Aug. 25, 1959 E. F. SPEIDEN 2,900,841

PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR

Filed Oct. 20, 1953 6 Sheets-Sheet 1

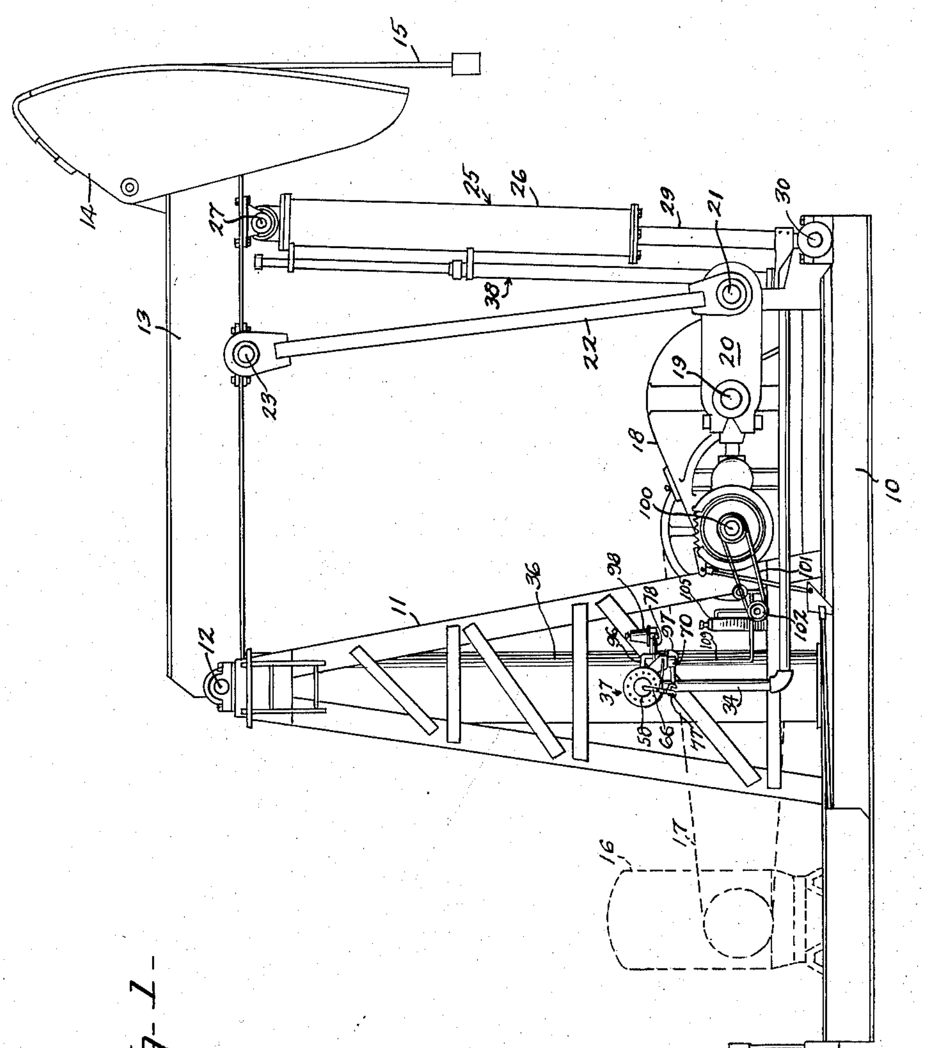
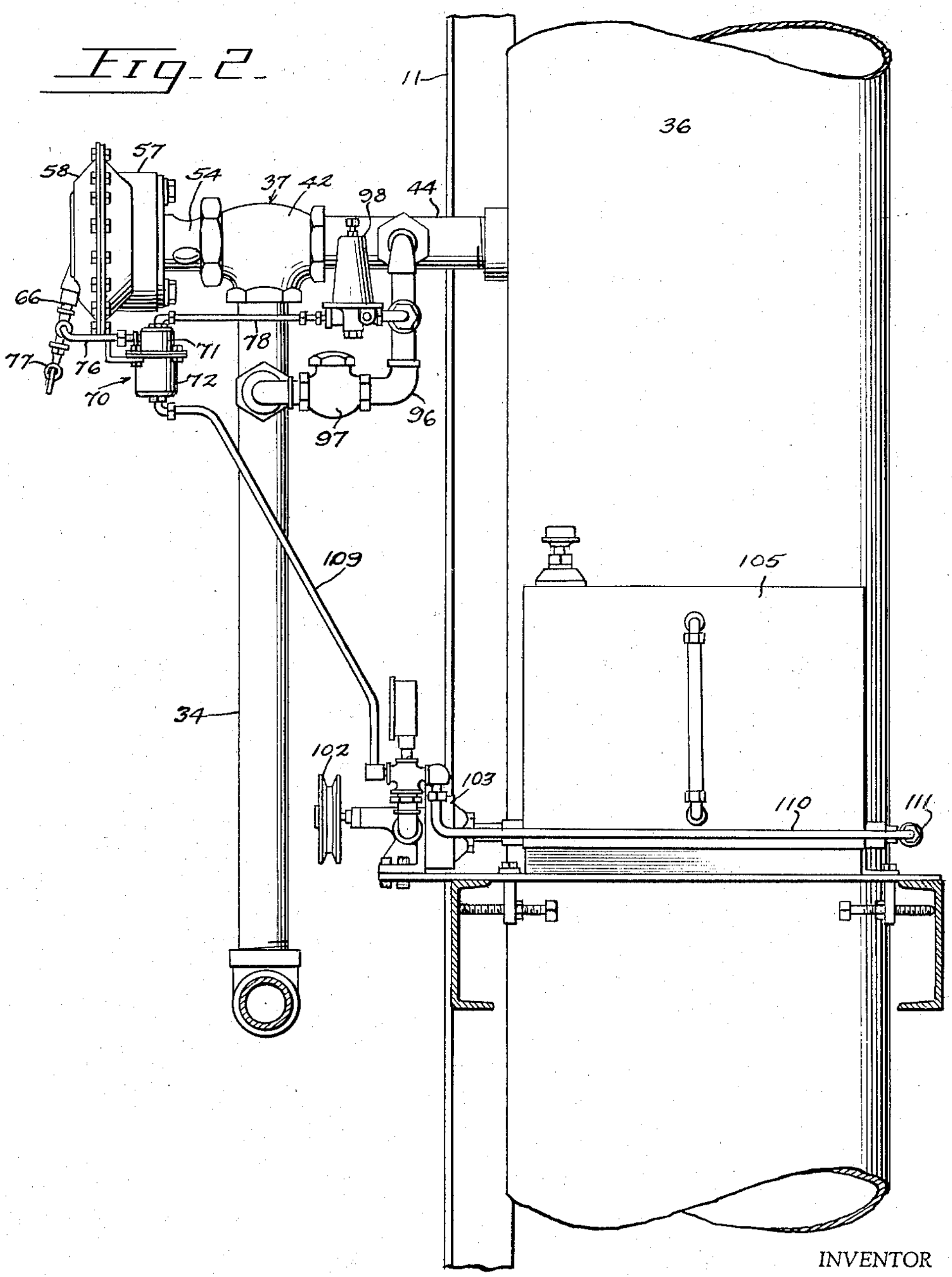


