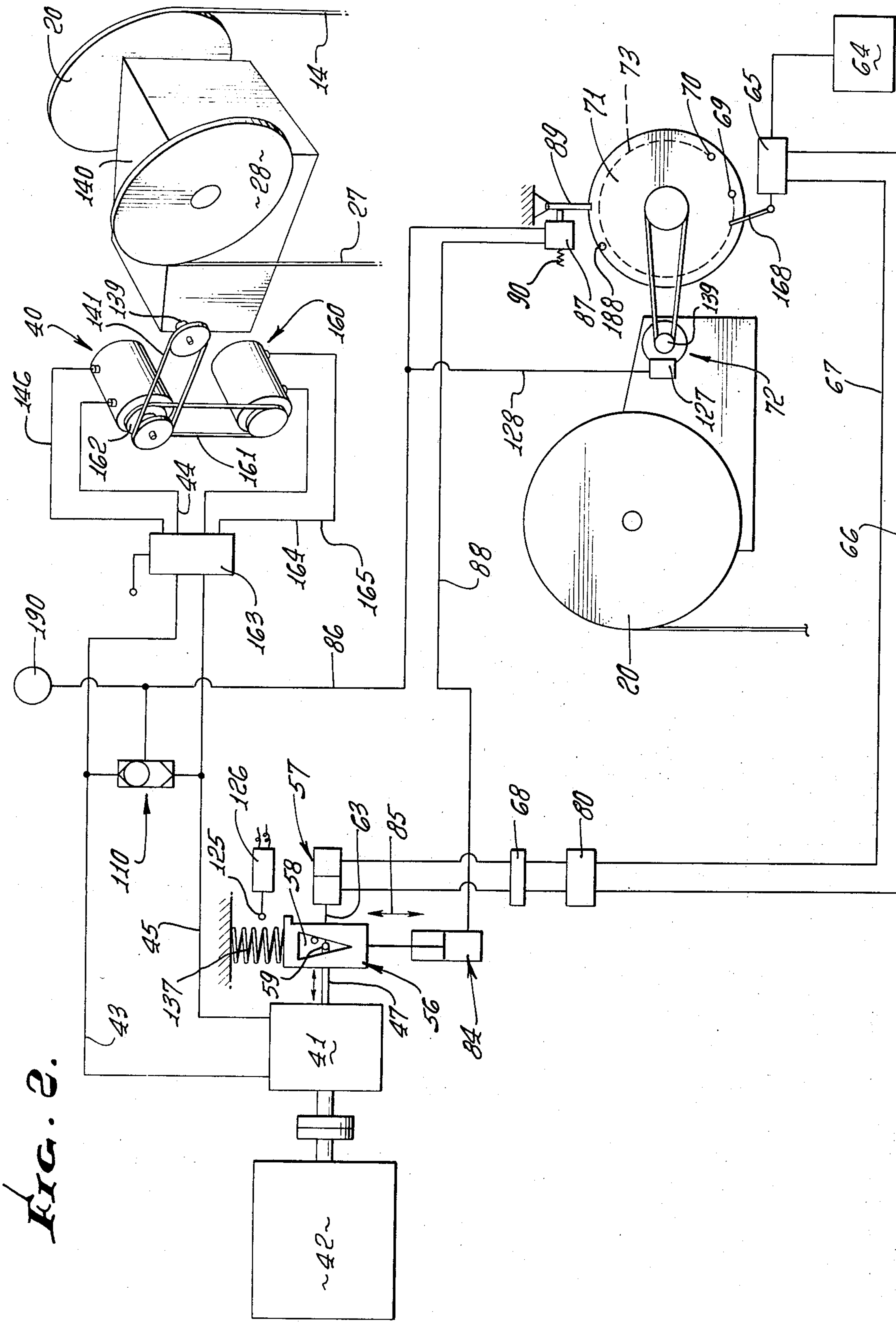

20
14
73
71
70
69
65
64
140
28
27
89
90
87
188
168
40
141
139
160
146
162
161
44
139
127
72
128
67
66
88
20
164
165
163
190
86
110
126
57
63
85
68
80
125
58
45
137
59
56
47
84
43
41
42

FIG. 2.

