April 8, 1941. I. X. CALHOUN 2,237,303

PUMPING MECHANISM FOR OIL WELLS

Filed June 1, 1938 4 Sheets-Sheet 1

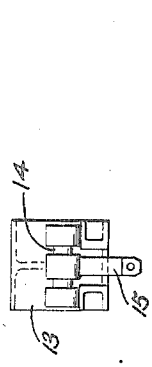


FIG. 1a.

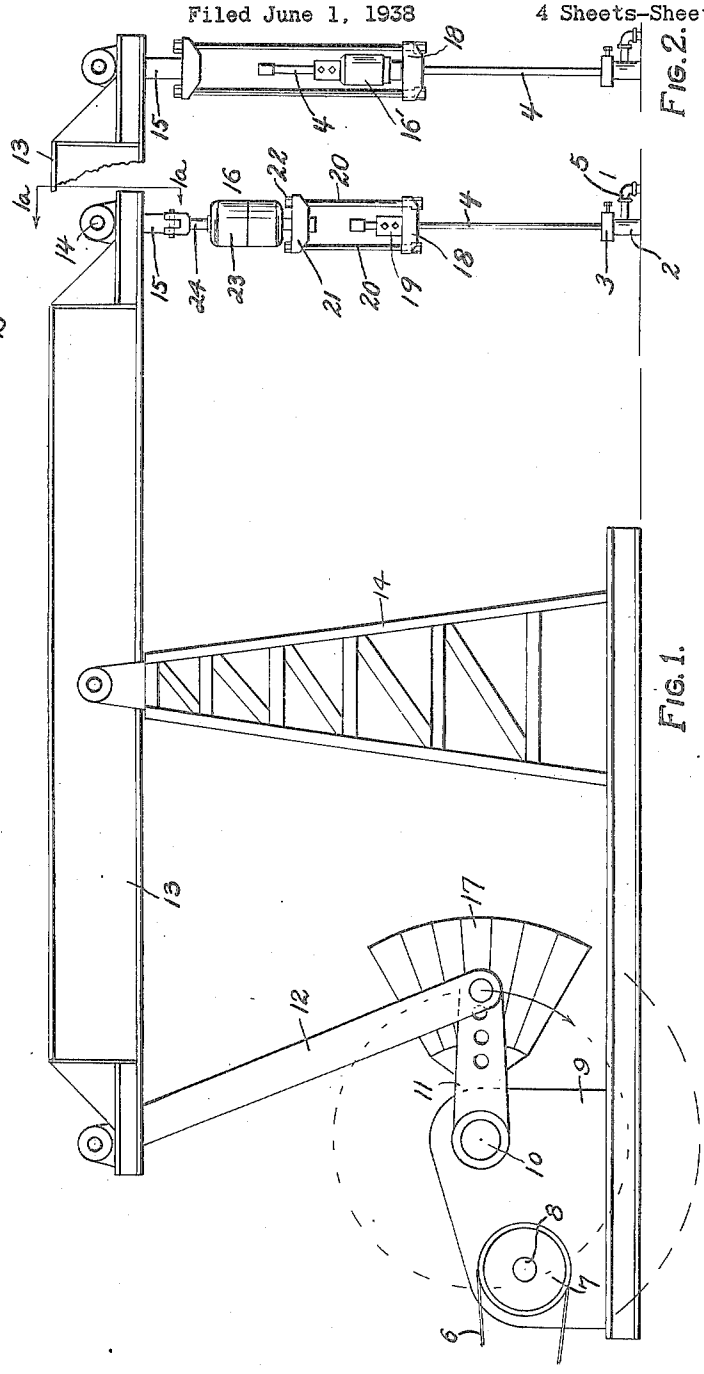


FIG. 2.

FIG. 1.

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PUMPING MECHANISM FOR OIL WELLS

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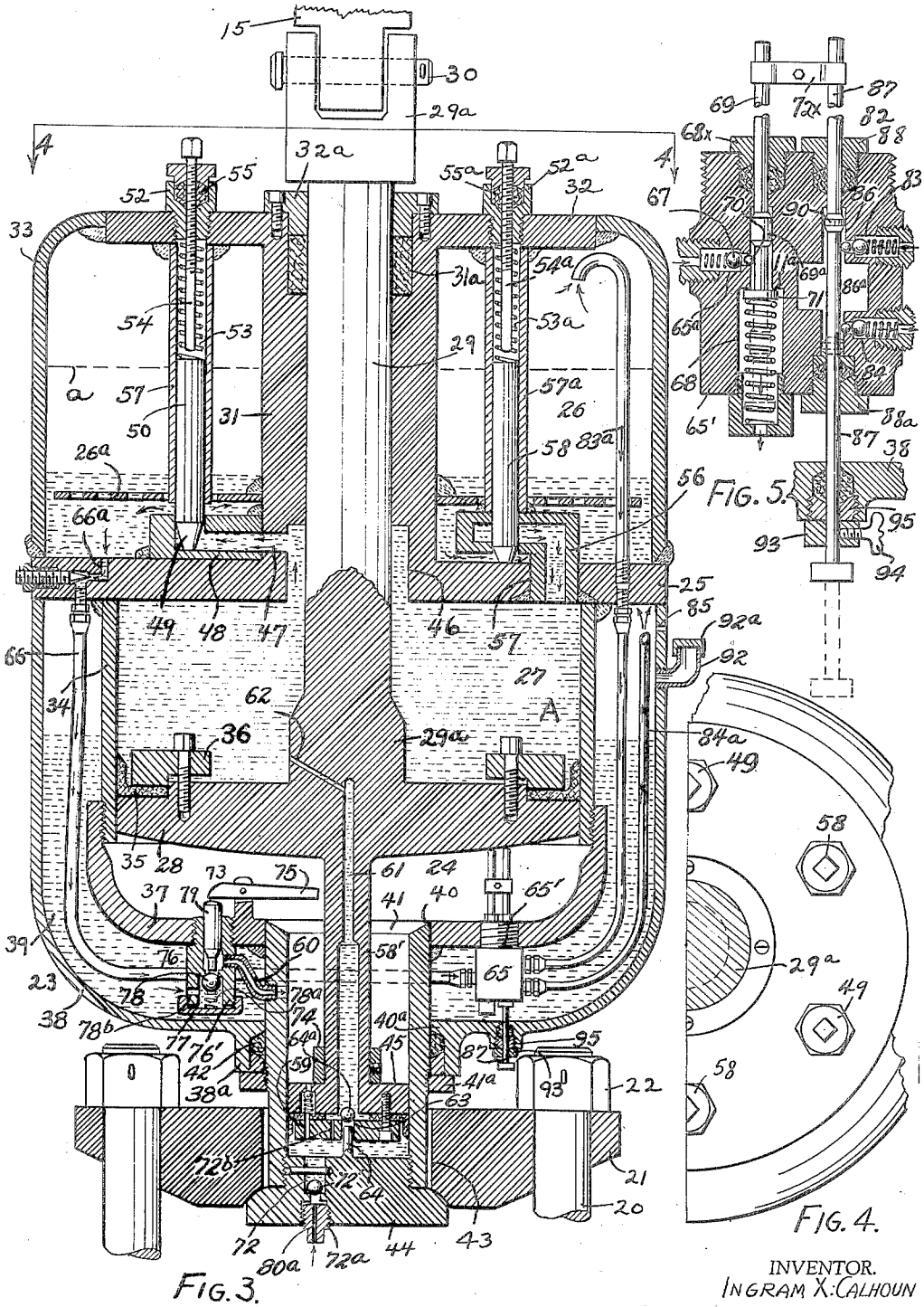


FIG. 3.

FIG. 5.

FIG. 4.