Fig. 1

INVENTOR
EDGAR F. SPEIDEN

BY John V. Phillips
ATTORNEY

Fig. 2



INVENTOR
EDGAR F. SPEIDEN
BY John Y. Phillips
ATTORNEY

PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR

Filed Oct. 20, 1953 6 Sheets-Sheet 3

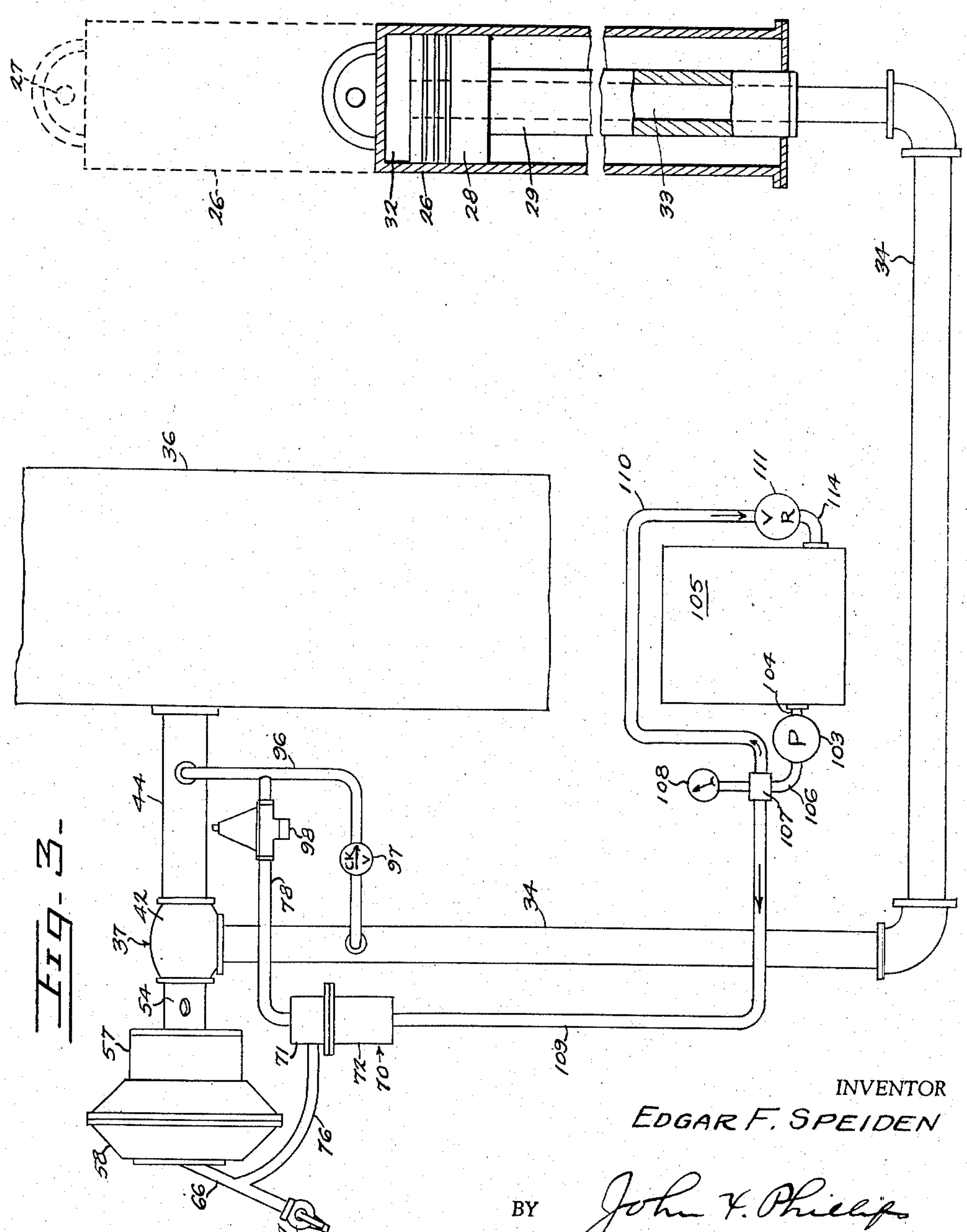


Fig. 3

INVENTOR
EDGAR F. SPEIDEN

BY John V. Phillips
ATTORNEY

Aug. 25, 1959 E. F. SPEIDEN 2,900,841
PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR
Filed Oct. 20, 1953 6 Sheets-Sheet 4

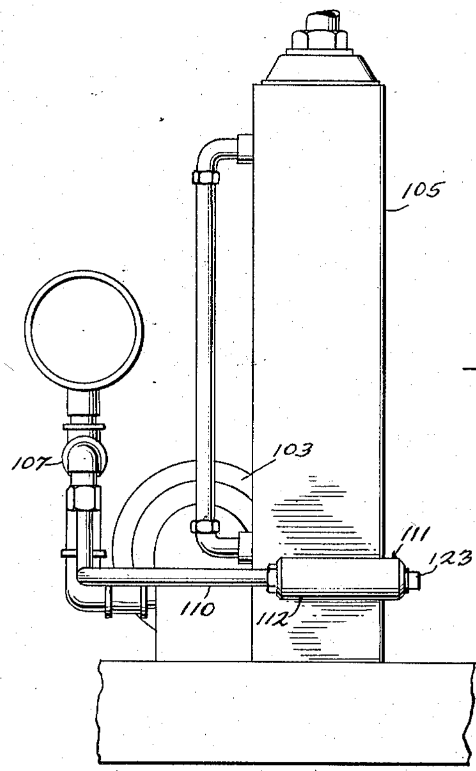
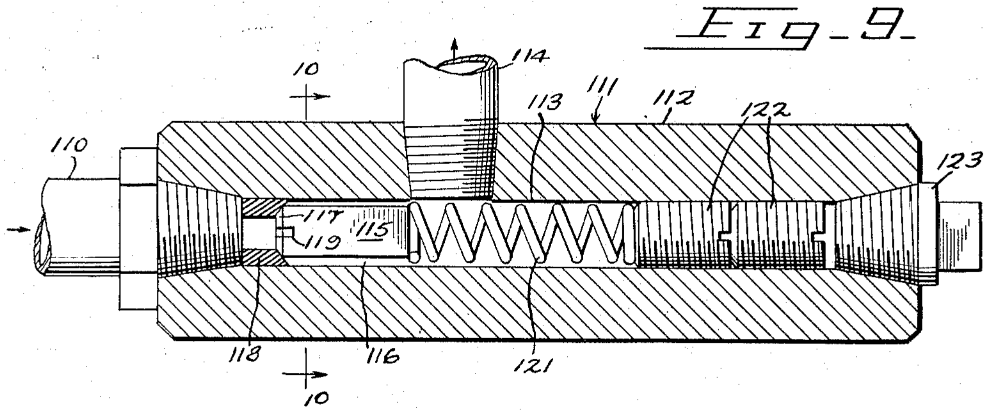


