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APPARATUS FOR COMPENSATING FOR GRADUAL CHANGES IN LOAD ON A WALKING BEAM PUMP

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Fig. 1.

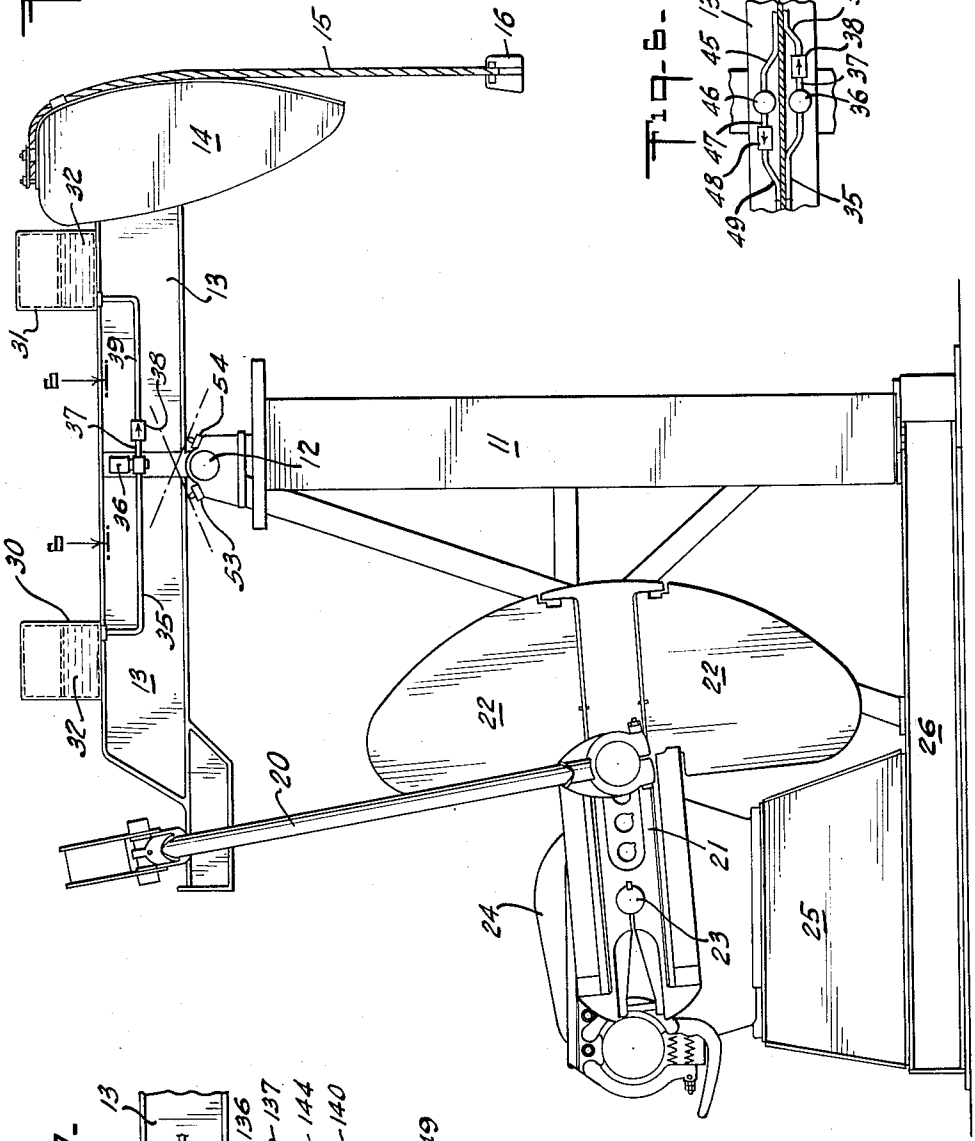
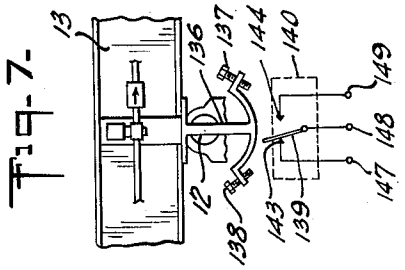


Fig. 6.