CONTROL OF WELL FLUID LEVEL

BACKGROUND OF THE INVENTION

This invention relates generally to the pumping of wells such as oil wells. More particularly it concerns the control of pumping of an oil well in such manner as to automatically control the fluid level in the well.

Oil production engineers everywhere are aware that the machinery being used by the oil producing industry to raise fluid from the well bore to the surface is far from being efficient, and the cost of raising a barrel of fluid to the surface is a factor they all have to reckon with. An efficient pumping operation is one that has the proper size surface lifting machinery and power source along with the right size down hole pump and the right tubing and rod string to keep the fluid pumped down to the pump shoe depth, the fluid column and the rod string counterbalanced at the surface to effect a minimum of power consumption. This type of operation is almost impossible to accomplish with the surface lifting machinery that is currently being used on many thousands of wells, unless there is a constant reading on the depth of the fluid in the well bore and a constant changing of counterbalances on the units and constant changes of the strokes per minute, all of which changes are extremely difficult or too costly to implement.

It would be safe to say there are no **100%** efficient pumping operations with beam-type, counterbalanced pumping units, the reasons being the following:

If a well counterbalanced polish rod load is raising fluid from the pump shoe depth and it is not pounding fluid and the bottom hole pump is operating at 100 percent efficiency, the operation would be efficient until the first pump wear would start. A bottom hole pump is subject to wear from the first stroke it makes, so that after a few strokes the pump starts to lose some of its efficiency. Fluid in the well bore will start to accumulate over the pump, decreasing efficiency; and to capture the fluid over the pump the counterbalanced unit must be speeded up in its number of strokes per minute, or the stroke must be lengthened. If the power source is a combustion engine, speeding up the unit is quite simple; however if the power source is electrical, a lengthy operation of changing the pulleys on the electric motor is required. If the well is a large volume producer, 4 or 5 hours down time will cause fluid accumulation over the pump that may require many days and even weeks in order to pull the fluid down to the pump shoe level. In the meantime, the pumping operation is out of balance and causing excessive power consumption and useless wear and tear on surface and down hole equipment. This description would characterize an under pumping operation.

In order to overcome the above mentioned problems, some production men go to oversized surface and down hole equipment that has the capacity of keeping the fluid pumped down to the shoe depth at all times. This type of operation will recover the fluid; however, there can be no greater damaging force to surface and down hole equipment than over pumping a well. Raising a column of fluid along with the weight of a rod string and dropping it back on a void or a semi-void is the direct cause of many surface and down hole equipment failures. For an example, if the polish rod load weighs 10,000 lbs. and the unit is making **10** strokes a minute, in a year's time this load is dropped back on to the tubing string 5,256,000 times. Tubing, rod strings, down hole pumps, and surface machinery pay a big price for this type of pumping operation as well as oil cleaning chemical costs to demulsify the fluid pumped from the well. There can be little doubt that this type of over pumping operation is the cause of rod wear and fatigue tubing wear and collar leaks, excessive wear especially to balls and seats in the bottom hole pump, and it is safe to state that if a fluid log reading shows over a long period of time that the fluid is at the shoe, the well is being over pumped.

Many of the problems of under pumping and over pumping can be overcome by causing the pumping unit to either speed up or slow down at the command of the fluid column in the well bore i.e., the fluid level in the bore controls the operation of the surface machinery that pumps the well. If the fluid is at the pump shoe, the control causes the unit to slow down; and if there is a fluid column over the pump, the control system causes the unit to speed up. If the fluid is surging in the well bore, the control system will speed up and slow down with the surge.

