Oct. 14, 1941. W. H. WINEMAN 2,259,020

APPARATUS FOR PUMPING WELLS

Filed Dec. 9, 1938 2 Sheets-Sheet 1

Fig. 1.

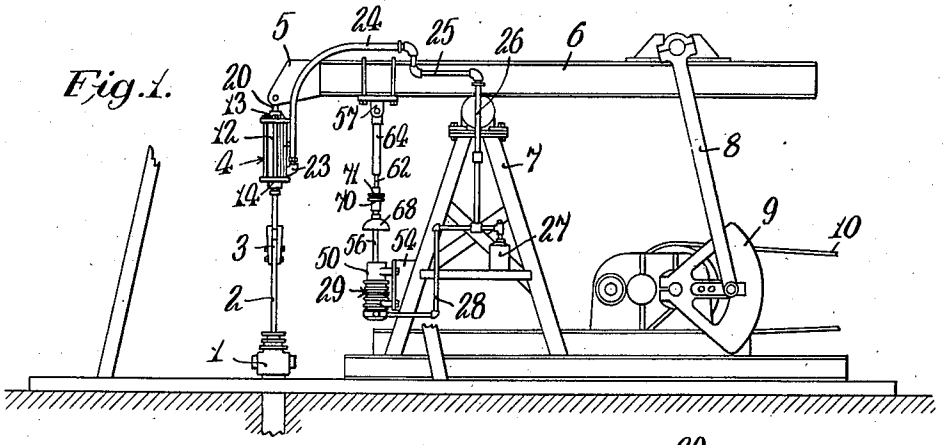


Fig. 2.

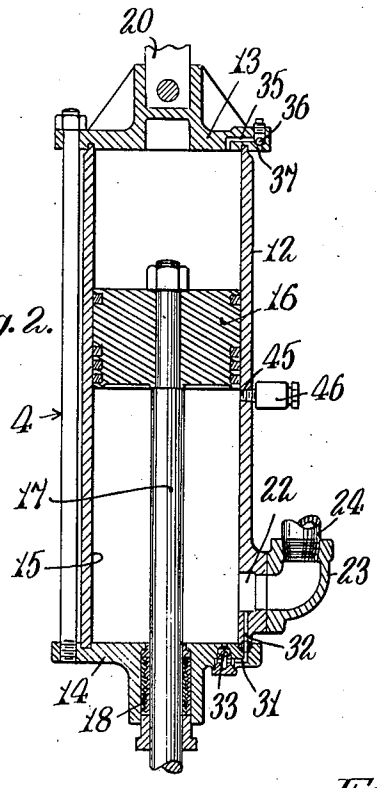


Fig. 3.

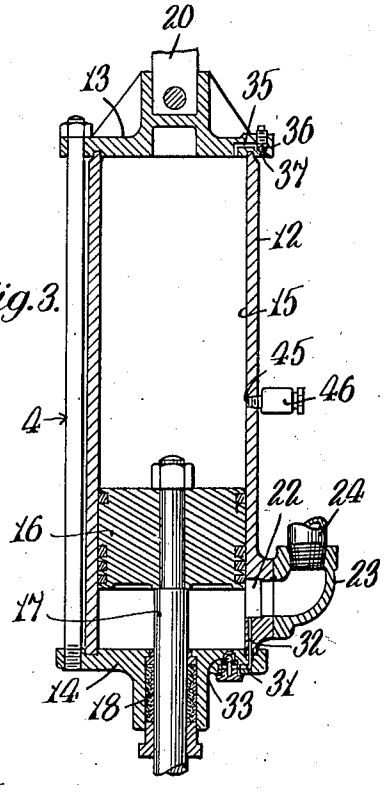


Fig. 4.

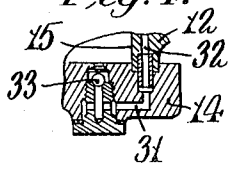
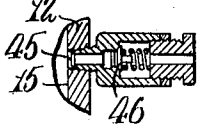


Fig. 5.