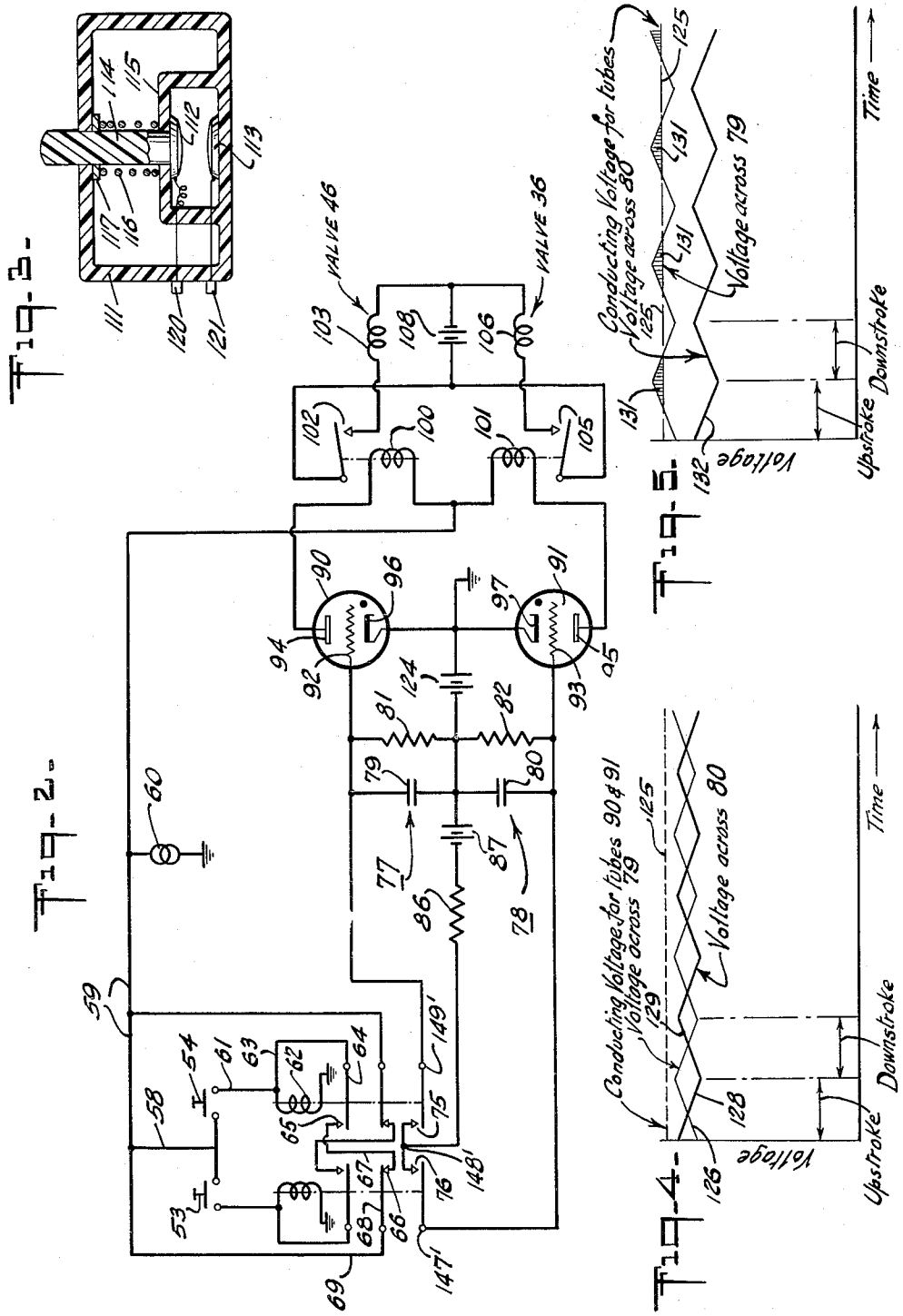
Fig. 7.



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APPARATUS FOR COMPENSATING FOR GRADUAL CHANGES IN LOAD ON A WALKING BEAM PUMP

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3,016,767

APPARATUS FOR COMPENSATING FOR GRADUAL CHANGES IN LOAD ON A WALKING BEAM PUMP

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9 Claims. (Cl. 74—589)

This invention is concerned with oil well pumping in general, and more specifically with an improvement for use with oil well pumps of the walking beam type.

Oil well pumps of the walking beam type employ various counterbalance arrangements which operate in such a manner that the load on the prime mover is equalized between the pumping and the return strokes. The problem for thus counterbalancing pumps of this type, involves a counterbalance for equalizing the weight of the sucker rod string, in addition to providing a balance between the load applied during the pumping stroke as against the load that exists during the return stroke. One of the most often employed arrangements is that which uses a weighted crank for rocking the walking beam up and down. The weight is so adjusted that the prime mover or driving motor must raise the weight up, to the top of the crank rotation, during the return stroke of the pump. In this way, a load is applied on the prime mover to lift this weight (since it exceeds the dead weight of the sucker rod string and pump elements), during the return stroke. While during the pumping stroke, this same weight (in falling from the upper position thereof to the lower) acts to aid the prime mover in applying lifting force for raising the sucker rod string, in addition to the column of oil that is being pumped during the pumping stroke. It is quite common to have the arrangement made so that adjustment may be made of the radial position for the counterweights that are carried on the crank arm. By providing such an adjustment, the rotating counterweight elements may be set for a given pumping load so that the pumping and return strokes will be substantially equal as to the load applied to the prime mover. However, with this arrangement, it is necessary to stop the pumping operation in order to make any additional adjustments should the pumping load change.