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PUMPING MECHANISM FOR OIL WELLS

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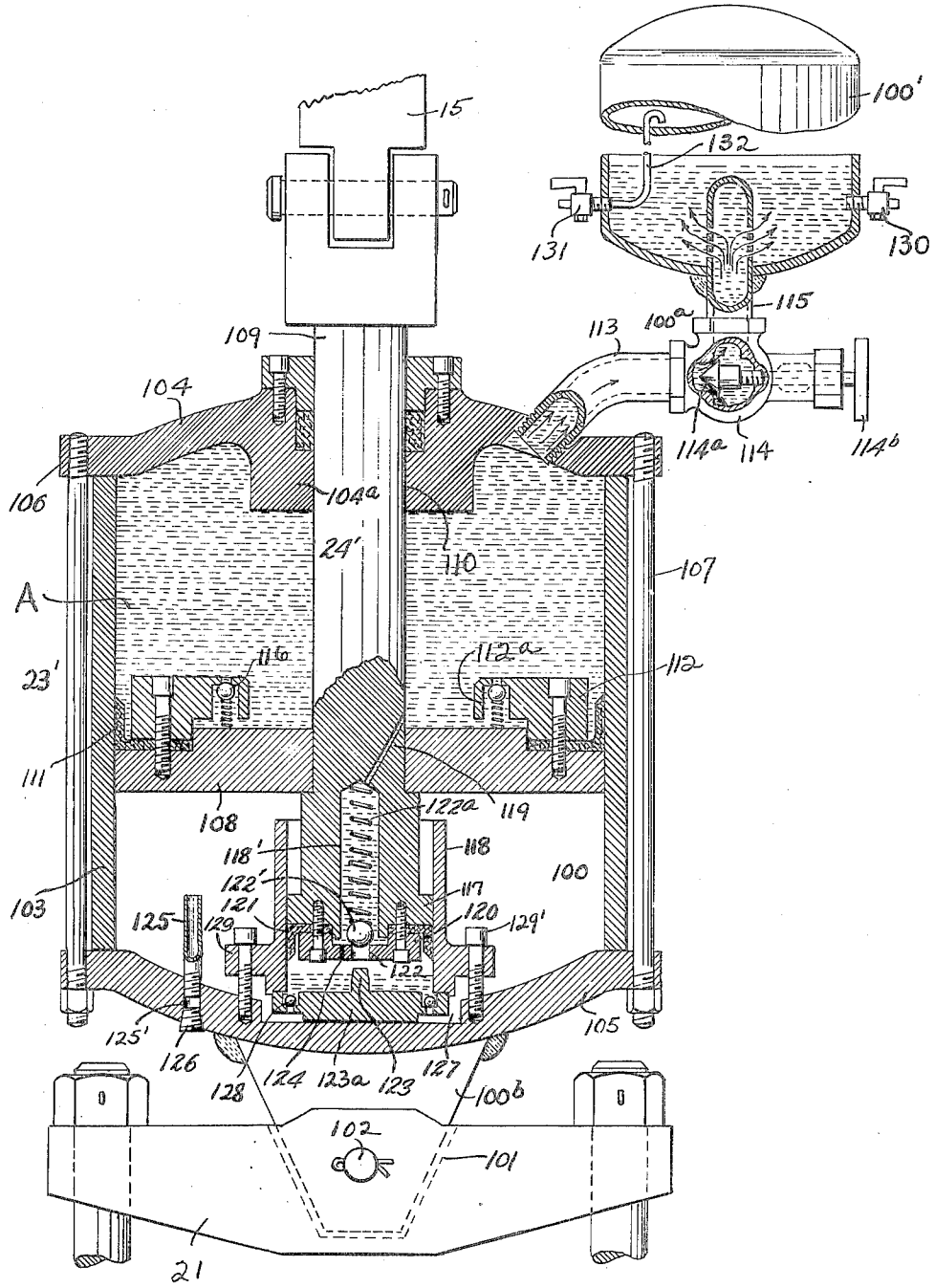


FIG. 6.

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PUMPING MECHANISM FOR OIL WELLS

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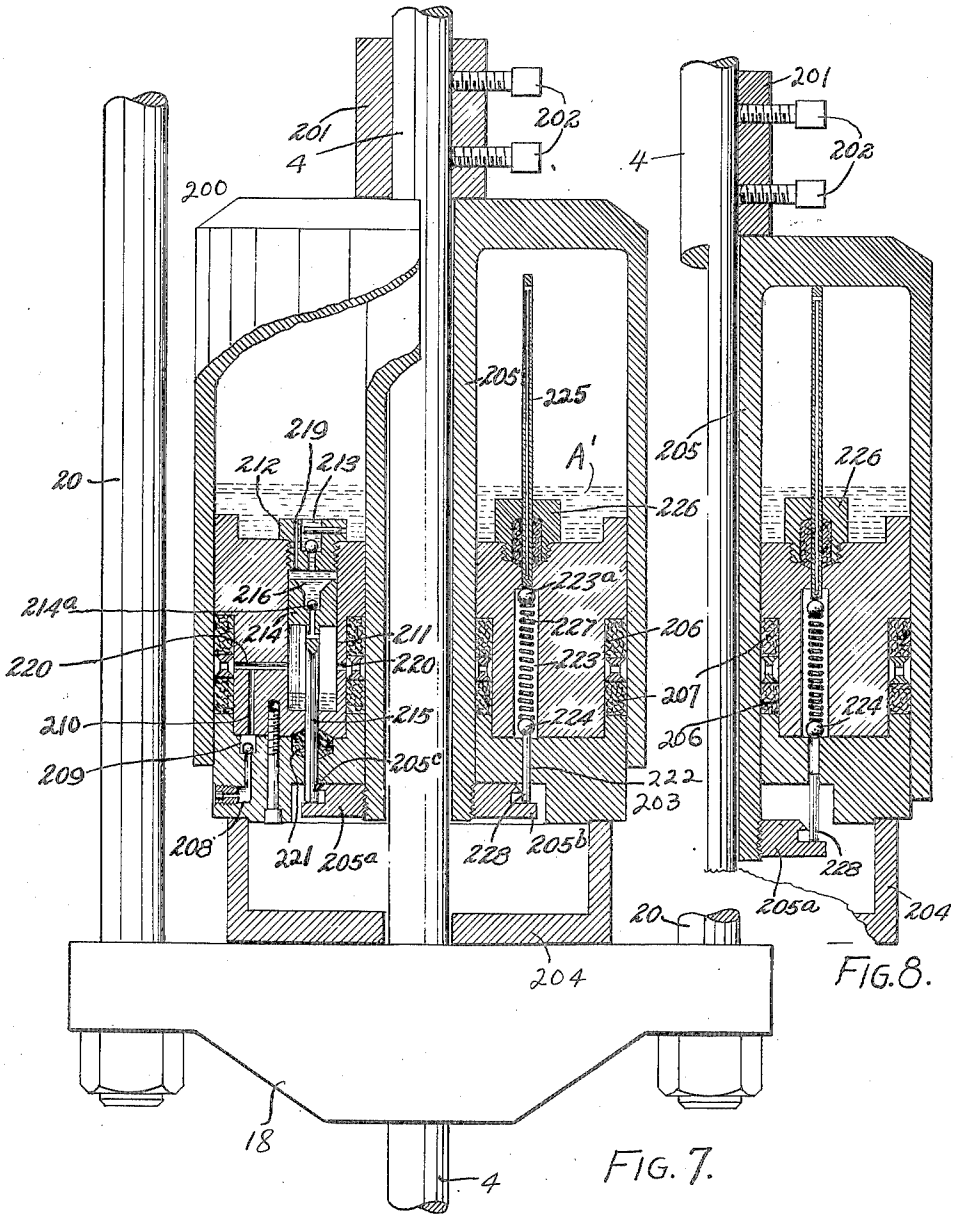
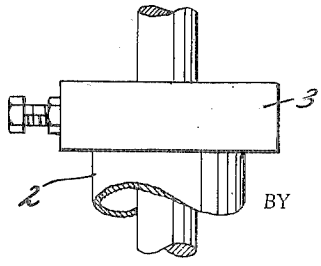


FIG. 8.

FIG. 7.



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UNITED STATES PATENT OFFICE

2,237,303

PUMPING MECHANISM FOR OIL WELLS

Ingram X. Calhoun, Oklahoma City, Okla.