Fig-4-

Fig-9-



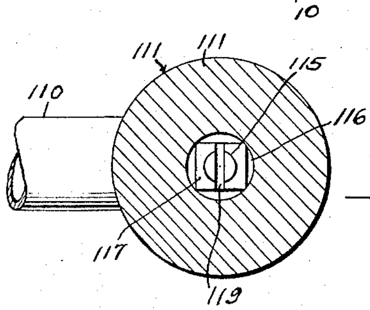


Fig-10-

INVENTOR
EDGAR F. SPEIDEN

BY John V. Phillips
ATTORNEY

Aug. 25, 1959 E. F. SPEIDEN 2,900,841

PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR

Filed Oct. 20, 1953 6 Sheets-Sheet 5

Fig. 7.

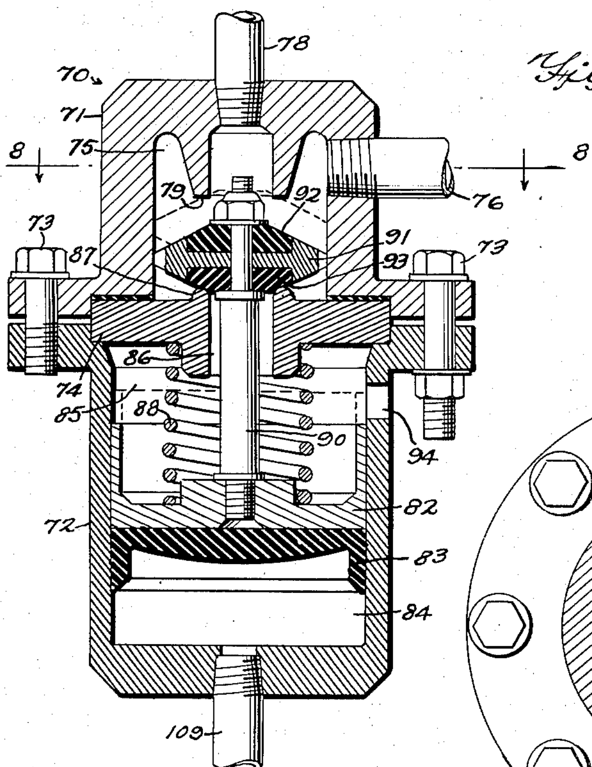


Fig. 8.

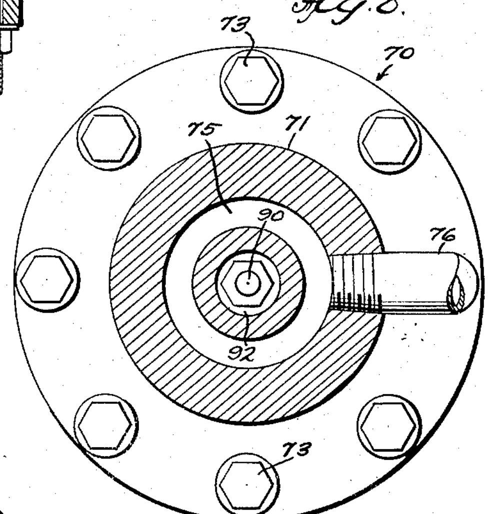
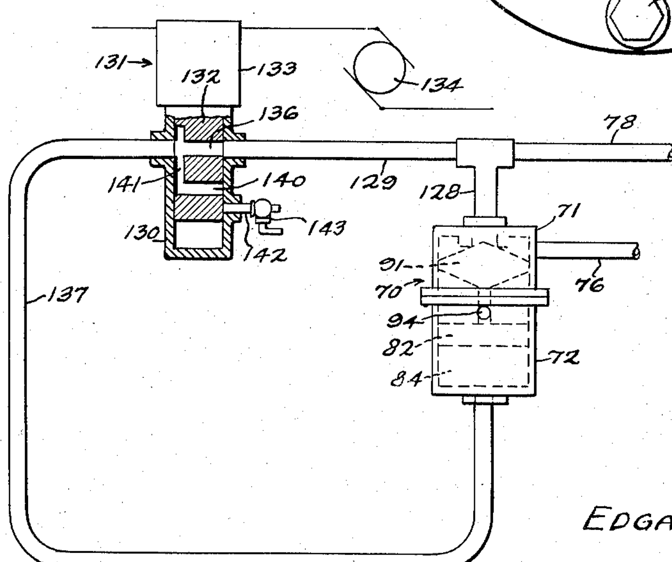


Fig. 11.



INVENTOR

EDGAR F. SPEIDEN

BY John V. Phillips

ATTORNEY

Aug. 25, 1959 E. F. SPEIDEN **2,900,841**

PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR

Filed Oct. 20, 1953 6 Sheets-Sheet 6

Fig. 5.