There has been suggested an arrangement for overcoming the above-indicated necessity of stopping the pumping operation in order to adjust the counterbalance for changes in pumping load. However, the suggested arrangement involved a complicated mechanism. In addition, the suggested arrangement was not applicable to the most commonly used type of walking beam pump, such as that generally described above. It was only applicable to a special structure in which the walking beam element must be counterbalanced by means of a fluid pressure piston arrangement.

Consequently, it is an object of this invention to provide an automatic compensation adjustment for walking beam type oil well pumps, which will continuously make adjustment to compensate for changes in the pumping load. The system according to this invention is at the same time simple, reliable and trouble-free.

Another object of the invention is to teach a system for continuously compensating for gradual changes in the pumping load. Such apparatus involves a shifting of the application of weights to opposite sides of the pivot for the walking beam. This shifting of weights is carried out automatically and continuously as the pumping load changes to compensate for such changes and thus maintain the load on the prime mover equalized for both pumping and return strokes.

Briefly, this invention is concerned with apparatus for reciprocating a pump plunger. Such apparatus includes a walking beam attached to said plunger at one end of said beam, and a prime mover for rocking said beam about a pivot, as well as a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger. In such an arrangement of elements, the invention consists of the combination of a fluid container means attached to said walking beam on opposite sides of said pivot. The combination also includes timing means for detecting unbalance between said pumping and said return strokes, and means controlled by said timing means for causing fluid to flow from one of said container means to the other until balance has been restored between the pumping and return strokes of the plunger.

The foregoing and other objects and benefits of the invention will be made clear by the following more detailed description which is illustrated in the drawings, in which;

FIG. 1 is a side elevation, illustrating a walking beam type oil well pump, having the added elements in accordance with this invention thereon;

FIG. 2 is a circuit diagram, illustrating an electrical control system for use with the elements as shown in FIG. 1;

FIG. 3 is an enlarged, schematic, cross-section view of one of the switches employed for determining the extreme positions of the walking beam;

FIG. 4 is a graph illustrating the action of the electrical elements employed in the FIG. 2 circuit;

FIG. 5 is another graph illustrating the conditions of the same electrical elements, under unbalanced pumping conditions;

FIG. 6 is a cross-sectional, detail, plan view taken along the lines **6—6** of FIG. 1 looking in the direction of the arrows; and

FIG. 7 is a fragmentary view of the walking beam, showing a modified switching arrangement.

Referring to FIG. 1, it will be observed that there is illustrated one of the commonly employed styles of walking beam type pumps that are commonly used in oil well pumping installations. The well-known elements of this type of pumping equipment include a Sampson post **11** for supporting a pivot shaft **12** about which a walking beam **13** is pivoted for a rocking motion. At one end of the walking beam **13**, there is a horsehead element **14** for attaching the sucker rod string (not shown) that extends into the well for connecting the pump (not shown) in such a manner that no sideways pull will be exerted on the sucker rod string as the walking beam **13** moves up and down. There is a flexible cable **15** that is attached at the top of the horsehead **14** and has the lower end thereof coupled to the non-illustrated sucker rod string, by any convenient type of coupling element such as a coupling **16** illustrated.

At the other end of the walking beam **13**, there is attached, in a pivotal manner, a pitman assembly **20** that connects a crank arm **21** with that end of the walking beam **13**, in order to transform rotary motion of the crank arm **21** into rocking movement by the walking beam **13**. Also attached to the crank arm **21**, there is a pair of counterbalance weights **22**, which rotate through the circular path indicated by a dashed line, showing the clearance circle therefor.

The radial position of the counterbalance weights **22**, may be adjusted relatively to a drive shaft **23**. However, the details of such adjustment form no part of this in-

vention and will not be described. It will be noted, however, that such adjustment must be carried out when the pumping action is at a standstill, since this adjustment is made and set by bolts located along the crank arm **21**.

The prime mover, which drives drive shaft **23**, may take any convenient form such as an electric motor **24** that is mounted on a pedestal **25**, which is in turn supported on a framework **26**. Framework **26** supports the entire mechanism including the Sampson post **11**.