SUMMARY OF THE INVENTION

It is a major object of the invention to provide a system of improved design that will operate to control reversing of the main drive for the pumping unit as well as its rate of displacement in response to changes in the weight of the column of well fluid pumped upwardly by the sub-surface pump, in order to obviate the problems of under and over pumping as referred to above. In this regard, the system is designed to automatically change the rate of well pumping to maintain the level of the unpumped column of well fluid within a predetermined depth range in order that minimum power can be required to operate the pumping system. Once the desired depth range has been determined and the control apparatus set for that desired level (as for example by counterweight selection, as will be seen), the pumping system after activation will in effect sense the difference between the desired well fluid level depth range and the actual fluid level. The system will then increase or decrease its pumping rate to permit the actual fluid level to stabilize itself within the predetermined or selected depth range.

With the above in mind, the system incorporates, in combination with a reversible main drive the output displacement of which effects vertical stroking of a sub-surface well pump, the following elements:

a. first control means for reversing the main drive at predetermined limits corresponding to upper and lower limits of the well pump stroke, and

b. second control means for controlling the rate of such displacement of the main drive in response to changes in the level of the sub-surface column of well fluid.

More specifically, the main drive may typically include a reversible hydraulic motor or torque converter and supply means to supply hydraulic fluid to the hydraulic motor or torque converter at a rate controlled by the referenced second means, and characterized in that the supply rate increases as the level of fluid standing in the well increases above a preset level, and conversely the supply rate decreases as the fluid level in the well decreases below the present level. For this purpose, the first control means may include a flow regulator movable to proportionally control the rate of hydraulic fluid supply to the motor via the supply means, and the second control means may control movement of the regulator in response to changes in the pressure of supply fluid delivered to the hydraulic motor or converter. Further, the second control means may include an adjustable limiter to limit movement of the flow regulator, and means to actuate the limiter in correspondence with pressure of supply fluid in the supply system as it corresponds to the actual down-hole fluid level as against the pre-set level. Such means may advantageously "sample" the supply fluid pressure only during the lift stroke of the down-hole pump, as will be seen.

Additional objects include the provision of a counterbalancing assembly connected with the main drive to counterbalance weight imposed by the well pump, rod string and well fluid being lifted.

Also, the stroke of the well pump may be very simply controlled or adjusted by shifting the positions of pins on a rotor driven in synchronism with the main drive, the pins controlling reversing of a valve through which pressure is supplied to an actuator for displacing the regulator, as referred to.

These and other objects and advantages of the invention, as well as the details of an illustration embodiment, will be more fully understood from the following description and drawings, in which:

DRAWING DESCRIPTION

FIG. 1 is a side elevation showing one installation incorporating the invention;

FIG. 2 is a diagram showing elements of the control system;

FIG. 3 is a diagram showing sub-surface pump speed during its cycling; and

FIG. 4 is a fragmentary section showing flow control porting.

DETAILED DESCRIPTION

Referring to FIG. 1, the typical oil well illustrated has outer casing **10** and production tubing **11** extending therein. Carried within the lower extent of the tubing **11** is a pump means **13** which is vertically reciprocable in response to up and down travel of the cable **14** and rod string **12**. The pump may comprise a piston or swab operable to elevate a column of production fluid toward flow line **16** extending from the casing head **17**.

The cable **14** extends upwardly of the casing head to spool on winding drum **20** driven alternately in opposite directions by drive means such as beam type pumping unit gear box **21**, with output shaft **22**.

Adjustable weight structure may be provided to exert torque on the drum **20** in counterbalancing relation to the weight suspended by the wire line and exerting suspension torque on that drum. Such structure may include a counterweight reservoir positioned to be moved upwardly and downwardly as cable **14** moves downwardly and upwardly respectively, whereby the drive unit **21** including a suitably small prime mover need only supply minimum power to effect vertical reciprocation of the well pump, the need for large gasoline or Diesel engines being obviated. More specifically, a counter-weight reservoir or traveling tube **24** is accommodated for vertical movement within casing **25** in a bore or rat hole **26** drilled in the earth to a depth sufficient to permit maximum travel corresponding to selected ranges for the well pump. See in this regard U.S. Pat. No. 3,516,762.