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Oct. 14, 1941. W. H. WINEMAN 2,259,020

APPARATUS FOR PUMPING WELLS

Filed Dec. 9, 1938 2 Sheets-Sheet 2

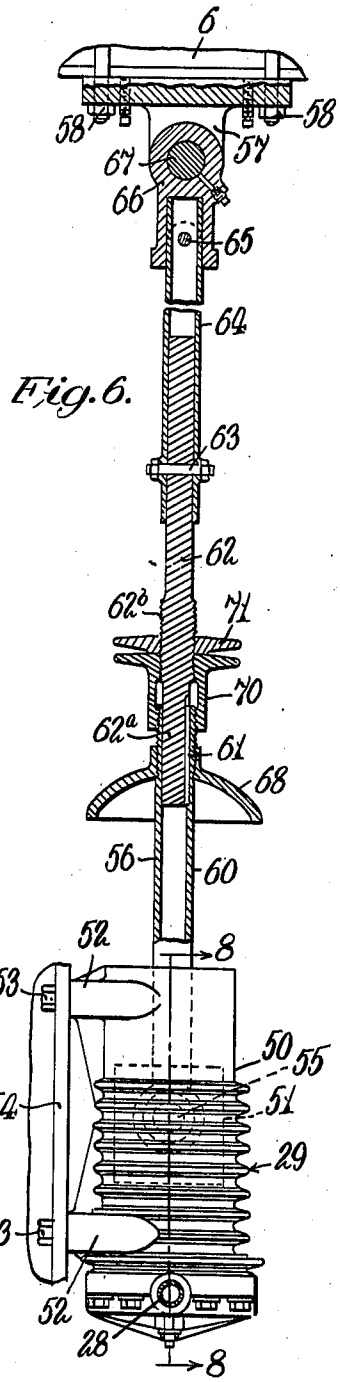
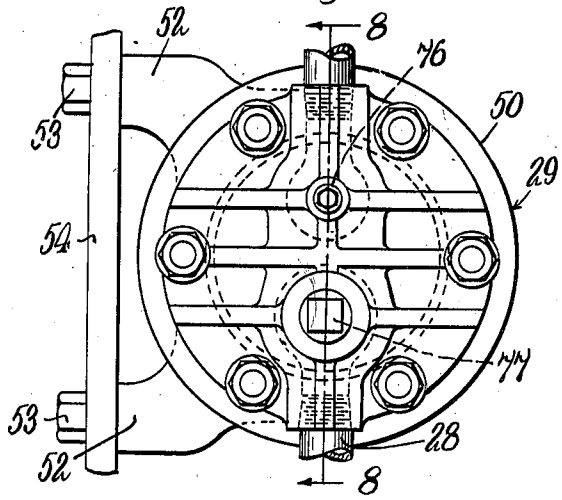


Fig. 6.

Fig. 7.



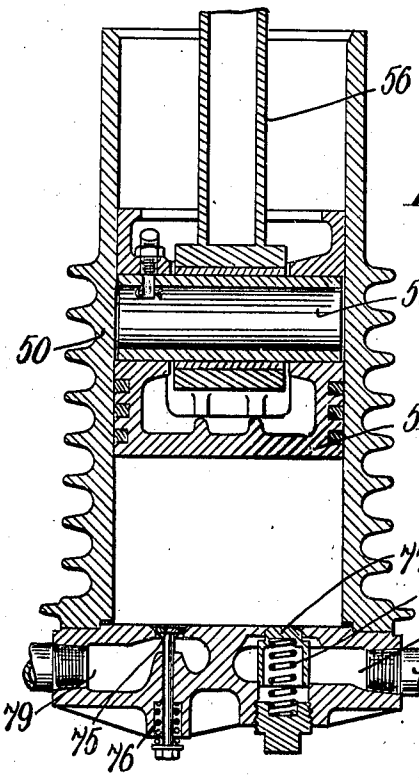


Fig. 8.

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UNITED STATES PATENT OFFICE

2,259,020

APPARATUS FOR PUMPING WELLS

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Application December 9, 1938, Serial No. 244,783

17 Claims. (Cl. 255—16)

My invention relates to pumping apparatus, and more particularly to apparatus for pumping oil wells by means of so-called "beam" well pumping equipment. From another aspect, my invention relates more generally to devices for minimizing stresses between a device to be reciprocated and a source of reciprocatory motion.

Most wells which are maintained on a producing basis beyond the time when they will flow naturally, are operated by some form of "beam" well pumping device. These devices are effective, but are subject to various difficulties, being not well adapted to exceedingly deep wells because of the weight of the sucker rod lines necessary to support the relatively high stresses produced, being subject to frequent rod breakage due to the variations in stress and the comparatively high stresses to which the rod lines are subjected, and also requiring, although this is perhaps not so important a factor, somewhat more power because of the operating cycle than is requisite to do the work of simply lifting the sucker rod line, the pump plunger and the oil which is pumped.

It is an object of my invention to provide an improved pumping system. It is another subject of my invention to provide an improved device for incorporation in a "beam" well pumping system which will free the latter from a number of its disadvantages. It is another object of my invention to provide an improved pump actuating apparatus. It is a further object of my invention to provide an improved device for reducing sucker rod peak loads and stress ranges in beam-type pumping systems. It is a still further object, but a more general one, of my invention to provide an improved arrangement for minimizing the stresses between a source of reciprocating motion and the device which is reciprocated thereby. Other objects and advantages of my invention will hereinafter more fully appear.