It will be noted that the walking beam type pump structure, so far described, may be adjusted so that the load, as applied to the coupling **16** and transmitted back to the drive shaft **23**, is equalized as between the pumping and return strokes. The pumping stroke may be defined as the movement of coupling **16** upward from its lowermost position to its uppermost position; and the return stroke may be defined as the return movement thereof from its uppermost position to the lowermost position again. Such equalization or counterbalance, is carried out by providing the counterweights **22** with a sufficient weight and moment arm such that the downward movement of these counterweights **22**, will be aiding the pumping stroke as it lifts the elements attached to coupling **16**, but will not be in excess thereof. Then on the return stroke, the counterweights **22** must be lifted so that their effect is applied to counteract the negative load applied to coupling **16**. Thus the net effect provides for a positive load on the drive shaft **23**, which is adjusted to be equal to that positive load that existed during the preceding pumping stroke. In the absence of this arrangement, or something similar thereto, the return stroke would be a negative load on the drive shaft **23** and the range of load variation would be extremely great with a consequent high shock load and wear effects on the moving parts.

Even though the counterweights **22** have been accurately adjusted for a given load, to provide an equalized drive shaft load during pumping and return strokes, the pumping load will often vary over a period of time so that an imbalance will result due to such pumping load change. In accordance with this invention, it is contemplated that an adjustment may be made of the application of counterbalancing weights located on opposite sides of the pivot shaft **12** of the walking beam **13** in order to compensate for any changes in the pumping load as they occur.

A particular embodiment for carrying out the invention is illustrated in FIG. 1 as including a pair of fluid tanks **30** and **31**, which are each attached to the upper surface of the walking beam **13**. Beam **13** may conveniently be in the form of an I-beam. These tanks **30** and **31** are preferably located about equi-distant on either side of the pivot **12**. Within the tanks **30** and **31**, there is carried a sufficient quantity of an appropriate fluid **32**, such that when the walking beam **13** is level and the fluid has reached equilibrium, each of the tanks **30** and **31** will be about half full. This liquid, or fluid, **32** may be any feasible fluid having sufficient weight to provide the required counterbalance effects for compensating for pumping load changes that are to be expected for a given installation.

The necessary shifting of fluid **32** from one of the tanks **30** or **31** to the other, may be carried out in various ways in accordance with the invention. One specific arrangement that may be employed, includes two fluid circuit connections between the tanks **30** and **31**, one of which is in view in FIG. 1. Thus, one fluid circuit connection includes a tube or pipe **35** that is directly connected to the bottom of the tank **30**, and carries fluid **32** therein. Tube **35** is connected at the other end thereof to one port of a solenoid-operated valve **36**, preferably of a type that is closed when not energized and open when the solenoid thereof is energized. Connected to the other port of solenoid valve **36**, there is a short length of tube **37** that has the other end thereof connected to one end of a check valve **38**. Check valve **38** acts to allow passage of fluid only in the direction indicated by the arrow, i.e., from tank **30** to tank **31**. At the other end of check valve **38**, there is a tube **39** which completes a fluid circuit connection to the bottom of the tank **31**.

Referring to FIG. 6, it will be observed that there is a substantially duplicate set of elements located on the other side of a center web **42** of the walking beam **13**. Thus, there is a tube **45** connected to the bottom of tank **31** and also connected to one port of another solenoid valve **46**, which corresponds to valve **36**. Solenoid valve **46** has the other port thereof connected by a short length of tube **47**, to a check valve **48**, that is connected for allowing passage of fluid only in the opposite direction from fluid passage through check valve **38**, i.e., from tank **31** to tank **30** as indicated by the arrow. Finally, there is a tube **49** which connects the other end of check valve **48** with the bottom of tank **30**.

Referring again to FIG. 1, it will be noted that there is a pair of push-button type switches **53** and **54** which are actuated by the lower surface of the walking beam **13** as it reaches its extreme rocking positions, i.e., when it is tipped the maximum amount in each direction, or at the beginning and end of each of the pumping and return strokes. These switches **53** and **54** act in an electrical control circuit for determining the action of solenoid valves **36** and **46**.

Referring to FIG. 2, the elements of a circuit for controlling the action of solenoid valves **36** and **46** will be described. The various elements involved in the electrical control circuit include the switches **53** and **54** which have one terminal of each, connected together, and in common (via a wire **58** and another wire **59**) to the ungrounded terminal of an A.C. current supply source **60**, schematically indicated. The other terminal of each of the switches **53** and **54** is connected in a separate but similar relay circuit, so that only one of these circuits need be indicated in detail. Thus, from the other terminal of switch **54**, there is a circuit via a wire **61** to one end of a relay coil **62**. The other end of relay coil **62** is connected to ground as illustrated. In addition, there is a holding circuit for the relay coil **62** which may be traced as follows: beginning at the ground connection shown and continuing over the coil **62**, thence via a wire **63** to a switch blade **64** of the relay. Blade **64** is biased to the illustrated position out of contact with a contact **65**, when the relay coil **62** is not energized. The holding circuit may be continued from the contact **65** to a contact **66**, on the other relay, via a wire **67**. A switch blade **68** is biased into contact with contact **66** so long as the relay is de-energized. The holding circuit then may be continued on via a wire **69**, which is connected to the power supply wire **59** that leads to one side of power source **60**, the other side of which is grounded. Thus whenever switch **54** is closed, relay coil **62** will be energized and will actuate its contacts to close a holding circuit for maintaining this state of energization (that includes normally closed contacts on the other relay) until the other relay (which is in circuit with the other switch **53**) is energized. Therefore, relay coil **62** will be energized at the beginning of a pumping stroke and will remain energized until the end of such stroke (or the beginning of a return stroke) as determined by the closing of the other switch **53**. It will be clear that the same operation takes place with the other relay, under control of the closing of switch **53**.