Application June 1, 1938, Serial No. 211,181

15 Claims. (Cl. 255—16)

This invention relates to a pumping mechanism for oil wells, being applicable to wells of various depths including wells having a depth of several thousand feet. In mechanisms for pumping oil from oil wells, great difficulty has been experienced in breakage of the sucker rods, necessitating considerable expense and long shut downs. In a well having a depth of about 6,000 feet, the weight of the dead load approximates 14,000 lbs. and that of the live load (column of oil) approximates 10,000 lbs., totalling 24,000 lbs., which, under practical conditions, is lifted about six feet in each power stroke of the power mechanism. As it is usual for the power mechanism to effect from 10 to 16 pumping strokes per minute, it will be seen that the change in direction of movement of this heavy mass of materials (the sucker rods) subjects them to undue strains, especially at the end of the down stroke and on the start of the up-stroke when the live load is picked up, with the result that the sucker rods or connections between them break and hence necessitate frequent shut downs. Furthermore, additional strains are imparted to the sucker rods during movement thereof in either direction due to obstructions and disalinement in the tubing in which they reciprocate and impurities in the oil. Obviously, where greater output of oil is desired, the number of strokes per minute is increased, the effect of which is to increase the danger of breakage of the sucker rods.

One object of the invention is to provide an improved load distributing means between the power means and the sucker rods of an oil well pumping mechanism, whereby the strains on the sucker rods are relieved, so that danger of breakage thereof is minimized and substantially eliminated.

Another object of the invention is to provide an improved load distributing means of this character employing a compression chamber wherein an atmosphere is compressed by forcing liquid therein.

Another object of the invention is to provide an improved load distributing means of this character having an atmosphere compression chamber, operable to compensate for variations in the weight of the load in the lift strokes of the sucker rods and traveling valve in the oil barrel and to relieve strains on the sucker rods during movement thereof in either direction.

Another object of the invention is to provide an improved load distributing mechanism of this character having a chamber in which an atmosphere is compressed by forcing liquid thereinto and having means for preventing the escape of liquid and for supplying both atmosphere and liquid when required.

Another object of the invention is to provide an improved mechanism of this character having a chamber in which an atmosphere is compressed by the supply of liquid thereto and in which provision is made to automatically maintain the supply of atmosphere in the compression chamber.

Another object of the invention is to construct an improved load distributing mechanism having an atmosphere compression chamber provided with means for controlling the pressure in the chamber due to variations in the weight of the load and changes in the exterior atmosphere conditions.

Another object of the invention is to provide an improved mechanism of this character having a chamber in which an atmosphere is compressed by the delivery of liquid thereinto from a liquid chamber and incorporating a liquid reservoir into which escaping liquid flows and provision is made to supply liquid to the liquid chamber from the reservoir to insure an adequate supply thereof in the liquid chamber.

A further object of the invention is to provide an improved load distributing means having a piston operable to compress a fluid and wherein provision is made to automatically control the length of the piston stroke to prevent undue movement of the piston due to variations in the weight of the load.

Other objects of the invention will be apparent to those skilled in the art to which my invention relates from the following description taken in connection with the accompanying drawings, wherein

Fig. 1 is an elevation of an oil well and the operating mechanism therefor (the latter being substantially diagrammatic) and having incorporated in it load distributing means embodying my invention.

Fig. 1*a* is a fragmentary view on the line 1*a*—1*a* of Fig. 1.

Fig. 2 is a fragmentary elevation showing a modified form of construction.

Fig. 3 is a longitudinal section through the load distributing means shown in Fig. 1, enlarged.

Fig. 4 is a fragmentary section on the line 4—4 of Fig. 3.

Fig. 5 is a detail sectional view of certain valve mechanisms.

Fig. 6 is a sectional view of a different embodiment of the invention.

Fig. 7 is a longitudinal section through the load distributing means shown in Fig. 2.

Fig. 8 is a fragmentary section similar to Fig. 7, but showing the parts in operated position.

In the drawings, 1 indicates the well from which projects the usual tubing 2 having a cap 3 through which the upper section 4 of the sucker rods reciprocates in making the pumping strokes, the tubing 2 having connected to it a discharge pipe 5 which conveys the supplied oil to a suitable reservoir (not shown). The tubing 2 leads into the casing and downward to a point below the oil level and encloses the traveling valve which is connected to the lower end of the sucker rods in the usual way and is operated vertically to effect pumping of the oil up through the tubing 2, this portion of the well and the mechanism therein not being shown, as it may be of any desired construction and forms no part of my invention.

The operating mechanism consists of a motor or driven member (not shown) transmitting power preferably through a belt 6 and pulley 7 to a shaft 8, the latter being suitably mounted in a housing 9. The housing 9 encloses a suitable gear reducing mechanism, operating to drivingly connect the shaft 8 to a shaft 10 also suitably mounted in the housing. The shaft 10 is provided with a crank 11 which is connected through a link 12 to one end of a walking beam 13, suitably fulcrumed on a standard or post 14. The other end of the walking beam 13 is preferably bifurcated to form a support for the opposite ends of a shaft 14, which forms the pivot for a depending link 15 (see Fig. 1a). The upper end portion of the sucker rod 4 is operatively connected to the link 15 by a load distributing means indicated as an entirety at 16, whereby the walking beam serves to raise and lower, that is, reciprocate the sucker rods in the usual manner to effect the pumping operation. The crank 11 is provided with a counterbalance 17 which is preferably equal to the weight of the dead load plus one-half of the live load, so that the load on the gearing and motor is substantially equal in rocking the walking beam in opposite directions.

Referring particularly to Figs. 1, 3, 4 and 5, 18 indicates a cross bar through which extends the rod 4, the latter being provided with a collar 19 suitably bolted or clamped to the rod and arranged to rest on the cross bar. The cross bar 18 is connected by bars 20 to an upper cross bar 21, the bars 20 being preferably threaded at their lower ends in the cross bar 18, and their upper ends extending through openings formed in the cross bar 21 and provided with nuts 22 on their upper end to engage the cross bar 21.

The load distributing means 16 comprises two members indicated as an entirety at 23, 24, relatively movable substantially axially of the sucker rods, one thereof being connected to the cross bar 21 and the other connected to the link 15. In the form of construction now being referred to the member 23 consists of a casing of circular contour connected at its lower end to the adjacent cross bar 21 and having a transverse wall 25 to divide the casing into an upper chamber 26 in which an atmosphere (preferably air) is compressed and a lower chamber 27 for a body of liquid A (such as light oil). The member 24 consists of a piston 28 which slidably engages the walls of the chamber 27 to force the liquid into the chamber 26, whereby the atmosphere therein is compressed, as later set forth, and a piston rod 29 preferably formed integrally with the piston 28 and connected at its upper end to the link 15. The piston rod 29 is provided at its upper end with a bifurcated fitting 29a in which fits a depending lug on the link 15, a pin 30 extending through the lug and bifurcations to pivotally connect these parts together. The dividing wall 25 is provided with an integral, upstanding sleeve 31, through which the piston rod 29 slidably extends, the rod being guided by the inner walls of the sleeve, and the latter is provided at its upper end with an integral annular plate or wall 32, which cooperates with a shell 33 and dividing wall 25 to form the chamber 26, these parts being preferably welded together in liquid and atmosphere tight relation to insure a sealed chamber. The upper end of the sleeve 31 is recessed at 31a to provide for a suitable gland. Below the dividing wall 25 and preferably welded thereto is a cylinder 34 with which the periphery of the piston 28 engages, a suitable sealing ring 35 held in position by an annulus 36 being provided to prevent undue leakage past the piston. The lower end of the cylinder 34 is connected (preferably by screw threads) to a bottom wall 37 and surrounding the cylinder 34 and bottom wall 37 is a shell 38, the walls of which are spaced from the cylinder 34 and bottom wall 37 to form a reservoir 39 for liquid (similar to that employed in the chamber 27) into and from which the liquid is conveyed as later set forth. The upper end of the shell 38 is held in engagement with the dividing wall 25 in the manner later set forth. The bottom walls of the closure wall 37 and shell 38 are formed with alined openings 40, 40a, respectively, in which is mounted the upper portion of a tubular member 41 opening at its upper end into the space within the wall 37 and below the piston 28 for a purpose later set forth. The tubular member 41 is welded to the wall 37, whereas the opening 40a therefor through the shell 38 is sealed by a suitable gland 42 between the tubular member and a collar 38a on the bottom wall of the shell, to insure closing of the reservoir 39. As shown, a ring nut 41a threaded on the tubular member 41 and tightened against the collar 38a serves to support the shell 38 in position with its upper end in rigid engagement with the wall 25. The tubular member 41 extends below the shell 38 and through an opening 43 formed in the adjacent cross bar 21 and carries at its lower end a head 44 which engages the lower side of the cross bar to connect the casing member 23 thereto. By preference, the head 44 consists of a plug threaded into the lower end of the tubular member 41 to close it (except as hereinafter pointed out), the tubular member 41 and plug 44 serving as a cylinder for a piston 45 to provide an auxiliary pump for supplying air to the chamber 26 and liquid to the chamber 27, as will later be set forth.