Reservoir **24** is connected by cable **27** with the drive **21** as via a drum **28** also connected with shaft **22**, the direction of spooling of cable **27** on drum **28** being opposite to that of cable **14** on drum **20**. The quantity of counterweight material in reservoir **24** may be adjusted in weight compensating relation to variations in the load to be lifted in the well by cable **14**, that load including the weight of the rod string, bottom hole pumping means **13**, and the weight of the column of production fluid in the tubing **11**. Any adjustable and measurable counter-weight material may be employed, the objective being to provide a predetermined counterbalancing force which thereby in effect establishes the pre-set surface level of the column **110** of production fluid in the well corresponding to minimum energy output of the main drive operated at the surface to capture the fluid entering the well bore to pump the well, and due to system balance.

Referring now to FIG. **2**, it shows one form of system which, in accordance with the invention, is operable to adjust the pumping of the well to control the production fluid level in the well. In this regard, the main drive **21** is reversible, its output displacement (as at shaft **22**) effects vertical stroking of the sub-surface pump (as at **13** for example); and the drive may typically include a reversible hydraulic motor **40** and supply means to supply hydraulic fluid to the motor at a controlled rate. The motor may be connected to the input shaft **139** of the drive gear box **140** by a chain drive **141**. More specifically, the supply means may include a pump **41** driven by prime mover **42**, either to deliver fluid via lines **43** and **44** to the motor (with return flow via lines **146** and **45**) to the pump for clockwise operation of the motor, or to deliver fluid via lines **45** and **146** to the motor (with return flow via lines **44** and **43** to the pump), for counterclockwise operation of the motor.

Within the above environment, first control means is provided for reversing the main drive at predetermined limits corresponding to upper and lower limits of the well pump stroke; and there is also second control means for controlling the rate of output displacement of the main drive (i.e. the rate of angular displacement of shaft **22**, and of linear displacement of the cable **14**, for example) in response to changes in the pressure of supply fluid to the hydraulic motor or torque converter, as such pressure corresponds to the actual production fluid level in the well as against the preset level. In this regard, it is characteristic of the control of hydraulic fluid supplying pump **41** by the referenced second means that the rate of hydraulic fluid supply to the motor or converter is increased as the surface level of the production fluid column in the well increases, and the rate of hydraulic fluid supply to the motor or converter is decreased as the well fluid surface level decreases (as for example occurs as the down-hole pump pumps down the column fluid faster than fluid flows into the well from the formation). For this purpose, the first control means may include a flow regulator movable to proportionally control the rate of hydraulic fluid supply to the motor via the pump; also the second control means typically controls flow regulator movement in response to changes in the pressure of hydraulic fluid delivery to the motor or torque converter.

Merely as illustrative, FIG. 4 shows a flow regulator valve **46** movable endwise by rod **47** to proportionally control hydraulic fluid supply to one or the other of lines **43** and **45**, via port **48** in the regulator and ports **49** and **50** in the body **51**. When pressure flow is directed as shown to line **43**, return flow via line **45** passes to the pump sump via ports **52** and **53** in the regulator and body; and, similar return flow ports **54** and **55**, may communicate with line **43** when regulator port **48** registers with port **50**.

The first control means may include a first actuator **57** to effect movement of the flow regulator, and the second control means may typically include an adjustable limiter **56** to limit movement of the flow regulator **46**, there being a second actuator **84** to adjust the position of the limiter.