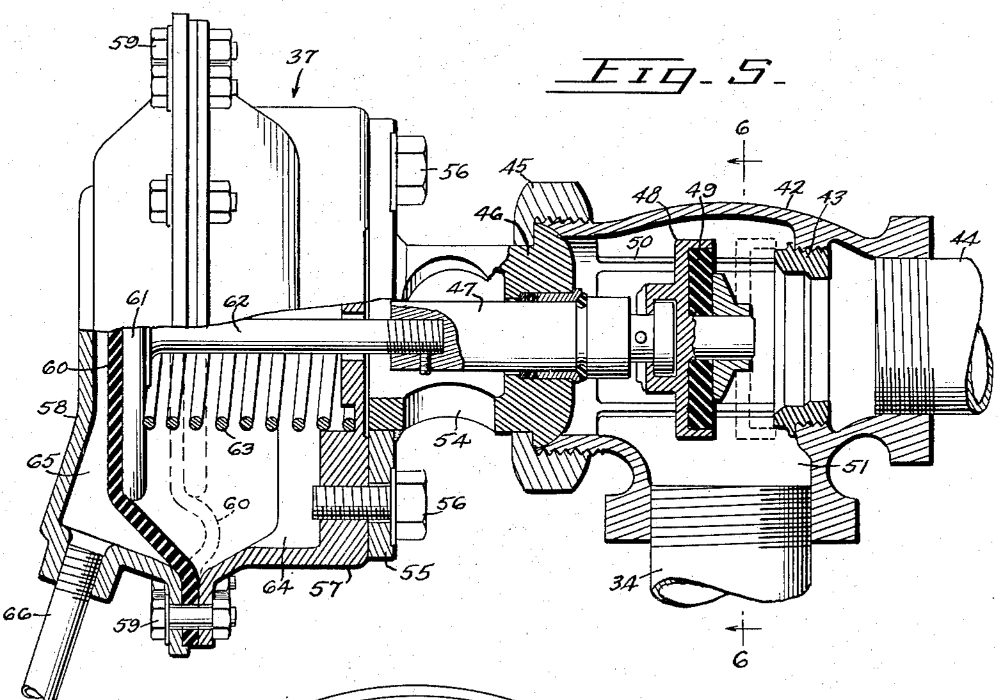
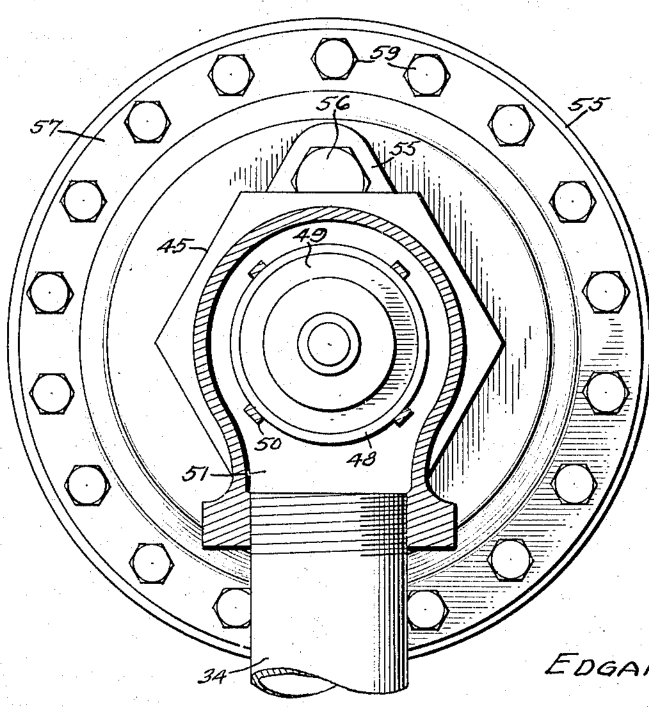


Fig. 6.



INVENTOR
EDGAR F. SPEIDEN

BY John Y. Phillips
ATTORNEY

2,900,841

PNEUMATIC COUNTERBALANCE HAVING A CONTROL MECHANISM THEREFOR

Edgar F. Speiden, Parkersburg, W. Va., assignor to The Parkersburg Rig & Reel Company, Parkersburg, W. Va., a corporation of West Virginia

Application October 20, 1953, Serial No. 387,261

15 Claims. (Cl. 74—589)

This invention relates to a pneumatic counterbalance having a control mechanism therefor, particularly for oil well drilling rigs.

It is now the common practice in the operation of oil well drilling rigs to provide a pneumatic counterbalance for the walking beam, such structure operating to store energy on the down stroke of the rods and to expend energy on the up stroke, as is well known. In one type of such unit in common operation, the capacity of the air for counterbalancing purposes is substantially increased by the use of a receiver communicating with the pressure chamber of the counterbalance. Such receiver is provided with a manually operable cut-off valve to retain air under pressure in the receiver when the pumping rig is shut down for any purpose, for example, for servicing.

It is not unusual for operators to neglect to close the cut-off valve when shutting down a unit. Neither is it unusual for the prime mover on the unit to stop due to power failure or other cause when no one is present to close the shut-off valve. In either case, so much air may escape from the system that considerable additional work is required to start the unit back in normal operation. When the prime mover is an electric motor, it is not uncommon to have the unit operate on a cycle of so many hours of pumping and so many hours idle. Such units are usually controlled by a time clock. In other motor-driven units, the operating cycle may require several days of pumping and several days idle, and such units may be operated from a remote control station. In both cases, there may be no one present to close or open the cut-off valve when the unit is stopped or started.

When, after a shut-down of the unit for any cause, the air pressure drops so low as not to permit the starting of the unit with its prime mover, the well must first be disconnected from the beam and the prime mover then utilized to restore pressure in the system through the compressor operated by the walking beam. The well is then reconnected to the beam and normal pumping operations resumed.

An important object of the present invention is to provide a pneumatic counterbalance system employing a receiver normally connected to the pressure chamber of the counterbalance unit, and to provide such receiver with automatic means for cutting off communication between the receiver and the counterbalance unit, when the unit is shut down, to retain air under pressure in the receiver, thus facilitating the restarting of the unit.

A further object is to provide such a system wherein the automatic control means is responsive directly or indirectly to the operation of the prime mover so as to immediately close communication between the receiver and the counterbalance unit whenever the prime mover ceases operation.

A further object is to provide a novel control valve for controlling communication between the receiver and the counterbalance unit and wherein the control valve is biased to open position to remain in such position during normal operation of the unit, and to provide automatic means, operable whenever the pumping unit ceases operation, to overcome the biasing means of the control valve and close such valve to disconnect the receiver from the counterbalance unit.

A further object is to provide such a system wherein pressure in the receiver is utilized at least partially as the biasing means tending to open the control valve when the unit is started in operation, and wherein the same pressure is utilized automatically when the counterbalance ceases to operate, to close the control valve for the purpose stated.

A further object is to provide such a system wherein the control means lends itself readily to operation by any type of fluid under pressure such as hydraulic pressure, when the prime mover is an internal combustion engine, and to air pressure controlled by a solenoid valve, when the prime mover is an electric motor.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown two embodiments of the invention. In this showing:

Figure 1 is a side elevation of a pneumatically counterbalanced walking beam showing the invention applied;

Figure 2 is an enlarged fragmentary elevation showing a portion of the receiver and the control valve mechanism therefor and associated elements, looking from the right-hand side of the receiver in Figure 1;

Figure 3 is a generally similar view showing the parts diagrammatically and including the counterbalance unit with the cylinder thereof shown in section;

Figure 4 is a side elevation of the hydraulic reservoir and associated elements used in one form of the invention;

Figure 5 is an enlarged sectional view of the control or cut-off valve, parts being shown in elevation;

Figure 6 is a transverse sectional view on line **6—6** of Figure 5;

Figure 7 is an enlarged axial sectional view through the relay valve device for operating the control valve;

Figure 8 is a section on line **8—8** of Figure 7;

Figure 9 is an enlarged sectional view through a pressure relief valve;

Figure 10 is a section on line **10—10** of Figure 9; and

Figure 11 is a diagrammatic view of a modified type of system utilizing a solenoid valve in conjunction with the relay valve.