The lower end of the sleeve 31 is recessed at 46 and communicates through a plurality of ports 47 formed in the sleeve with ducts each formed in a plate 48, the outer ends of the ducts forming seats for inlet valves 49 to permit flow of the liquid into the chamber 26 when the wall 25 and piston 28 move one toward the other. In the form of construction shown (Fig. 3), the outer end of each duct leads through the top wall of the plate 48 and the valve element of the valve 49 consists of a plunger 50 slidably mounted in a tube 51 rigidly connected to and depending from the wall 32. The wall 32 is

formed with threaded openings to removably receive plugs **52** each of which forms an abutment for an expansion spring **53**, the spring in turn being arranged to engage the upper end of the adjacent plunger **50** and normally tends to force the latter into engagement with its seat. The valves **49** serve to choke the flow of the fluid from the chamber **27** into the chamber **26**. Obviously, the movement of the plungers may be controlled by an adjustment of the springs; by preference I limit the movement of each plunger by a stop, consisting of a rod **54** which is adjustably threaded through the adjacent plug **52**, so that its inner end may serve as an adjustable stop to limit the unseating movement of the adjacent plunger **50**. Each rod **54** is sealed by a suitable gland **55**. The inner end of the piston rod **29** adjacent the piston is enlarged as shown at *29a'*, so as to fit into the recess **46**, to shut off the flow of the liquid into the chamber **26** before the wall **25** and piston **28** reach the end of their movement toward each other. The offset at the upper end of the enlargement *29a'* is of conical shape so as to effect a gradual cut-off of the liquid as the enlargement approaches the recess. When the flow of liquid through the ports **47** is cut-off by the enlargement *29a'*, at quantity of liquid is confined in the chamber **27** between the piston **28** and wall **25** to act as a dash-pot and hence prevents contact of the piston or parts carried thereby with the wall **25**. As shown, the enlargement extends to a point above the annulus **36** and bolts which secure the latter in place. The outlet for the liquid from the chamber **26** to the chamber **27** when the wall **25** and piston move away from each other is provided by one or more fittings **56** preferably having a capacity substantially equal to the capacity of the inlet ducts and valves **49**. Each fitting **56** (only one being shown) consists of a hollow, angular member the vertical portion of which is fixedly mounted in an opening **57** formed in the dividing wall **25** so as to discharge the liquid into the chamber **27**. The horizontal portion of the fitting **56** is elevated above the wall **25** and its upper and lower walls are formed with aligned openings, the lower opening forming a seat for a choke valve element **58** which projects through the upper opening and slides in a tube **51***a* rigidly connected to and depending from the wall **32**. The wall **32** is formed with threaded openings to removably receive plugs **52***a* and between each plug **52***a* and the adjacent plunger or valve element is an expansion spring **53***a* normally tending to maintain the valve element in engagement with its seat. The unseating movement of each valve element **58** is limited by a rod **54***a* the upper portion of which extends through an opening formed in the adjacent plug and has threaded engagement therewith to permit adjustment of the rod endwise, the rod being sealed by a suitable gland **55***a*.

It will be noted that the valve elements **50** and **58** are shaped at their lower ends so that pressure of the liquid thereon will effect unseating of the valves. As shown, in Fig. 4, the inlet choke valves and outlet choke valves are arranged alternately around the sleeve **31**, and the movement of each may be regulated independently of the other valves. By providing choke valves in the inlet and outlet ducts, flow of the liquid from either chamber to the other is retarded to prevent undue sudden movements between the members **23, 24**.

By preference I provide in the chamber **26** in close relation to the inlet choke valves **49** a baffle **26***a* arranged to prevent surging of the oil in streams into and through the body of liquid in this chamber when forced thereinto. The baffle **26***a* consists of a plate extending around the sleeve **31** and formed with a plurality of openings to permit the rise and fall of the liquid therethrough. The plate may fit upon the sleeve **31** and be suitably secured thereto as by welding.

When the operating mechanism is not running, the parts of the load distributing means **16** may occupy the position shown in Fig. 3, the liquid A filling the chamber **27** and also filling the chamber **26** to a level above the inlet and outlet valves **49** and **58**, with the atmosphere in the chamber **26** compressed to the desired degree. In the arrangement and construction shown having a piston of 8⅛ inches in diameter and operating in a well having a depth of about 6000 feet, the pressure in the chamber **26** would be approximately 280 lbs. per square inch. In the operation, in the up-stroke of the piston to raise the traveling valve and sucker rods **4**, the piston **28** will move relative to the wall **25** and force the liquid through the inlet choke valves **49** into the chamber **26** to approximately the level indicated by the line *a* and compressing the atmosphere thereinto approximately 480 lbs. per square inch, thereby relieving sudden strains on the sucker rods. In the down-stroke of the piston, the built-up pressure in the chamber **26** forces the liquid A through the outlet choke valves **58** into the chamber **27**, thereby causing relative movement of the piston **28** and wall **25** away from each other, so that the weight of the dead load is distributed during a part of or throughout the down-stroke. At the end of the down stroke and in starting the up-stroke, the piston **28** will move relative to the casing **23**, and thus force the liquid A into the chamber **26** and again compress the atmosphere therein, thereby distributing the load on the sucker rods. The forcing of the liquid A into the chamber **26** and therefrom also takes place during the movement of the sucker rods upwardly or downwardly in the event resistance to their travel takes place, so that the load distributing means relieves any and all sudden strains on the rods during their movement. It will thus be noted that in the start of each up-stroke of the sucker rods, the atmosphere in the chamber is put under higher compression and upon release of the applied force or load, the atmosphere expands to force the liquid A back into the chamber **27**, the valves **49** or **58** serving to choke the flow of the liquid in each direction to relieve the rods of sudden strains; also the same operation takes place during movement of the sucker rods in either direction in the event their movement is retarded for any reason. The increase in compression of the atmosphere in each up-stroke of the sucker rods is dependent on the amount of oil taken in by the traveling valve.

Means are provided for automatically supplying liquid A to the chamber **27** and discharging the liquid from the chamber for automatically controlling the level of the liquid in the latter chamber and thus controlling the volumetric capacity of the chamber above the liquid level, the purpose being (*a*) to maintain a minimum variation in the range of movement of the piston **28** relative to the member **23**, notwithstanding changes in the weight of the load (particularly the live load in succeeding up-strokes of the sucker rods) and expansion and contraction of the atmosphere in