The limiter **56** is shown as a body having a delta shaped cut-out **58** receiving the pin **59** integral with rod **47**, as appears in both FIGS. **2** and **4**. Actuator **57** is shown to have an override connection with the rod **47**, as via a lug **60** on rod **47** confined between actuating springs **61** and **62** carried by the actuator rod **63**. When the actuator rod **63** is displaced to the left as seen in FIG. **4**, rod **47** is also displaced to the left by spring **62**, and until pin **59** engages the angled wall **58*a*** of delta slot **58**, after which the spring **62** is compressed as the actuator rod **63** completes its leftward stroke. Similarly, when the actuator rod is displaced to the right, regulator rod **47** is moved to the right until pin **59** engages angled wall **58*b*** of the slot **58** in limiter **56**. It is seen therefore, that the degree of leftward and rightward movement of the regulator valve **46** is governed by the position of the limiter **56** and that this in turn controls the rate of output displacement of the main drive, i.e., the rate at which the well pump is elevated or lowered in the well.

Actuator **57** may be caused to stroke in opposite directions by auxiliary fluid pressure supply from source **64** through reversible flow control valve **65**, lines **66** and **67**, and adjustable acceleration control valve **68**. Valve **65** is operated between alternate positions (to control pressure flow of auxiliary fluid through either of lines **66** and **67**) by alternate engagement of a shifting finger **168** with pins **69** and **70** adjustably located on the rotor or feedback wheel **71**. The latter is rotated forwardly and reversely in synchronism with the rotation of shaft **22**, as via a large ratio gear reducer mechanism **72**. Thus when rotor **71** completes its rotation in one direction corresponding to completion of subsurface pump lift, pin **69** engages finger **168** to shift valve **65** to deliver auxiliary fluid pressure to one side of the piston in actuator **57** for reversing hydraulic fluid flow to the drive motor **40** (causing the motor to lower the sub-surface pump at a rate controlled by the position of limiter **56** as described) and when rotor **71** completes its rotation in the opposite direction, corresponding to completion of sub-surface pump lowering, pin **70** engages finger **168** to shift valve **65** to deliver auxiliary fluid pressure to the opposite side of the piston in actuator **57**, for again reversing hydraulic fluid flow to the drive motor **40** (causing the motor to lift the subsurface pump, again at a rate controlled by the position of the limiter **56**). It will be understood that the top and bottom stroke limiting pins **69** and **70** can be located anywhere along the broken line circle **73** on rotor **71**, suitable holes being provided, thereby to control the length of the sub-surface pump stroke. For example, if the bottom four feet of the stroke of the subsurface pump are associated with a badly worn condition of the cylindrical surface in which the pump swab or element slides, the bottom limit of the pump stroke can be elevated out of that range by adjustment of the bottom limit pin.

Acceleration control valve **68** has an adjustable position which controls the acceleration of the sub-surface pump to maximum up and down velocity, as indicated by the slopes at **76** and **77** of the performance curve in FIG. **3**. This corresponds to the rate at which the regulator **46** is shifted to its final position in either direction, by actuator **57**, the rate at which actuator **57** shifts being controlled by the valve **68**. Valve **68** can be adjusted in the field or fixed at the factory, and locked, to prevent tampering.

If at any time the operator wishes to shift the regulator **46** manually, he simply operates the by-pass valve **80** which by-passes fluid pressure from either one of lines **66** and **67** to the other; this then allows him to move the rod **63** manually to shift rod **47**.

The second control means may include a second actuator **84** to control the displacement of the limiter **56** as for example in directions indicated by arrows **85** in FIG. **2**, thereby to control the rate at which the subsurface valve is stroked. Spring **137** resists upmovement of the limiter **56**. Also included is what may be referred to as means for supplying fluid pressure to the second actuator **84** in correspondence to the pressure to supply fluid delivery to the motor or converter **40**. See in this regard, the sensing valve **87** which intermittently samples the pressure in line **86**, alternately connected by valve **110** with lines **43** and **45**, and also transmits that pressure via line **88** to the piston in actuator **84**. The timing of such sampling is controlled by rotation of rotor **71**; for example, a pin **188** on that rotor may intermittently contact a spring urged lever **89** which then shifts valve **87** for a brief interval to send the line pressure to actuator **84**, the spring **90** restoring the valve **87** to a non-sampling state. Valve **87** is actuated when the rotor **71** turns counterclockwise, and at a point **91** in the lifting cycle (seen in FIG. **3**) when maximum pressure is delivered to lines **16** and **86**; however, valve **87** is not actuated when the rotor turns counterclockwise. Valve unit **110** connected between lines **43** and **45** bleeds the higher pressure in either to line **86**. A pressure sensor **190** is located in line **86**. In regard to sampling, as described, when the fluid level in the well deviates from the norm, established by selective counterbalancing as described, the motor or converter **40** will labor, and the pressure of the hydraulic fluid in sampling line **86** will correspondingly change (increase or decrease). It is this pressure change which is continuously sampled for operating the controls, as described.