Referring to Figure 1, there is illustrated a pneumatically counterbalanced pumping unit comprising a base **10** on which is mounted the usual Samson post **11** pivotally connected as at **12** to a walking beam **13**. This beam carries the usual head **14** connected through a suitable cable **15** with conventional polished rods (not shown) of the oil well.

A conventional prime mover **16**, which may be of any desired type, operates through a belt or chain **17** to drive a conventional speed reducing unit **18** having an output shaft **19** to which is connected a crank **20**. A crank pin **21** pivotally connects the crank to a pitman **22** having pivotal connection as at **23** with the walking beam to oscillate the latter in a vertical plane on the axis of the pivot **12** in the usual manner.

The pumping unit described above is counterbalanced in its operation by a pneumatic counterbalance indicated as a whole by the numeral **25**. This counterbalance comprises a cylinder **26** pivoted at its upper end as at **27** to the walking beam. A piston **28** (Figure 3) is mounted in the cylinder **26** and carried by the upper end of a piston rod **29** shown only diagrammatically in Figure 3 and pivotally connected at its lower end as at 30 (Figure 1) to the base 10 in accordance with conventional practice. The piston 28 and cylinder 26 define a pressure chamber 32 which expands upon upward swinging movement of the walking beam and is contracted upon downward movement of the beam to place air in the chamber 32 under increasing pressure to store energy under such conditions. The piston rod 29 is hollow to provide therethrough a passage 33 communicating at its upper end with the chamber 32 and at its lower end with a pipe or conduit 34 leading in a manner to be described to a receiver 36. As thus far described, the pneumatic counterbalancing system is conventional, and in the usual practice, communication between the pipe 34 and receiver 36 is controlled by a manually operated cut-off valve. In accordance with the present invention, this communication is controlled by an automatic valve indicated as a whole by the numeral 37 and described in detail below.

In accordance with conventional practice, the valve 37 is open when the pumping unit is in operation, and the average air pressure in the system throughout each cycle of walking beam operation is that required to exert an upward pressure against the walking beam equal to the weight of the pump rods plus one half the weight of the fluid column above the plunger of the well pump.

Other accessory devices are associated with the pumping unit such as a compressor 38 (Figure 1), an intermediate air receiver, etc. These accessory devices have not been particularly illustrated since they may be of any operative type and form no part per se of the present invention. For the purpose of illustration, the pipe 34 has been shown in Figure 3 as leading directly from the tubular piston rod 33 to the valve 37 and thence to the main receiver 36.

The control or cut-off valve has been illustrated in detail in Figure 5. This valve is a complete operative mechanism and comprises a valve housing 42 having a valve seat 43 therein controlling communication between the central portion of the valve housing 42 and the receiver 36 through a pipe 44. The other end of the valve housing 42 is connected by a union 45 to a bearing member 46 in which is slidable a rod 47. This rod carries a valve body 48 to which is connected a valve 49 engageable with the seat 43 upon movement of the rod 47 toward the seat 43 in a manner to be described. The valve body 48 preferably moves in a suitable valve guide 50. The pipe 34 communicates with the central chamber 51 of the valve housing 42 as shown in Figure 5.

The bearing 46 has an extended apertured sleeve portion 54 carrying a plate 55 to which is secured by screws 56 one housing 57 of a diaphragm device, the other housing of which is indicated at 58. These housing members are secured together by bolts 59 and clamped therebetween is the peripheral portion of a diaphragm 60 of any suitable flexible material. A bearing plate 61 attached to the diaphragm carries a stem 62 fixed to the adjacent end of the stem 47 in axial alinement therewith. A spring 63 biases the diaphragm 60 to a position in which the valve 49 is open. This spring is arranged in the chamber 64 of the casing member 57 which communicates with the atmosphere through the apertures of the sleeve member 54. The chamber 65 of the casing member 58 has communication with a pipe 66 for a purpose to be described.

In Figures 7 and 8 there is illustrated a relay valve for controlling pressures in the diaphragm chamber 65. The relay valve is indicated as a whole by the numeral 70 and comprises upper and lower casing members 71 and 72 respectively having flanged adjacent ends secured together by screws 73 with an interposed valve seat unit 74 therebetween. The latter member, together with the casing member 71, defines a chamber 75 in constant communication with a pipe 76, connected to the pipe 66, and such connection therein having a manually operable bleed valve 77 (Figure 3) for releasing air pressure in the diaphragm chamber 65 when desirable. Another pipe 78 (Figure 7) communicates with the chamber 75 through a valve seat 79 further referred to below.

A piston 82 is slidable in the housing 72, which is of cylindrical form, and includes a lipped cup 83 of deformable material to provide an effective seal between a chamber 84 below the piston 83 and a chamber 85 above this piston. The latter chamber is adapted to communicate with the chamber 75 through a passage 86 in the valve seat unit 74, and the upper end of the passage 86 terminates in a valve seat 87.

Fluid under pressure is supplied to the chamber 84 in ways to be described, only when the pumping unit is in operation. When such pressure is present, the piston 82 is urged upwardly against the tension of compression spring 88, and this spring moves the piston 82 downwardly when pressure ceases to exist in the chamber 84 incident to the shutting down of the pumping unit.

A stem 90 is connected at its lower end to the piston 82. This stem projects loosely through the passage 86 and carries at its upper end a valve body 91 having upper and lower valve elements 92 and 93 respectively engageable with the seats 79 and 87. When no pressure is present in the chamber 84, the pipes 76 and 78 communicate with each other and the chambers 75 and 85 are disconnected by valve element 93. When the pumping unit is operating and pressure is present in the chamber 84, the valve element 92 engages the seat 79, thus disconnecting pipes 76 and 78 from each other and establishing communication between the pipe 76 and chamber 85, the valve 93 then being open. The chamber 85 is vented to the atmosphere as at 94. Under the conditions referred to, therefore, atmospheric pressure will be established in the pipe 76 and hence in the diaphragm chamber 65 (Figure 5).