For making use of this timing of the pumping and return strokes, there are two sets of normally open contacts **75** and **76**, one on each of the relays controlled by switches **54** and **53** respectively. These contacts **75** and **76** are each in circuit with one of a pair of RC circuits **77** and **78** respectively. RC circuit **77** includes a capacitor **79**, and RC circuit **78** includes a capacitor **80** therein. Connected across capacitor **79**, i.e., in paral-

lel therewith, there is a resistor **81**; and likewise, connected across capacitor **80**, there is a resistor **82**. Connected in series with each of the capacitors **79** and **80** alternatively (via the contacts **75** or **76**) there is a resistor **86** that is in series with a voltage source, such as a battery **87** indicated.

Connected to receive the voltages existing across the capacitors **79** and **80** of the RC circuits **77** and **78**, is a pair of triode electron tubes **90** and **91**. Although these tubes **90** and **91** might take various other forms, it is preferred that they be gas tubes in the nature of thyratrons, as indicated by the gas tube symbols. Each of these tubes has a grid **92** and **93** respectively, in addition to a plate **94** and **95** respectively. Furthermore, there is of course a cathode **96** and **97** respectively on the tubes **90** and **91**. Connected in the plate circuit of each of the tubes **90** and **91**, there is a relay coil **100** and **101** respectively. Relay coil **100** actuates a pair of normally open contacts **102**, for energizing a solenoid **103** of the solenoid valve **46**. Similarly, there is a pair of normally open contacts **105** actuated by the relay coil **101** to closed position when it is energized. These contacts **105** are in controlling circuit relation with a solenoid **106**, that is the solenoid for actuating the other of the solenoid valves, viz. valve **36**. It will be observed that there is a separate source of power, such as a battery **108** indicated, for energizing the solenoids **103** or **106** in accordance with the closing of the controlling circuits for each.

Referring to FIG. 3, it is pointed out that a suggested structure for the switches **53** and **54**, is here illustrated. It is to be noted that many different switch structures might be employed, and that that illustrated is largely schematic in nature as well as merely illustrative in intent. There is shown a main housing **111** which supports and encloses a pair of electrical contacts **112** and **113**. Contact **112** is supported, for movement therewith, on the end of an insulating material plunger **114** which is slideably supported by a hole through the top of the housing **111**, and a similar hole in the top of an inner support structure **115**. The plunger **114** is urged to the upper position, as viewed in FIG. 3, by means of a coil spring **116** which bears against the outer surface of the top of support structure **115**, and also against a flange **117** attached to the plunger **114**, so that spring **116** is compressed when the plunger **114** is depressed, e.g., by pressure applied to the tip or outer extremity thereof. Contacts **112** and **113** are electrically connected to a pair of terminals **120** and **121** respectively by electric wires, as illustrated.

Operation

The operation of the system may best be described by beginning with the electric circuit which will be described in connection with the graphs illustrated in FIGS. 4 and 5. In general, the operation of the fluid flow control system is that of timing the period for each pumping cycle, and for each return cycle, in such a way that whenever one of these two cycles exceeds the other in duration, the circuit arrangement will cause one of the tubes **90** or **91** to fire so that current is passed through the corresponding relay coil **100** or **101**. This energizes the coresponding solenoid **103** or **106** so that the solenoid valve with which the energized solenoid is associated, will be opened. Consequently, so long as this valve remains open, the fluid **32** may flow through the connecting tubes and via the check valve that are associated with this valve **36** or **46**, and thus redistribute the weight of fluid **32** existing in the two tanks **30** and **31**. This redistribution of the fluid **32** will be in the proper direction for changing the balance of the fluid **32**, so as to counterbalance the changes in pumping load which have caused the difference in time between the two pumping and return stroke periods. Therefore, a balanced condition will be automatically reestablished.