It should be noted in FIG. **2** that when the limiter **56** is in uppermost position, the pin **59** is confined to center position against travel, the regulator **46** will be in neutral position and no hydraulic fluid will flow to the drive motor **40**. When limiter **56** approaches uppermost position, it actuates limit sensor **125** which operates a device **126** such as a relay which shuts down the entire system. This will occur at a predetermined minimal oil flow from the underground formation to the pump **13**, which cannot fill the pump even at its slowest operating speed (this corresponds to a correspondingly high pressure in line **86**).

An hydraulically operated brake **127** connected at **128** with line **86** will sense breakage of the cable **14**, or cable **27**, as by loss of pressure, and automatically apply the brake to the drive input shaft **139**, thereby to prevent runaway and further damage to the equipment.

Hydraulic motor **160** in FIG. **2** is for emergency use; it will normally run at a much higher torque and lower speed than motor **40**; and it is used as during maintenance or repair of the sub-surface pump or counter weighting apparatus. When so used, chain **161** is installed to couple from motor **160** to the pulley **162** on the shaft of motor **40**. This requires removal and replacement of chain **141**, assuring that only one motor can be operated at a time. Also, selector valve **163** must be shifted to supply hydraulic pressure to motor **160** via lines **164** and **165** communicable with lines **43** and **44**, and to disconnect lines **146** and **45** from the latter.

As will be appreciated, the equipment is capable of pumping the well fluid down faster than the fluid can enter the well bore from the formation; it is capable of so pumping until the fluid level in the well reaches a norm predetermined by selected counterbalancing; and it is capable, through sampling, to slow down or speed up the pumping action so as to pump only at such rate as is required to capture fluid entering the well bore. Therefore, it is the rate of fluid entry into the well bore from the formation that controls the surface equipment, all without any down-hole sensing equipment.

We claim:

1. In a system to automatically adjust the pumping of a well to control the actual level of production fluid freely standing in the well and above the pump, the combination with a reversible main drive the output displacement of which effects vertical stroking of a sub-surface well pump and of a rod string extending from the well head to the pump, of:

a. first control means for reversing the main drive at predetermined limits corresponding to upper and lower limits of the well pump stroke, and

b. second control means for controlling the rate of said displacement of the main drive in response to changes in said actual level in the well from a predetermined level by increasing the rate of said displacement of the main drive in response to rising of said actual level above said predetermined level, and decreasing the rate of said displacement of the main drive in response to dropping of said actual level, below said predetermined level, said main drive and said second control means located at the well head.

2. The combination of claim **1** wherein said main drive includes a reversible hydraulic motor and supply means to supply hydraulic fluid to the motor at a rate controlled by said second means and characterized in that the supply rate increases as said actual level increases, and the supply rate decreases as said actual level decreases.

3. In a system to automatically adjust the pumping of a well to control the actual level of production fluid in the well, the combination with a reversible main drive the output displacement of which effects vertically stroking of a sub-surface well pump of:

a. first control means for reversing the main drive at predetermined limits corresponding to upper and lower limits of the well pump stroke, and

b. second control means for controlling the rate of said displacement of the main drive in response to changes in said actual level in the well from a predetermined level,

c. said main drive including a reversible motor, and supply means to supply hydraulic fluid to the motor at a rate controlled by said second means and characterized in that the supply rate increases as said actual level increases and the supply rate decreases as said actual level decreases, and

d. said first control means including a flow regulator movable to proportionally control the rate of hydraulic fluid supply to the motor via said supply means, and said second control means controlling the extent of movement of the regulator.