Referring to Figure 3, it will be noted that a pipe 96 is tapped at one end into the pipe 44 and at its other end into the pipe 34 with a check valve 97 interposed therein. The pipe 96 provides a bypass around the valve 37 and, with the check valve 97, comprises a safety means to prevent rupture of the piping between the counterbalance and the valve 37 in the event the valve 49 (Figure 5) closes while the pumping unit is still in operation.

One end of the pipe 78 (Figure 3) is tapped into the pipe 96 between the check valve 97 and pipe 44, and in the pipe 78 is interposed a pressure regulating valve 98. Accordingly, while air from the receiver 36 is connected to the pipe 78 leading to the relay valve chamber 75, the air pressure in this chamber is regulated and will be substantially below pressures in the receiver 36.

Two types of means are illustrated for establishing pressure in the chamber 84 (Figure 7) while the pumping unit is in operation. The high speed shaft 100 of the speed reducing unit 18 drives a belt 101 passing around a pulley 102 for thus driving a pump 103 (Figures 2 and 3), preferably of the hydraulic type. This pump has its intake side connected as at 104 to a hydraulic fluid reservoir 105 and the outlet side of the pump is connected to a pipe 106 having a T 107 preferably provided with a pressure gage 108. The run of the T is connected respectively to a pipe 109 leading to the relay valve chamber 84 (Figure 7) and to a pipe 110 which communicates with a relief valve 111 shown in detail in Figures 9 and 10.

The relief valve 111 comprises a valve body 112 having a bore 113 therein communicating through a pipe 114 (Figures 3 and 9) with the reservoir 105. A valve 115 is mounted in the bore 113 and is square or otherwise rectangular in cross section to provide channels 116 through which hydraulic fluid can flow from pipe 110 to pipe 114 under conditions which will become apparent. The valve 115 is provided with a conical end valve face 117 engageable with a similarly shaped valve seat 118. The end of the valve 115 is provided with a transverse slot 119 which affords restricted communication between the pipe 110 and the bore 113 when the valve face 117 is seated.

A spring 121 urges the valve 115 toward closed position and is backed up preferably by a plurality of adjusting plugs 122 followed by a closure plug 123. The plugs 122 may be adjusted and different springs 121 employed to predetermine the pressure at which the valve 115 opens.

It will be apparent that the pump 103 is driven constantly whenever the pumping unit is in operation, thus supplying hydraulic pressure to the relay valve chamber 84. Excess hydraulic fluid will be bypassed through pipe 110 and relief valve 111 to the reservoir 105.

The pump 103, reservoir 105 and associated elements may be dispensed with if the prime mover is an electric motor. Under such conditions, the relay valve device will be controlled in the manner shown in Figure 11. Under such conditions, the pipe 78 will be connected to the relay valve chamber 75 through a T 128, and the run of this T is connected through a pipe 129 to the housing 130 of a solenoid valve indicated as a whole by the numeral 131. A valve 132 is arranged in the housing 130 and is biased downwardly by any suitable means (not shown), and is movable to the upper position shown in Figure 11 upon energization of a solenoid 133. For the purpose of illustration, this solenoid is shown as being connected in series with the motor 134 forming the prime mover of the pumping unit. However, any suitable circuit control means may be provided for the solenoid to energize it whenever the prime mover is operating, thus maintaining the valve 132 in the position shown in Figure 11.

The valve 132 is provided with a through passage 136 alined with the pipe 129 when the solenoid 133 is energized, thus connecting this pipe to a pipe 137 leading to the relay valve chamber 84 in place of the pipe 109 previously described. Whenever the pumping unit is in operation, therefore, the valve element 92 (Figure 7) will be closed and the pipe 76 will be exhausted to the atmosphere, thus maintaining atmospheric pressure in the diaphragm chamber 65 (Figure 5).

The valve 132 further comprises a transverse port 140 communicating at one side of the valve with the port 136 through a longitudinal passage 141. This passage extends above the port 136 to communicate with the pipe 137 when the valve 132 drops upon de-energization of the solenoid 133. Under such conditions, the pipe 129 will be cut off from the passage 136 and the pipe 137 will communicate with an exhaust pipe 142 preferably provided with a manually operable valve 143 for controlling the rate of exhaustion of air from the relay valve chamber 84 for a purpose to be described.

Operation

The operation of the form of the invention shown in Figures 1–10, inclusive, is as follows. The pumping unit shown in Figure 1 operates in the conventional manner, the walking beam 13 oscillating about the axis of the pivot 12 to effect reciprocation of the well rods, power being delivered from the prime mover 16 through the speed reducing unit 18, crank 20, and pitman 22. The pump 103 will be constantly driven and will maintain pressure in the relay valve chamber 84 to hold the piston 82 in its upper dotted line position shown in Figure 7. The valve element 92 will remain engaged with the seat 79 and the pipe 78 (Figures 2 and 3) will be closed to communication with the pipe 76. This pipe, which is in fixed communication with the diaphragm chamber 65 through pipe 66, will be open to the atmosphere through chamber 75, passage 86, chamber 85, and vent openings 94. Accordingly, the chamber 65 (Figure 5) will be under atmospheric pressure, and the spring 63 will maintain the valve 49 open. Thus, the pipe 44, leading to the receiver 36, will be in open communication with the pipe 34 and therefore in communication with the counterbalance chamber 32 through the hollow piston rod 33. Accordingly, the necessary volume of air under pressure for counterbalancing the pumping unit will be present to be utilized in the usual manner. Energy will be stored upon downward movement of the walking beam 13 and will be expended upon the up stroke of the pump rods to counterbalance the pumping action.

As previously stated, the valve 37 is substituted for the conventional manual cut-off valve. Such valve is operated in conventional units of this type whenever the pumping unit is shut down. However, the operator sometimes forgets to shut the valve, and if he shuts it, he often forgets to open the valve when the unit is restarted. Under the latter condition, the compressor 38 (Figure 1) will operate to build up its intended pressure, but the volume of air present under pressure obviously is not sufficient for counterbalancing purposes. If pressure is lost from the receiver 36, it is necessary to uncouple the pump rods from the walking beam, operate the beam to restore the necessary quantity of air under pressure, and then shut down the unit and recouple the pump rods before restoring the normal operation. This entails a considerable amount of work and lost time.

With the present system, the stopping of the prime mover 16 stops the pump 103 which no longer operates to generate pressure in the relay valve chamber 84 (Figure 7). The relief valve 111 (Figure 9) then comes into operation to provide leakage from the outlet side of the pump through the slot 119 into the bore 113 and thence into the reservoir 105 through pipe 114. This will result in a somewhat delayed relieving of the pressure in the diaphragm chamber 84, thus preventing the sudden dropping of the valve body 91 and momentarily preventing communication between pipes 76 and 78. This protects the piping of the apparatus when the rotating parts turn over several times after power of the prime mover has been cut off, for a purpose which will become apparent.