In order to carry out the above general operative conditions, tubes **90** and **91** are connected in parallel to an A.C. plate supply obtained from A.C. source **60**. This A.C. source **60** may be any convenient alternating current supply, such as the usual sixty cycle power available generally throughout this country. The voltage of the plate supply may desirably be increased by means of a transformer (not shown) in order to provide better operating conditions. By employing an A.C. supply on the plates of tubes **90** and **91**, the control of whether or not these tubes pass current during positive cycles of the plate supply, may be in the nature of a D.C. voltage. Thus, should the grid voltage of either of these tubes rise above the critical value so that tube fires, it will only continue to fire so long as such grid voltage is maintained above such critical value. In other words, as soon as the voltage applied to the grid of either of these tubes falls below the critical value, such tube will stop firing, and no longer conduct until the grid voltage again rises above such value.

It is pointed out that there is a grid bias E.M.F. applied to the grids **92** and **93**, which may be any feasible D.C. voltage, e.g., that supplied by a battery **124** illustrated.

Referring to FIGS. 4 and 5, the illustrated graphs show the relationship between time as the abscissa, and voltage as the ordinate. As indicated by the captions, the bias voltage, i.e., battery **124**, is set to a level as indicated by a dashed line **125** on each of the graphs. This means that whenever the grid voltage applied to either of the tubes **90** or **91** exceeds the amplitude of the fixed bias voltage indicated by dashed line **125**, the tube will fire and pass current, during each positive half cycle of the plate supply. Now by predetermining the relative values for the elements of RC circuits **77** and **78**, the grid voltages on the grids of tubes **90** and **91** may be made to act in the manner illustrated in FIG. 4; so long as the charging and discharging periods for capacitors **79** and **80** (of the RC circuits **77** and **78**) remain equal.

Thus as a specific example, beginning with a pumping stroke, the switch **54** will be closed as the walking beam **13** reaches the bottom of its downward stroke (considering the free-end thereof that is coupled to the well pump via cable **15** and coupling **16**). Therefore, at the beginning of a pumping stroke, the relay coil **62** will be energized and switch contacts **75** will be closed. This will close a circuit for charging capacitor **79** so that it will rise toward the voltage of battery **87**, with a time constant (or rate of charge) determined by the capacitance of capacitor **79** and the resistance of resistor **86**. (This charging condition is represented on the FIG. 4 graph by a line **126**. Then at the end of this pumping stroke, i.e., when the walking beam reaches the top of its swing (considering the free end thereof) switch **53** will be closed and this will energize the other relay that is in circuit therewith so that contacts **76** will be closed, at the same time as contacts **75** are opened. Reaching the top of a swing marks the beginning of a return stroke, or the ending of the pumping stroke just described, and it will be noted that the highest point on the line **126** is still below the critical level indicated by dashed line **125**.

Continuing to follow the conditions with respect to capacitor **79**, it will be observed that the voltage applied across this capacitor will then begin to fall, at approximately the same rate as it rose during the charging period just preceding. This falling voltage condition is illustrated in FIG. 4, by a line **127**. It will be noted that the fall in voltage which thus takes place, is determined by the values of capacitor **79** and bleeder resistor **81**, which latter is connected across the former.

It will be observed that during the same two pumping and return strokes, just described, the other capacitor **80** will have the voltage applied thereacross acting similarly but in the opposite direction. This is true because, during the first described pumping stroke, capacitor **80** is disconnected from the voltage of battery **87** (contacts **76** are open); and it is being discharged at a rate deter-

mined by the resistance of resistor **82**. This may be represented by a line **128** which crosses line **126** on the graph of FIG. 4. Furthermore, similarly but in opposite manner, a line **129** represents the conditions as to the voltage applied across capacitor **80** during the return stroke described above. It will be further observed that the maximum voltage reached by either capacitor **79** or capacitor **80** (and consequently by the corresponding grid **92** or grid **93** that is connected thereto), remains always less than the value of voltage necessary to cause the tubes **90** or **91** to conduct. Such value is indicated on the graph by the dashed line **125**.

In FIG. 5, the graph illustrates conditions after an unbalance has existed between the pumping load and the counterbalance arrangement (excluding the effects of fluid **32**). Here it is pointed out that by reason of the unbalance having occurred, the time for completing a pumping stroke will have been increased while the time for completing the succeeding return stroke will have been correspondingly decreased. Thus, the voltage applied across capacitor **79** will have increased more than it decreased during each unbalanced complete cycle of a pumping and a return stroke. Therefore, the voltage across capacitor **79** will have increased to the extent that for at least part of the pumping stroke, the voltage applied to the grid **92** of tube **90** is above the critical voltage indicated by dashed line **125**. Consequently the tube **90** will become conducting throughout a period indicated by shaded portions **131** of the FIG. 5 graph. At the same time as the voltage across capacitor **79** has thus increased so as to rise above critical value **125**, the voltage across capacitor **80** will have decreased and thus tube **91** will remain non-conducting as indicated by a line **132** on the graph of FIG. 5.