the chamber 26 due to changes in temperature of the weather, and (b) to insure operation of the load distributing means over a long period of time without servicing. These means include the auxiliary pump already referred to. As shown, the piston 45 is provided with an integral rod 58', which is preferably integrally connected to the piston 28, whereby the piston 45 is reciprocated therewith. The piston 45 is formed with a port 59, normally closed by a spring operated ball valve, which in the up-stroke of the piston, permits the oil supplied into the cylinder or tubular member 41 due to leakage of liquid past the seal ring 35 or supplied by a pipe 60, as later set forth, to flow to the lower side of the piston. The rod 58' is formed with a longitudinal opening 61 which leads from the space below the piston 45 as later set forth and is connected at its upper end to a duct 62 leading into the chamber 27 above the piston 28. While the opening 61 and duct 62 and the space below the piston 45 are always filled with liquid, at least to a predetermined level therein for a purpose later set forth, the liquid cannot escape past the ball valve for the valve port 59 and in the down stroke of the piston 45 excess oil in the space below the piston will be forced up through an opening 63 formed in the piston, past a ball valve 64*a* therefore and through the opening 61 and duct 62 into the chamber 27. The ball 64*a* is normally held seated by the pressure thereon of the liquid in the opening 61 to close the opening 63 in the up-stroke of the piston 45. The reservoir 39 is provided with a supply of liquid A when pumping operations are to start. The supply of liquid A in the reservoir 39 is supplemented at intervals by the operation of a valve mechanism indicated as an entirety at 65, controlled by the relative movement of the members 23, 24. The liquid A supplied to the reservoir 39 is taken from the chamber 26, such discharge being co-operatively related to the supply of liquid into and through the chamber 27 to control the liquid level in the chamber 26. The valve mechanism 65 is preferably mounted in the reservoir 39 so that its discharge outlet opens thereinto, the upper end of the housing 65' for the valve mechanism terminating in a threaded boss which is screwed into an opening formed in the bottom portion of the wall 37 to support the mechanism thereon. The inlet port 65*a* of the valve mechanism is connected to a pipe 66, which in turn is connected to a passage 66*a* preferably formed in the wall 25 and controlled by an adjustable needle valve 66*b* to regulate the flow of the liquid to the valve mechanism 65. The inlet port 65*a* is normally closed by a spring operated ball valve 67 (see Fig. 5). The valve housing 65' is formed with a through opening 68 which communicates with the inlet port 65*a* and serves as the outlet for the valve mechanism into chamber 39. The upper portion of the opening 68 and the opening through a plug 68*x* forms a guide for a thrust rod 69 having an enlargement or cam 69*a*, which, when the rod is moved endwise downwardly, engages with a ball 70 mounted in the inlet 65*a* in contact with the valve 67 and through the ball 70 operates the valve 67 to permit discharge of the liquid in the pipe 66 into the reservoir. The thrust rod 69 extends upwardly into the path of movement of the piston 28, so that when the relative movement between the wall 25 and piston 28, one away from the other, is sufficient to effect engagement of the piston with the rod 69, the valve 67 will be opened to admit liquid to the reservoir 39. As shown, the plug 68*x* is threaded into the opening 68 to provide a suitable gland which seals the opening 68. The upward endwise movement of the rod 69 is limited by a head 71 on its lower end engaging a wall 71*a* formed by enlarging the lower portion of the opening 68, the rod 69 being normally biased upwardly by a coiled spring interposed between the head 71 and a cup-shaped member 71*b* mounted in the lower end of the opening 68. The valve mechanism 65 is operated by the piston 28 when the relative movement between it and the wall 25, one away from the other, is increased, and such operation serves to reduce the quantity of liquid A contained in the chamber 26 to control the liquid level therein. In the event the piston 28 moves away from the wall 25 to approximately its extreme position, the cam 69*a* will ride past the valve 67 and permit the latter to close so as to prevent an undue quantity of the liquid being discharged from the chamber 26.

92 indicates a nipple mounted in the side wall of the shell 38 above the liquid level therein and arranged to permit the supply of liquid to the reservoir when necessary. The nipple 92 is preferably closed by a cap 92*a*. The shell 38 may be provided with a gage (not shown) to indicate the level of the liquid therein or such level in the event it drops to or below a predetermined height.

To prevent the range of movement of the piston 28 and wall, one toward the other, increasing to its extreme limit of movement I provide means, indicated as an entirety at 73, for automatically supplying liquid through the chamber 27 to the chamber 26 to increase its volume therein, that is, raise the liquid level therein in relation to the volume of that portion of the chamber 26 above the liquid level, the effect of which is to reduce the range of relative movement between the piston 28 and wall 25.

The liquid supply means 73 consists in providing on the rod 58' a shoulder 74 which, in the upward movement of the rod 58', engages one end of a lever 75 suitably fulcrumed on the wall 37, and a valve mechanism, indicated as an entirety at 76, arranged to be operated by the lever 75, to admit liquid to the pipe 60, which discharges the liquid into the tubular member 41, whereby the auxiliary pump may force the liquid from the tubular member 41 into the chamber 27, the effect of which is to increase the volume of liquid in the chamber 26. The shoulder 74 preferably comprises a collar slidably mounted on the rod 58' and fixed thereto by a set screw, which permits the collar to be arranged in any adjusted position longitudinally of the rod 58' to effect the operation of the lever 75 at any predetermined position of the rod 58' in the up-stroke of the piston 45, and to thereby regulate the range of relative movement between the members 23, 24. The valve mechanism 76 comprises a tubular fitting 76' screw threaded at its upper end into an opening formed in the wall 37 and closed at its lower end by a cap 77 and provided intermediate its ends with a valve seat for a valve element 78 (preferably a ball valve), which is normally biased to its seat by a spring 78*a*. The side wall of the fitting 76' below the valve is formed with an inlet 78*b* to admit liquid from the reservoir 39 and above the valve with an opening into which the inner end of the pipe 60 is suitably secured. The upper portion of the opening through the fitting 76' forms a guide for a plunger 79, the upper end of which is disposed in operative relation to the opposite end of the lever 75, so that when said lever is operated, as already set forth,

the plunger 79 unseats the valve element 78 and permits the liquid to flow into the tubular member 41.

The liquid delivered from the pipe 60 into the tubular member 41 will then be forced by the auxiliary pump through the opening 61 and duct 62 into the chamber 27.

The atmosphere is automatically supplied to the chamber 26, the effect of which is to gradually increase the range of relative movement of the piston 28 and wall 25, one away from the other, and to then automatically discharge the atmosphere from the chamber 26, the effect of which is to reduce the range of relative movement between the piston 28 and wall 25. The cycle of movement takes place in succeeding movements of the piston to compensate for variations in the load weight and changes in temperature of the weather.

The atmosphere is supplied to the chamber 26 by operation of the auxiliary pump in the following manner: the head 44 is formed with a through opening 72 shaped to provide a seat for a ball valve element 72', which is normally closed by the pressure of liquid above it. The lower end of the opening 72 is threaded to receive a plug 72*a* which is formed with a small opening to limit the intake of air in each up-stroke of the piston 45. In the down-stroke of the piston 45, the air which is drawn through the opening 72, is forced up through the opening 63 into the opening 61 where the air will follow along with the liquid forced therethrough or bubble up through the liquid and likewise bubble through the liquid in the chamber 27 and finally pass into the chamber 26. Sufficient liquid is maintained in the tubular member 41 below the piston 45 so that the latter will engage with the liquid in each down stroke of the piston, this liquid being supplied through a very small opening 72*b* formed in the piston 45, the purpose being to effect pressure on the liquid and air by the piston in its down-stroke, whereby the air sucked in through the opening 72 and liquid flowing through the valve 59 may be forced up through the opening 63 formed in the piston into the opening 61. As the piston 45 nears the end of its down stroke, a pin 64, provided on the head 44, operates to substantially close the opening 63, so that the liquid remaining in the bottom portion of the tubular member 41 acts as a dash-pot for the piston 45. The supply of atmosphere into the chamber 26 will have the effect of gradually increasing the pressure therein, so that in the succeeding relative movements of the piston 28 and wall 25 one away from the other, such movements will progressively increase and ultimately cause the piston 28 to engage the thrust rod 69 and also operate a valve mechanism, indicated as an entirety at 82, to permit a small quantity of atmosphere to escape in each stroke of the piston 28 to relieve the pressure in the chamber 26 and prevent the piston and casing 23 moving to a position wherein the fitting 29*a* will engage the wall 32 or a cap 32*a* thereon. The valve mechanism 82 is preferably associated with the valve mechanism 65. As shown in Fig. 5, the housing 65' is formed with a valved inlet 83 connected to a pipe 83*a* leading from the upper portion of the chamber 26 and a valved outlet 84 connected to a pipe 84*a* which extends upwardly through the reservoir 39, its upper end opening thereinto above the level of the liquid A therein, a vent 85 being provided in the shell 38; but obviously the pipe 84*a* may be extended to a point outside the shell. The housing 65' is formed with a through opening 86 in communication with the outlet port of the inlet 83 and inlet port of the outlet 84, and between these ports the opening 86 is enlarged to form a receiver 86*a*. A thrust rod 87 extends through the opening 86, being guided in openings formed in plugs 88, 88*a*, threaded into recesses formed in the upper and lower ends of the opening 86 and providing suitable glands in said recesses. The thrust rod 87 extends upwardly into the path of movement of the piston 28, being normally biased upwardly by the spring operating through rod 69 and bar 72*x*. Since the bar 72*x* connects the rods 69 and 87 together, the upward movement of the latter is limited by the head 71. The rod 87 is provided with an enlargement or cam 90, which in the normal upper position of the rod is above the outlet port for the inlet 83, so that in the downward movement of the piston 28, the cam 90 will, through a ball mounted in the inlet 83 in engagement with the valve element therefor, open the inlet and permit atmosphere to flow into the receiver or chamber 86*a*, and in the event the rod 87 is moved downwardly by the piston 28 far enough to effect engagement of the cam 90 with a ball mounted in the outlet 84 in contact with the valve element therefor, the valved outlet will be opened to permit escape of the atmosphere from the receiver 86*a*, thus reducing the pressure in the chamber 26 to limit the relative movement between the members 23, 24, one away from the other, so that the fitting 29*a* will not engage the cap 32*a*. Since the receiver 86*a* is normally closed by the valve for the outlet 84 leading therefrom, the valved inlet 83 may be opened by the cam 90 without danger of the atmosphere escaping and reducing the compression in the chamber 26.