4. The combination of claim **3** wherein said first control means includes a first actuator, and said second control means includes an adjustable limiter to limit movement of the flow regulator, a second actuator to adjust the limiter, and means to supply fluid pressure to the second actuator in correspondence to the pressure of said hydraulic fluid supply to the motor.

5. The combination of claim **1** including a counterbalancing assembly connected with the main drive to counterbalance the weight imposed on the main drive by the well pump, the drive connection to the pump, and production fluid in the well.

6. The combination of claim **4** wherein said means to supply fluid pressure to the second actuator includes a pressure line to receive the pressure of hydraulic fluid supply to the motor, and structure synchronized with the operation of the main drive to sample the pressure in said line when the well pump is stroking upwardly.

7. The combination of claim **6** wherein said structure comprises a rotor reversibly driven in synchronism with said main drive, and a pressure gating valve in said line and operated in response to turning of the rotor.

8. The combination of claim **3** wherein said first control means includes a first reversible actuator to move the regulator, ducting to supply auxiliary fluid pressure to the first reversible actuator, and a reversible valve operable in synchronism with the operation of the main drive control to control auxiliary fluid pressure supply to the first actuator for reversing the displacement thereof.

9. The combination of claim **8** wherein the first control means includes a rotor driven in opposite directions in synchronism with the main drive, and adjustable means to control reversing of the valve in response to rotation of the rotor.

10. The combination of claim **9** wherein said adjustable means comprises pins carried by the rotor for position adjustment thereon.

11. The combination of claim **3** including means to supply to the second control means the pressure of hydraulic fluid supply to the motor in either of two lines, corresponding to forward and reverse drive of the motor.

12. In a system to automatically adjust the pumping of a well to control the actual level of production fluid freely standing in the well and above the pump, the combination with a reversible main drive the output displacement of which effects vertical stroking of a sub-surface well pump of:

a. first control means for reversing the main drive at predetermined limits corresponding to upper and lower limits of the well pump stroke, and

b. second control means for controlling the rate of said displacement of the main drive in response to changes in said actual level in the well from a predetermined level by increasing the rate of said displacement of the main drive in response to rising of said actual level, and decreasing the rate of said displacement of the main drive in response to dropping of said actual level,

c. there being counterbalancing structure near the well surface which counterbalances weight exerted by a column of fluid pumped upwardly in the well by said pump, the amount of counterbalance remaining fixed during operation of said first and second control means, for establishing said predetermined level.

13. In a system to automatically adjust the pumping of a well to control the actual level of production fluid freely standing in the well and above a pump being vertically stroked, the improvement which comprises

a. means responsive to the fluid level in the well to control the rate of pumping of the well by controlling the vertical speed of said stroking so as to maintain said actual level near a predetermined level, and

b. means for controlling the length of said stroking.

14. The system of claim **13** wherein the system includes pumping structure movable up and down in the well, and counterbalancing structure near the well surface counterbalancing the weight of said pumping structure and a column of well fluid pumped upwardly in the well by said pumping structure.

15. In the method of adjusting the pumping of a well to control the actual level of production fluid freely standing in the well and above a pump and rod string being vertically stroked, the steps that include

a. sensing, at the surface of the well, the well pumping requirements as imposed by the actual level of fluid in the well, and

b. controlling the rate of pumping by controlling the vertical speed of said stroking at the well head and in response to such sensing thereby to increase said speed in response to rising of said active level above a predetermined level and to decrease said speed in response to dropping of said actual level below said predetermined level so as to maintain said actual level near said predetermined level.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,807,902 Dated April 30, 1974

Inventor(s) Donovan B. Grable and Bill C. Laney

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, line 19; "speed in response to rising of said active level" should read -- speed in response to rising of said actual level --

Signed and sealed this 19th day of November 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.