It will be noted that under the conditions illustrated by the graph of FIG. 5, the tube **90** is rendered conducting for a period beginning about midway through the pumping stroke and continuing to the succeeding period about midway through the succeeding return stroke. Thus, during this time, the corresponding solenoid **103** will be energized via its relay contacts **102** and the valve **46** controlled thereby will be opened to allow transfer of the fluid **32** from tank **31** to the tank **30**. Such transfer of the fluid will reduce the weight of fluid remaining in tank **31** and increase the weight existing in tank **30** so that the change in pumping load which caused an unbalance, will tend to be counteracted or counterbalanced by such change. Thus, the full cycle balance for prime mover **24**, as applied via drive shaft **23** (i.e. load during pumping stroke substantially equal to load during return stroke), will be restored as soon as sufficient of the fluid **32** has been shifted in a counterbalancing manner.

No serious problem of "hunting" exists in the making of the shift of fluid **32** from one of the containers **30** or **31** to the other, because the time of the pumping and return strokes is relatively long and the rate of pumping load change is quite slow. Furthermore, by having the threshold value of the bias voltage on tubes **90** and **91** close to the peak voltage on capacitors **79** and **80** when the two strokes are equal, a good sensitivity may be obtained so that a small counteracting shift of fluid **32** will take place immediately upon any unbalance caused by pumping load changes. In addition, if the fluid shifts are not enough to balance these pumping load changes, the amount of fluid shift during each full cycle (both pumping and return strokes) will increase up to a maximum and will continue to be shifted until balance is restored.

It is to be noted that whereas the FIG. 5 illustration provides for the solenoid valve **46** (solenoid coil **103**) to be opened during the time when the walking beam **13** is tipped so that tank **31** is higher than tank **30**, such timing of the valve opening might exceed this desirable time period if the pumping load should change faster than the ability to counterbalance such change by the shifting of fluid **32**. Therefore check valves **38** and **48** are employed so that the shift of the fluid **32** is restricted to the desired direction, even if solenoid valve **36** or **46** should remain open for more than the time when the walking beam **13** is tipped in the correct direction.

It will be observed that there has been set forth a given embodiment of the invention insofar as one set of elements for carrying out the compensation, is concerned.

FIG. 7 illustrates a modification for switching the RC circuits at the beginning and end of each stroke, which would replace the arrangement described above (employing switches **53** and **54** and the relays with holding circuits associated therewith). This modified arrangement contemplates the use of a quadrant bracket **136**, which is bolted in place on the lower surface of the walking beam **13**, and which extends below the center line of the pivot shaft **12**. At the two extremities of the free end of quadrant **136**, there is a pair of adjustable screws **137** and **138** for making contact with a snap action blade **139** of a two position snap action switch **140**. Switch **140** has a pair of stationary contacts **143** and **144** which make contact alternatively with the switch blade **139**. The action of this switch **140** is such that it is of a snap acting type and the blade **139** will remain in contact with either of the stationary contacts **143** or **144** until forcibly displaced far enough to snap over into contact with the other of these two stationary contacts. Consequently a circuit will be closed between a terminal **147** (that is connected to stationary contact **143**) and a terminal **148** (that is connected to the blade **139**) when the blade is in the illustrated position. Otherwise the alternative circuit may be closed, i.e. between terminal **148** and a terminal **149** (that is connected to the contact **144**) when the switch blade **139** is in the other position from that illustrated. Thus, the two circuits are closed in the alternative at the extreme tilting positions of the walking beam **13**.

Now it will be clear that the alternative switch structure illustrated in FIG. 7, may be connected into the electrical circuit of FIG. 2, so as to replace and eliminate switches **53** and **54** in addition to the relay and holding circuits associated therewith. Thus, terminals **147**, **148** and **149** are indicated on FIG. 2 with prime marks employed, indicating that when the snap action switch arrangement according to FIG. 7 is employed, the switches **75** and **76** as well as the relays upon which they are located and the controlling switches **53** and **54**, will be eliminated. The operation of the system remains identical to that described above and no further explanation is deemed necessary.

While certain embodiments have been described in considerable detail in accordance with the applicable statutes, this is not to be taken as in any way limiting the invention but merely as being descriptive thereof.

It is claimed:

1. In an apparatus for reciprocating a member through a power stroke and a return stroke, including a driving element and a counterbalance acting in aid of said power stroke but in opposition to said return stroke for balancing the magnitude of the load on said driving element during said return stroke with respect to said power stroke, the combination of means for applying a pair of opposing forces one in aid of and the other in opposition to said load on the driving element, means for determining unbalance between the magnitude of said load during said return stroke relative to that during said power stroke, and means controlled by said unbalance determining means for reducing one and adding to the other of said pair of opposing forces in order to restore balance between the magnitude of the load during said power stroke and during said return stroke.