From the foregoing description it will be seen that in each up-stroke of the piston 28 air is sucked into the tubular member 41 and then pumped into the chamber 26 and that the resulting increase in pressure therein serves to increase the relative movement between the piston 28 and wall 25 one away from the other and that when this movement increases to an undue extent, the pressure is reduced in the chamber 26, as already described, to limit it at approximately a predetermined position.

Due to the fact that I provided for the discharge of liquid from the chamber 26 due to the movement of the piston 28 away from the wall 25, and operation of the valve mechanism 65, as above described, so that the liquid level in the chamber 26 is lowered with each operation of the valve mechanism 65, the volumetric capacity of the chamber above the liquid level is increased, and hence the relative movements of the piston 28 and wall 25, one toward the other, is increased, until the shoulder 74, operates the liquid supply mechanism 73. The operation of the mechanism 73 serves to supply the liquid into and through the chamber 27 to the chamber 26, thereby raising the liquid level in the latter and thus reducing the volumetric capacity thereof above the liquid level and re-establishing in the chamber 26 sufficient atmosphere pressure to limit the movements of the piston 28 and wall 25 one toward the other.

It will thus be seen that the limit of movement of the piston 28 and wall 25 in either direction, one relative to the other, is controlled automatically by the valve mechanisms 65, 82 and 73 in connection with the auxiliary pump, the desired range of relative movement being dependent

upon the adjustment of the collar **74**. It will also be seen that the range of relative movement of the members **23**, **24**, is maintained within substantially predetermined limits, not withstanding the changes in the applied loads and temperature of the weather. It will also be noted that I incorporate in the casing **23** a reservoir for a supply of liquid from which the liquid is automatically drawn to raise the liquid level in the chamber **26**, and to receive liquid automatically discharged from said chamber, as required from time to time in the operation of the mechanism.

It will further be noted that the mechanism is self contained and capable of operating over a long period of time without servicing of atmosphere or liquid, or adjustment.

I provide means for throwing out the operation of or disconnecting the valve mechanisms **65** and **82**, when any part of the mechanism is being tested or when, due to the leakage in the traveling valve or other abnormal condition, flow of oil from the well ceases. These means consist in extending the rod **87** through the bottom wall of the shell **38** and providing thereon below the shell a collar **93** adapted to be fixed to the rod in different positions by a thumb screw **94**. By moving the rods **69** and **87** downwardly with their cams **69***a* and **90** below the valves **67** and **84**, respectively, and positioning the collar **93** in engagement with the plug **95** which closes the opening through the shell for the rod, these valve mechanisms will be made inoperative, so that atmosphere cannot be supplied to or discharged from the chamber **26** and the liquid level therein will remain substantially constant, and any liquid supplied by the valve mechanism **73** will not affect the operation of the members **23**, **24**, under these conditions.

Fig. 6 illustrates a different embodiment of the invention wherein the construction is somewhat simplified. Referring to this view, **23'**, **24'**, indicate the two relatively movable members, the former member comprising a casing **100** and a compression chamber **100'**, in which an atmosphere is compressed, having a liquid connection **100***a* with the casing **100**. The bottom wall of the casing **100** is provided with a depending lug **100***b* fitting into a recess **101** formed in the cross bar **21** and pivotally connected to the side walls of the recess by a pin **102**. The casing **100** consists of a cylindrical side wall **103**, an upper end wall **104** and a lower end wall **105**, the end walls having lateral lugs **106** to which rods **107** are secured to clamp the end walls to the opposite ends of the side wall **103**, suitable means being provided to seal the joints between these parts. The relatively movable member **24'** comprises a piston **108** arranged to reciprocate within the casing **100** and a rod **109** for the piston extending through an opening **110** formed in the end wall **104** and connected to the link **15**, preferably in a manner similar to that shown in Fig. 3. The piston **108** is provided with a suitable seal ring **111** held in position by an annulus **112**. The piston **108**, wall **103** and end wall **104** form a chamber for the liquid utilized to compress the atmosphere in the chamber **100'**. The liquid connection **100***a* consists of a pipe **113** threaded at its inner end into an opening formed in the end wall **104**, and connected at its outer end to a fitting **114** and a pipe **115** leading from the fitting **114** into the lower end of the compression chamber **100'**, that portion of the pipe **115** within the chamber preferably being formed with a plurality of ports through which the liquid flows into and out of the chamber. With the piston **108** at substantially the end of its movement away from the wall **104**, as shown in Fig. 6, the liquid A fills the cylinder or casing **100** above the piston, the connection **100***a* and the lower portion of the chamber **100'**, and in the relative movement of the members **23'**, **24'**, that is, movement of the piston **108** and wall **104** one toward the other, due to a load on the sucker rods, the liquid is forced into the chamber **100'** to raise the level therein and thus increase the compression of the contained atmosphere; and upon release of the load the piston **108** and wall **104** move in the opposite direction and the liquid is forced back into the liquid chamber. The fitting **114** is provided with a valve seat for a valve element **114***a*, which is adjustable by a handle **114***b* to control or check the flow of the liquid A to and from the chamber **100'**. The connection **100***a* preferably serves to rigidly support the chamber **100'** on the casing **100**.

The end wall **104** is provided on its inner side with an annular boss **104***a*, which surrounds the rod **109** and co-operates with the inner side wall of the annulus **112**, in the movement of the piston **108** and wall **104**, one toward the other, to form a dash-pot to prevent contact of the piston and boss. The annulus **112** is formed with a circumferential recess **112***a* in communication with the liquid chamber and the upper wall of the recess is provided with a plurality of normally closed, spring operated valves **116** (two valves being shown), which release the resulting suction effect in the event the boss **104***a* projects into the space within the annulus **112**, as above set forth, upon movement of the piston and wall one away from the other.

The piston rod **109** extends downwardly below the piston **108** and is provided at its lower end with a piston **117** reciprocatable in a cylinder **118**, the latter being closed at its lower end by an end plate **123***a*, to provide an auxiliary pump. The lower end of the piston rod **109** is formed with an inwardly extending opening **118'** and a duct **119**, in connected relation, the latter communicating with the liquid chamber above the piston **108**. The piston **117** has bolted on its lower side a plate **120** which secures a suitable seal ring **121** in position. The plate **120** is formed with an opening **122** forming a seat for a valve element **122'** which is normally biased to its seat by a spring **122***a*, but is unseated in the downward movement of the piston by an up-standing pin **123** provided on the plate **123***a*, whereby liquid in the cylinder **118** below the piston is pumped through the opening **118'** and duct **119** into the liquid chamber. The pin **123**, after unseating the valve **122'** to permit a quantity of liquid to flow through the adjacent opening, serves to close the opening to prevent further flow of the liquid therethrough, so that the remaining liquid in the cylinder **118** may serve as a dash-pot. For this purpose a predetermined quantity of liquid having a level above the end of movement of the piston in making its shortest stroke relative to the wall **105** is maintained in the cylinder. Oil is supplied to the cylinder **118** below the piston **117** through a relatively small opening **124** formed in the plate **120**, also by leakage past the seal ring **111** and seal ring **121**, and/or supplied through a fitting **125**, mounted in an opening **125'** formed in lower end wall **105**, the opening being closed by a removable screw plug **126**. The liquid leaking past the seal ring **111** and/or supplied through the fitting **125**, gravitates to the well **127** formed in

the end wall 105; the liquid in the well is sucked into the cylinder 118 through a plurality of valves 128 (two valves only being shown) formed in the plate 123a.