When pressure drops to the necessary extent in the relay valve chamber 84, the spring 88 will move the piston 82 downwardly, thus opening the valve 92 and closing the valve 93. The chamber 75 will now be cut off from the atmosphere, and pipes 76 and 78 will communicate with each other. Referring to Figures 3 and 5, it will be apparent that under such conditions air will flow from pipe 78 through pipes 76 and 66 into the diaphragm chamber 65. Due to the use of the pressure reducing valve 98, air under pressure supplied to the chamber 65 will be below any pressures existing in the receiver 36. However, the diaphragm 60 is of substantial area and the total pressure thereagainst overcomes the spring 63 to move the valve 49 to closed position, the pressure affecting the diaphragm 60 likewise being sufficient to overcome receiver pressures in pipe 44 tending to prevent the seating of the valve 49.

From the foregoing, it will be apparent that fluid pressure is utilized to maintain the valve 49 closed whenever the pumping unit is not in operation, and, most practicably, this fluid pressure is derived from the receiver 36 itself. The valve 49 is maintained seated under pressure and prevents any leakage between pipes 34 and 44. Accordingly, the apparatus may remain out of operation for substantial periods of time without loss of pressure from the receiver 36.

When the pumping operation is to be restored, it is necessary merely to start the prime mover 16. The walking beam operation will then commence and the hydraulic pump 103 will immediately function and, almost instantly, pump the amount of hydraulic fluid necessary to overcome the tension of the spring 88 (Figure 7). The piston 82, accordingly, will be moved upwardly to very quickly open the valve 93 and close the valve 92. The diaphragm chamber 65 immediately will be cut off from communication with the pipe 78 and will be opened to the atmosphere through chamber 75, passage 86, etc. Promptly upon the starting of the prime mover, therefore, the chamber 65 will be relieved of pressure and the spring 63, assisted by receiver pressure acting directly on the valve 49, will move this valve to open position and connect pipes 34 and 44. The large volume of air under pressure in the receiver, accordingly, will be rendered available to the counterbalance unit, and operation of the pumping unit will be restored without loss of time and the expenditure of labor, as described above.

The valve 111 (Figures 9 and 10) is primarily a pressure relief valve. It will be apparent that the pump 103 operates continuously, and as soon as the necessary hydraulic fluid under pressure has been displaced to the relay valve chamber 84 to close the valve 92, the pumped hydraulic fluid must be taken care of. Under such conditions, the valve 115 is pushed under pressure from the seat 118 to permit the flow of hydraulic fluid back to the reservoir 105 through pipe 114 (Figures 3 and 9). By adjusting the set screws 122 and changing the compression of the spring 121, the discharge pressure of the pump 103 may be adjusted.

The operation of the form of the invention shown in Figure 11 is similar to that previously described. The same relay valve device 70 may be employed, and this device is shown in the diagrammatic representation in Figure 11. Instead of supplying liquid from a hydraulic pump (or air from a compressor) to the chamber 84 to move the piston 82 upwardly, air from the receiver 36 is used for this purpose. So long as the pumping unit is in operation, the valve 132 will be in the position shown in Figure 11 through energization of the solenoid 133. The pipe 78 thus will remain in communication with the pipe 137 to supply air under pressure to the chamber 84 to maintain the valve 92 (Figure 7) closed and the valve 93 open, thus maintaining the diaphragm chamber 65 (Figure 5) open to the atmosphere.

Assuming that the prime mover 134 is stopped, the circuit through the solenoid 133 will be opened and the valve 132 will drop to its lower position. The passage 136 will be moved out of registration with the pipe 129, and the pipe 137 will be connected to the atmosphere through passages 141 and 140, pipe 142 and valve 143. The relay valve chamber 84 thus will be connected to the atmosphere and the valve body 91 will drop to the solid-line position shown in Figure 7 to connect pipes 76 and 78. Thus, air under pressure will be supplied as before to the diaphragm chamber 65 to close the valve 49.

It is desirable, as previously stated, to slightly retard opening movement of the valve 92 to allow time for the pumping unit to come to rest. This avoids supplying excessive pressure to pipe 34 if the valve 37 is closed. The closing of this valve is slightly delayed by adjusting the valve 143 (Figure 11) to retard the rate of exhaustion of air pressure from the relay valve chamber 84 to the atmosphere, thus accomplishing the same result as the slot 119 shown in Figure 9.

The use of either of the systems referred to, therefore, is highly advantageous in preventing possible damage to the apparatus through failure of an attendant to open the usual cut-off valve connecting the receiver to the counterbalance unit when operation of the pumping unit is restarted. The system also prevents the loss of pressure from the receiver automatically whenever the prime mover of the pumping unit is stopped and immediately and automatically renders available a large volume of compressed air when the pumping unit is restarted. It is therefore unnecessary for an attendant to perform any function other than the stopping of the prime mover, provided an attendant's services are utilized for this purpose. Obviously, the functioning of the prime mover may be subject to remote control so that the pumping unit may be started in operation whenever desired, maintained in operation for any period of time, and then stopped. Moreover, the prime mover may be again started in operation by remote control without the necessity for the performance of any service by an attendant.

It is to be understood that the forms of the invention illustrated and described are illustrative only, and that the invention is defined in the appended claims.

I claim:

1. A counterbalancing apparatus for a pumping unit having a prime mover and a walking beam driven thereby and constituting therewith a continuously operable mechanism, comprising a pneumatic counterbalance connected between the walking beam and a stationary support, a pressure receiver communicating with said counterbalance, a valve controlling such communication, means biasing said valve to normally open position to maintain communication between said receiver and said counterbalance, a casing having a pressure responsive element therein connected to said valve and defining with said pressure responsive element a pressure chamber, a conduit connected between said chamber and said receiver, a relay valve in said conduit biased to open piping position, and means operative only during operation of said continuously operable mechanism for maintaining said relay valve closed whereby such valve automatically opens to supply pressure fluid from said receiver to said chamber to move said pressure responsive element against said biasing means to close said first-named valve when operation of said walking beam is stopped.