2. In apparatus for reciprocating a pump plunger, including a walking beam and counterbalanced drive means for rocking said walking beam about a pivot, the com-

bination of means for applying a pair of opposed moments of force to said walking beam about said pivot, means for detecting unbalanced loads on said drive means between the power and return strokes of said pump plunger, and means controlled by said detecting means for simultaneously adding to one of said moments of force while subtracting from the other in order to restore balance between the loads during the power and return strokes of said plunger.

3. In apparatus for reciprocating a pump plunger, including a walking beam and counterbalanced drive means for rocking said walking beam about a pivot, the combination of fluid container means attached to said walking beam on opposite sides of said pivot, means for detecting unbalanced loads on said drive means between the power and return strokes of said pump plunger, and means controlled by said detecting means for shifting fluid from one of said container means to the other to restore balance between the loads during the power and return strokes of said plunger.

4. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger, the combination of fluid container means attached to said walking beam on opposite sides of said pivot, timing means for detecting unbalance of the load on said prime mover between said pumping and said return strokes, and means controlled by said timing means for causing fluid to flow from one of said container means to the other until balance has been restored between the loads during the pumping and return strokes of the plunger.

5. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger, the combination of fluid container means attached to said walking beam on opposite sides of said pivot, conduit means for providing a fluid connection between said container means, valve means in said conduit means for controlling the direction of fluid transfer between said container means, timing means for detecting unbalance of the load on said prime mover between said pumping and said return strokes, and electrical circuit means controlled by said timing means for actuating said valve means to allow transfer of fluid in the proper direction until balance is restored to the load on said prime mover during said pumping and said return strokes by reason of such transfer.

6. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover beween the pumping and return strokes of said plunger, the combination of fluid containers attached to said walking beam on opposite sides of said pivot, conduits for interconnecting said containers, valve means in fluid circuit with said conduits for controlling the direction of transfer of fluid between said containers, and electrical circuit means including an RC timing circuit for determining an unbalance between said pumping and said return strokes and including means for actuating said valve means to allow transfer of fluid in the required direction in order to restore balance between said pumping and return strokes.

7. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger, the combination of fluid containers attached to said walking beam on opposite sides of said pivot, conduits for interconnecting said containers, valve means in fluid circuit with said conduits for controlling the direction of transfer of fluid between said containers, electrical circuit means for controlling the actuation of said valve means, comprising means for detecting an end point of each of said pumping and return strokes, a pair of RC circuits, means for charging one of said RC circuits during said pumping stroke, means for charging the other of said RC circuits during said return stroke, and means controlled by said RC circuits for actuating said valve means whenever unbalance exists between said pumping and return strokes so that fluid will flow from one container to the other until balance is restored.

8. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger, the combination of fluid containers attached to said walking beam on opposite sides of said pivot, conduits for interconnecting said containers, valve means in fluid circuit with said conduits for controlling the direction of transfer of fluid between said containers, electrical circuit means for controlling the actuation of said valve means, comprising means for detecting an end point of each of said pumping and return strokes, a pair of RC circuits, means for charging one of said RC circuits during said pumping stroke, means for charging the other of said RC circuits during said return stroke, electron discharge means for controlling the supply of actuating current to said valve means, said discharge means being normally biased to a non-conducting state and having said RC circuits connected thereto in order to provide a conducting state dependent upon which RC circuit is charged for the greater period of time, and solenoid means for actuating said valve means to control the flow of fluid in the proper direction so that a balanced condition between said pumping and return strokes will be restored.

9. In apparatus for reciprocating a pump plunger, including a walking beam attached to said plunger at one end of said beam, a prime mover for rocking said beam about a pivot and a counterbalance for equalizing the load on said prime mover between the pumping and return strokes of said plunger, the combination of fluid containers attached to said walking beam on opposite sides of said pivot, conduits for interconnecting said containers, a pair of solenoid operated valves in fluid circuit with said conduits for controlling the transfer of fluid between said containers in each direction, electrical circuit means for controlling the actuation of said pair of valves, comprising a pair of switches actuated by said walking beam at the extreme positions of tilt thereof to determine the extremities of said pumping and return strokes, a pair of RC circuits, means for connecting a potential across one of said RC circuits at the beginning of each of said pumping strokes, means for connecting a potential across the other of said RC circuits at the beginning of each of said return strokes, a pair of electron discharge means one for controlling the supply of actuating current to each of said solenoid valves, means for biasing said discharge means to render them non-conducting, and means for connecting one of said RC circuits to each of said discharge means to render same conducting when the charge exceeds said bias so that whenever said pumping and return strokes become unbalanced one of said valves will be actuated to allow fluid to flow in the proper direction to shift the weight of fluid in said containers so as to balance the pumping and return strokes again.

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