The plate 123a is interposed between the end wall 105 and the adjacent end of the cylinder 118, and the latter is provided with lugs 129, engaged by bolts 129' screwed into the end wall 105 and operating to rigidly clamp these parts together, the joint between the plate 123a and cylinder 118 being liquid and air tight. When it is found desirable to increase the volume of air or atmosphere in the compression chamber 100', the plug 126 is removed to permit the air to flow into the casing 100, which is under partial vacuum due to the operation of the auxiliary pump. Such supplied air is drawn in through the valves 128 and then pumped through the opening 122, into the opening 118', so that it may bubble up through the body of liquid into the chamber 100'. The pump will continue to supply air to the chamber 100' until the required pressure therein is built up, following which the plug 126 is replaced. If the air becomes incorporated in the liquid in the cylinder 118, it will be carried along with those portions of the liquid pumped therefrom.

If it is found necessary to increase the amount of liquid in the chamber 100' at any time, the plug 126 is removed and the liquid introduced through the fitting 125 and this oil will gravitate into the well 127 from which it will be pumped through the opening 118' duct 119, and liquid chamber into the chamber 100'. The liquid level in the chamber 100' may be lowered by opening the valve 130, and air pressure therein may be reduced by opening a valve 131 connected to a pipe 132 in communication with the upper portion of the chamber.

Figs. 2 and 7 illustrate another embodiment of the invention which is adapted to be interposed between the uppermost section of the connection between the rods and the walking beam 13. In this form of construction the relatively movable members consist of an inverted cylinder, indicated as an entirety at 200 with its end wall in engagement with a collar 201 secured to the upper portion of the rod 4 by bolts 202 and a piston, indicated as an entirety at 203, supported on the side wall of a cup-shaped member 204, the bottom wall of which rests on the cross bar 18. By preference, the cylinder 200, piston 203 and member 204 surround the sucker rod 4, the cylinder being provided with an axially disposed sleeve 205 fitting the rod 4 and extending downwardly from its end wall and preferably formed integral therewith. The lower end of the sleeve is provided with screw threads to support a collar 205a, whereby the collar may be adjusted endwise of the sleeve. The purpose of the collar will be later set forth. The piston is formed of related sections whereby the chambers, recesses, openings or ducts hereinafter referred to may be provided for when the sections are assembled and positioned in the cylinder. The piston 203 has sliding engagement with the outer wall of the sleeve 205 and inner wall of the cylinder side wall, the walls of the piston having annular recesses 206 for seal rings 207. The space within the cylinder 200 is filled with a quantity of liquid A' (such as light oil) to form an atmosphere or air seal between the piston and the cylinder and the remaining space is filled with atmosphere under any desired pressure. The piston 203 is formed in its side wall with an inlet 208 having a vertical section communicating with an enlarged recess 209 to accommodate a ball valve. The ball normally engages the outlet port of the inlet 208 to serve as a valve element to close the inlet. The recess 209 communicates with the inlet end of a duct 210 the outlet end of which communicates with a chamber 211. The upper end of the chamber 211 is closed by a screw plug 212 having a valved controlled opening 213 through it opening into the cylinder. 214 indicates a piston mounted in the chamber 211 and provided with a rod 215, which extends downwardly through the piston 203 and is connected at its lower end to the collar 205a. The collar 205a is provided with an annular shoulder 205b on which the rod rests and an annular rib 205c which projects into a recess formed in the rod so as to connect the collar and rod together, whereby relative movement between the cylinder 200 and piston 203 will effect a like movement of the piston 214 relative to the walls of the chamber 211. The upper end of the piston 214 is formed with a recess 216 and an opening leading therefrom downwardly through the rod and laterally of the latter to communicate with the chamber 211. A valve 214a normally closes the opening leading into the recess 216. Since the piston 214 reciprocates in the chamber 211, it will be seen that it operates as a pump to suck air in through the inlet 208 and duct 210 and to force it to the upper side of the piston and in turn to pump it through the valved opening 213 into the cylinder 200. The recess 216 and space above the piston 214 is partially filled with liquid supplied through an opening 219, the size of which permits liquid to drip into this space to maintain a small quantity of the liquid therein at all times. In the down stroke of the piston 214, a partial vacuum is formed above the liquid in the recess 216 and air flows through the piston into this recess past the valve 214a and rises into the space above the liquid. In the up-stroke of the piston 214, this air together with excess liquid in the recess 216, is forced through the opening 213 into the cylinder 200

It will be noted that the annular recesses 206 communicate through ducts 220 with the chamber 211 so that liquid leaking from the recesses and accumulating in the chamber 211 will be pumped by the piston 214 through the opening 213 into the cylinder 200. The rod 215 is sealed by a suitable gland 221.

222 indicates an opening extending through the piston 203, the intermediate portion thereof being enlarged at 223 to form a receiver or chamber and the upper end of the lower smaller portion of the opening forming a seat for a valve 224 to close the opening. 225 indicates a tube which slides in the upper smaller portion of the opening 222 and an opening formed in a hollow plug 226 screwed into the upper end of the opening 222, which is enlarged to accommodate a suitable gland to seal the tube 225. The tube 225 is closed at its opposite ends, but adjacent to its ends it is formed with lateral ports communicating with the interior of the tube, the port at the upper end of the tube permitting the atmosphere in the cylinder to flow into the tube. The tube 225 is normally biased upwardly by a spring 227, within the receiver 223, acting through a device 223a (preferably a ball) in engagement with the lower end of the tube 225, so as to dispose the upper end of the tube in position to be engaged by the end wall of the cylinder 200 and moved endwise.

When the tube **225** is biased to its uppermost postion (see Fig. 7), the port in the lower end portion thereof is above the upper end wall of the chamber **223** and closed by the adjacent walls of the opening **222**, but upon relative movement of the cylinder and piston far enough in the direction to effect engagement with and operation of the tube **225**, the atmosphere in the cylinder will flow through the tube and be admitted to the chamber **223** (see Fig. 8) and in the movement of these parts in the opposite direction to the position shown in Fig. 7, a thrust pin **228** mounted on the shoulder **205***b* and loosely fitting the lower portion of the opening **222** will unseat the valve **224** and permit the escape of the atmosphere from the chamber **223**, sufficient clearance between the pin **228** and walls of the opening being provided for this purpose. By preference, the spring **227** which normally tends to move the tube **225** upwardly is utilized to normally maintain the valve **224** in engagement with its seat.

Fig. 7 shows this form of construction when the parts are at rest, but in operation atmosphere is constantly being pumped into the cylinder **200** by the piston **214**, as already set forth, so that unless the pressure therein is relieved, the collar **205***a* would engage the piston **203**. To prevent this engagement I provide the tube **225** and dispose its upper end in the path of movement of the cylinder end wall, so that the latter will operate the tube and permit it to discharge atmosphere into the receiver **223**, and I provide between the receiver and a portion of the cylinder (that is, the collar **205***a* thereon) an escape means, so that in the movement of the collar toward the piston the atmosphere is allowed to escape and thus reduce the pressure in the cylinder. Accordingly, the pressure in the cylinder is automatically controlled.

The ball **223***a* yieldingly seats against the lower end of the adjacent portion of the opening **222** to close it, when the tube **225** is biased to its uppermost position.

To those skilled in the art to which my invention relates many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. My disclosures and the description herein are purely illustrative and not intended to be in any sense limiting.