2. A counterbalancing apparatus for a pumping unit having a prime mover and a walking beam driven thereby and constituting therewith a continuously operable mechanism, comprising a pneumatic counterbalance connected between the walking beam and a stationary support, a pressure receiver, a conduit connecting said receiver to said counterbalance to increase the volume of pressure fluid available for said counterbalance, a valve in said conduit controlling communication therethrough and biased to normally open position, a diaphragm housing, a diaphragm therein connected to said valve and forming with said housing a pressure chamber, piping connecting said receiver to said pressure chamber, a relay valve controlling said piping and biased to an open piping position, fluid pressure responsive means for moving said relay valve to closed position to trap pressure fluid in said receiver and exhaust said pressure chamber to the atmosphere, and means dependent upon operation of said continuously operable mechanism for subjecting said pressure responsive means to pressure fluid to maintain said relay valve closed.

3. Apparatus constructed in accordance with claim 2 provided with a control chamber to which pressure fluid is admitted to control said relay valve, and means for retarding the exhaustion of pressure fluid from said control chamber when the operation of said continuously operable mechanism is stopped.

4. Apparatus constructed in accordance with claim 2 wherein the means for supplying pressure fluid to operate said pressure responsive means comprises a pump operated by said continuously operable mechanism.

5. A counterbalancing apparatus for a pumping unit having a prime mover and a walking beam driven thereby and constituting therewith a continuously operable mechanism, comprising a fluid system including a counterbalance connected between the walking beam and the stationary support, a pressure receiver and a conduit connecting said receiver to said counterbalance to increase the volume of pressure fluid available to the latter, a valve in said conduit, a pressure operable unit comprising a casing and a pressure responsive element therein connected to said valve and defining with said casing a pressure chamber, piping connected between said fluid system and said chamber, a relay valve in said piping biased to one position to connect said fluid system with said chamber, said relay valve being movable to a second position to trap pressure fluid in said fluid system and to open said pressure chamber to the atmosphere, a pressure operable device having a housing and a pressure responsive unit therein connected to said relay valve and

forming with said housing a control chamber, and means subject to operation only so long as said continuously operable mechanism is operating to supply pressure to said control chamber to maintain said relay valve in said one position.

6. Apparatus constructed in accordance with claim 5 wherein said means comprises a pump driven by said continuously operable mechanism.

7. Apparatus constructed in accordance with claim 5 provided with means for controlling the releasing of pressure from said control chamber when operation of said continuously operable mechanism is stopped to delay movement of said relay valve away from said one position.

8. Apparatus constructed in accordance with claim 5 wherein said means comprises an auxiliary conduit connected between said piping and said control chamber, an auxiliary valve in said auxiliary conduit and biased to a position opening said auxiliary conduit to the atmosphere and closing it to said piping, and means subject to operation as long as said continuously operable mechanism is in operation for holding said auxiliary valve in a second position cutting off communication between said auxiliary conduit and the atmosphere and opening such conduit to said piping.

9. Apparatus constructed in accordance with claim 5 wherein said means comprises an auxiliary conduit connected between said piping and said control chamber, an auxiliary valve in said auxiliary conduit and biased to a position opening said auxiliary conduit to the atmosphere and closing it to said piping, means subject to operation as long as said continuously operable mechanism is in operation for holding said auxiliary valve in a second position cutting off communication between said auxiliary conduit and the atmosphere and opening such conduit to said piping, and a manually operable valve connected to said auxiliary valve and operative when the latter connects said control chamber to the atmosphere to control the rate of exhaustion of pressure fluid from said control chamber.

10. A counterbalancing apparatus for a pumping unit having a prime mover and a walking beam driven thereby and constituting therewith a continuously operable mechanism, comprising a pressure system including a counterbalance connected between the walking beam and a stationary support, a pressure receiver, a conduit connecting said pressure receiver to said counter-balance, and means operable by the walking beam for maintaining pressure in said system during operation of the walking beam, a normally open valve controlling said conduit, pressure responsive means comprising a control chamber into which fluid pressure is admissible to close said valve, piping connecting said system to said chamber, a relay valve device having a first valve seat in said piping, a relay chamber in which said valve seat is arranged and having a second seat opposite said first valve seat controlling communication between said relay chamber and the atmosphere, a relay valve biased into engagement with said second valve seat to open communication through said piping during operation of the walking beam, said relay valve being movable to engage the first valve seat to trap pressure in said system and open said control chamber to the atmosphere through said second valve seat, a pressure responsive unit connected to said relay valve, and means dependent upon operation of said continuously operable mechanism for supplying pressure to said pressure responsive unit to maintain said valve in engagement with said first valve seat.

11. Apparatus constructed in accordance with claim 10 wherein said means for supplying pressure to said pressure responsive unit comprises a pump driven by said prime mover to be operative only when said continuously operable mechanism is in operation.

12. Apparatus constructed in accordance with claim 10 wherein said means for supplying pressure to said pressure responsive unit comprises a pump driven by said prime mover to be operative only when said continuously operable mechanism is in operation, and means providing for retarded flow of pressure fluid from said pressure responsive unit when operation of said pump is stopped to delay movement of said relay valve away from said first valve seat.

13. Apparatus constructed in accordance with claim 10 wherein said means for supplying pressure to said pressure responsive unit comprises a hydraulic pump driven by said prime mover and having its outlet connected to said pressure responsive unit, a reservoir, and flow means conecting the outlet of said pump to said reservoir, said flow means having a flow restricting device therein.

14. Apparatus constructed in accordance with claim 10 wherein said means for supplying pressure to said pressure responsive unit comprises a hydraulic pump driven by said prime mover and having its outlet connected to said pressure responsive unit, a reservoir, a pipe connection between the outlet of said pump and said reservoir, and flow control means in said pipe conection, such means comprising a casing having a valve seat therein, a flow control valve biased into engagement with such seat and seating toward the outlet of said pump, said flow control valve having a groove affording restricted communication between said pump and said reservoir when such valve is closed, and being movable from its seat to relieve excess hydraulic pump pressures.

15. Apparatus constructed in accordance with claim 10 provided with an electric motor comprising said prime mover, the means for controlling the supplying of pressure to said pressure responsive unit comprising a pipe connection between said pressure system and said pressure responsive unit, a three-way valve in said pipe connection biased to a position opening said pipe connection to the atmosphere and closing it to said pressure system, and a solenoid subject to energization when said electric motor is energized for moving said three-way valve to a second position cutting off communication between said pipe connection and the atmosphere and opening said pipe connection to said pressure system.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 14,230	Earl et al.	Dec. 12, 1916
2,218,216	O'Leary	Oct. 15, 1940
2,291,499	Penick	July 28, 1942
2,293,916	Patterson	Aug. 25, 1942
2,341,864	Grumbaugh	Feb. 15, 1944
2,542,526	Holveck et al.	Feb. 20, 1951
2,593,564	Ives	Apr. 22, 1952
2,632,631	Griffin et al.	Mar. 24, 1953
2,636,576	Affleck	Apr. 28, 1953