What I claim is:

1. In a well pumping mechanism, the combination with power means and sucker rods arranged to reciprocate in the well, of load distributing means forming the operating connections btween said power means and said sucker rods for reciprocating the latter, said load distributing means comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members including a closed space for atmosphere under pressure and the other member being mounted to move within said first mentioned member, whereby the atmosphere is compressed in the relative movement of said members in one direction and expanded in their relative movement in the opposite direction, and means automatically actuated by said members due to excessive relative movement thereof in one direction for discharging atmosphere from said closed space.

2. In mechanism for well operations, the combination with power mechanism and sucker rods, of a pair of relatively movable members connected to said power mechanism and said sucker rods, respectively, one of said members comprising a piston and the other member comprising a casing forming a closed chamber for a fluid in a gaseous state under pressure and walls which cooperate with said piston to form a chamber filled with fluid in a liquid-state, and connections between said chambers, the relative movement of said members due to an increased load on said sucker rods or inertia serving to force liquid from said liquid chamber into said compression chamber to compress the atmosphere therein, and means automatically operated by the relative movement of said members for varying the volume of liquid in said chambers.

3. In mechanism for well operations, the combination with power mechanism and sucker rods, of a pair of relatively movable members connected to said power mechanism and said sucker rods, respectively, one of said members comprising a piston and the other member comprising a casing forming a closed chamber for an atmosphere under pressure and walls which cooperate with said piston to form a separate chamber connected to said compression chamber, said separate chamber and a portion of the compression chamber being filled with liquid, the relative movement of said members due to an increased load on said sucker rods or inertia serving to raise the level of the liquid in said compression chamber and compress the atmosphere therein, and means for controlling the level of the liquid in said compression chamber to compensate for variations in the weight of the load or changes in temperature.

4. In mechanism for well operations as claimed in claim 3 wherein said controlling means comprises a reservoir, means for discharging the liquid from said compression chamber into said reservoir, and separate means for pumping liquid from said reservoir into said separate chamber.

5. In mechanism for well operations, the combination with power mechanism and sucker rods, of a pair of relatively movable members connected to said power mechanism and said sucker rods, respectively, one of said members comprising a piston and the other member comprising a casing forming a chamber for an atmosphere under pressure and walls which cooperate with said piston to form a separate chamber connected to said compression chamber, said separate chamber and a portion of the compression chamber being filled with liquid, the relative movement of said members due to an increased load on said sucker rods or inertia serving to raise the level of the liquid in said compression chamber and compress the atmosphere therein, means actuated by each relative movement between said members for supplying air to said compression chamber and simultaneously discharging liquid therefrom to lower the level of the liquid therein, means permitting the escape of air from said compression chamber to limit the travel of one member relative to the other in one direction, and means for supplying liquid into said compression chamber to limit the travel of said member relative to the other member in the opposite direction.

6. In a mechanism for well operations, the combination with power means and sucker rods reciprocatable in the well, of operating connections between said power means and said sucker rods comprising a cylinder and a piston therein, said cylinder being charged with air under pressure, means operated by the relative movements between said cylinder and piston for supplying air

into said cylinder and means operated by a predetermined relative movement between said cylinder and piston permitting the escape of air from said cylinder.

7. In mechanism for well operations, the combination with power means and sucker rods reciprocable in the well, of operating connections between said power means and said sucker rods for operating the latter and comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members consisting of a cylinder and the other member consisting of a piston in said cylinder arranged to form a closed space therein partially filled with liquid, the space above the liquid being filled with air under pressure, an auxiliary pump, means for supplying to said pump liquid escaping past said piston, and an air inlet connected to said pump, said pump being carried by one of said members and arranged to be operated by the other member, whereby said auxiliary pump is operable to force the air and liquid into said cylinder above said piston.

8. In mechanism for well operations, the combination with power means, a frame connected to said power means and provided with a cross bar formed with an opening and sucker rods adapted to reciprocate in a well, the upper portion of said rods slidably extending through the opening in said cross bar, of an inverted cylinder and a piston therein forming between them a closed chamber filled with atmosphere under pressure, means for securing said cylinder to said sucker rods, said means including an axially disposed tubular member into which said sucker rods extend and said piston surrounding said tubular member and mounted on said cross bar.

9. In mechanism for well operations, the combination with power means, a frame connected to said power means and provided with a cross bar, which is formed with a vertical opening, and sucker rods adapted to reciprocate in a well, the upper portion of said rods extending through and reciprocatable in said opening and provided with an abutment, of a cylinder and a piston therein formed with axially disposed openings through which the sucker rods extend and interposed between and engaging with said cross bar and said abutment, said cylinder and piston forming between them a closed chamber filled with air under pressure.

10. In mechanism for well operations, the combination with power means, a frame connected to said power means and provided with a cross bar, which is formed with a vertical opening, and sucker rods adapted to reciprocate in a well, the upper portion of said rods extending through and reciprocatable in said opening and provided with an abutment, of an inverted cylinder engaging said abutment and a piston in said cylinder and engaging said cross bar, said cylinder and piston forming between them a closed chamber filled with air under pressure, said cylinder being provided with an axially disposed tubular member through which said sucker rods extend and said piston surrounding and slidably fitting said member.

11. In mechanism for well operations, the combination with power means, a frame connected to said power means and provided with a cross bar formed with an opening and sucker rods adapted to reciprocate in a well, the upper portion of said rods slidably extending through the opening in said cross bar, of an inverted cylinder and a piston therein forming between them a closed chamber filled in its lower portion with liquid and above the liquid with atmosphere under pressure, means for securing said cylinder to said sucker rods, said means including an axially disposed tubular member into which said sucker rods extend and said piston surrounding said tubular member and mounted on said cross bar.

12. In a well pumping mechanism, the combination with power means and sucker rods arranged to reciprocate in the well, of load distributing means forming the operating connections between said power means and said sucker rods for reciprocating the latter, said load distributing means comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members comprising a cylinder and the other member comprising a piston forming with the cylinder a chamber for a body of liquid, the upper end of the cylinder being closed and forming a space above the liquid for atmopshere under pressure, whereby the atmosphere is compressed in the relative movement of said members in one direction and expanded in their relative movement in the opposite direction, and means actuated by the relative movement of said members for injecting liquid escaping past said piston into said chamber.

13. In a well pumping mechanism, the combination with power means and sucker rods arranged to reciprocate in the well, of load distributing means forming the operating connections between said power means and said sucker rods for reciprocating the latter, said load distributing means comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members comprising a cylinder and the other member comprising a piston forming with the cylinder a chamber for a body of liquid, the upper end of the cylinder being closed and forming a space above the liquid for atmosphere under pressure, whereby the atmosphere is compressed in the relative movement of said members in one direction and expanded in their relative movement in the opposite direction, and means operated by the relative movement of said members for increasing or decreasing the compression in said closed chamber.

14. In a well pumping mechanism, the combination with power means and sucker rods arranged to reciprocate in the well, of load distributing means forming the operating connections between said power means and said sucker rods for reciprocating the latter, said load distributing means comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members comprising a cylinder and the other member comprising a piston forming with the cylinder a chamber for a body of liquid, the upper end of the cylinder being closed and forming a space above the liquid for atmosphere under pressure, whereby the atmosphere is compressed in the relative movement of said members in one direction and expanded in their relative movement in the opposite direction, means actuated by said members due to excessive relative movement thereof in one direction to reduce the compression in said compression chamber and separate means actuated by said members due to the relative movement thereof for supplying air into said chamber.

15. In a well pumping mechanism, the combination with power means and sucker rods arranged to reciprocate in the well, of load dis-

tributing means forming the operating connections between said power means and said sucker rods for reciprocating the latter, said load distributing means comprising relatively movable members connected to said power means and sucker rods, respectively, one of said members comprising a cylinder and the other member comprising a piston forming with the cylinder a chamber for a body of liquid, the upper end of the cylinder being closed and forming a space above the liquid for atmosphere under pressure, whereby the atmosphere is compressed in the relative movement of said members in one direction and expanded in their relative movement in the opposite direction, air intake means for supplying atmosphere into said cylinder, and means operated by a predetermined relative movement of said members in one direction for discharging atmosphere from said cylinder.

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