In the accompanying drawings, in which for purposes of illustration one embodiment which my invention may assume in practice has been shown:

Fig. 1 is an elevational view, in a somewhat diagrammatic form, of a pumping system in which the illustrative embodiment of the invention is incorporated.

Fig. 2 is an enlarged vertical sectional view through a stress-reducing cylinder and piston mechanism.

Fig. 3 is a view similar to Fig. 2, but showing parts in different relative positions.

Fig. 4 is an enlarged detail sectional view showing a portion of the lower head of the cylinder mechanism of Fig. 2, the section being on the same plane as Fig. 2.

Fig. 5 is a fragmentary detail sectional view through the relief valve shown in elevation in Fig. 2.

Fig. 6 is a view partially in section showing details of the pressure-providing means incorporated in Fig. 1.

Fig. 7 is an enlarged bottom view of the compressor cylinder shown in side elevation in Fig. 6.

Fig. 8 is a central sectional view on the section lines 8—8 of Figs. 6 and 7.

There are different methods by which the high stresses produces through the operation of a "beam" type pumping apparatus may be reduced and the wide stress ranges which accompany the use of these devices may be narrowed. One of these methods constitutes the subject matter of this present application.

According to a preferred embodiment of the present invention, a cylinder-and-piston stress-reducing device is arranged between the beam of the pumping unit and the polished rod, and an arrangement is adopted which causes the piston practically to float somewhere between positions above and below the center of the cylinder. Of course, with different cylinder proportions the zone of floating would be different. Ordinarily, the piston, when this element is connected to the polished rod, will, during the down-stroke of the sucker rod line, float in the cylinder in a relatively high position therein compared with its position during portions, at least, of the up-stroke of the sucker rod line. A cushion of air or other suitable gas under sufficient pressure will be maintained beneath the piston, with the volume of this gas under pressure such that relative upward movement of the cylinder with respect to the piston will be attended by a pressure increase at a substantial rate. Accordingly, when the beam accelerates on the up-stroke and the piston tends to lag behind with relation to the cylinder, there will be a definite rise in pressure over and above that required to balance the rod and fluid load, while when the beam moves on the down-stroke, the piston will move up with relation to the cylinder and the air pressure under it will drop to a value which will substantially balance the rod load only, without an excessively long relative upward movement of the piston. Provision may advantageously be made for the continuous making-up of any fluid lost during the working of the device, and for the venting of any excess of pressure fluid provided, and for limiting, by such venting, of the relative upward

travel of the piston. Furthermore, desirably, devices will be provided for effecting a positive cushioning of the piston in the event of extreme downward relative movement thereof, and in like manner there will be provision for effecting a cushioning of excess upward movements of the piston, should any occur, through suitable means. The source of pressure supply to the stress-reducing device may obviously be varied, but it will be found that a compressor operated off of the beam and having improved means for enabling a variation in the quantity of fluid pumped and for the lubrication thereof, will be highly advantageous.

Now referring to the structure specifically illustrated in this application, it will be noted that the well 1, containing a pump not shown, is adapted to be pumped through the reciprocation of a polished rod 2 which is connected by a suitable connecting device 3 to my improved stress-reducing mechanism generally designated 4 and through the latter and a beam hanger 5 to a walking beam 6. The walking beam 6 is pivotally supported upon a Sampson post 7 and is rocked about its pivot by a pitman 8 which connects it with a suitable beam driving unit; and one of these of conventional construction is shown at 9. Any suitable source of power, as for example a belt drive 10 from a motor or engine not shown, may be provided for the beam operating unit 9.

Referring now more particularly to the structure of the device 4, it will be observed that this includes a cylinder element 12 having associated therewith an upper head 13 and a lower head 14. The bore 15 of the cylinder element 12 contains a piston 16 which has a piston rod 17 passing through a suitably packed opening 18 in the lower head 14 and secured by the connecting device 3 to the polished rod line. The upper head 13 is connected by the connecting element 20 to the beam hanger 5. There is provided near the lower end of the cylinder element 12 a lateral connection 22 connected herein through an elbow 23, a flexible conduit 24, piping 25 and a further flexible conduit 26 to a small receiver tank 27, and to the discharge line 28 from a compressor, generally designated 29, whose details will later be described. The receiver tank may be unnecessary, and it may be made of variable effective clearance volume by filling it to different degrees with a suitable liquid.

The lower head 14 of the cylinder is provided with a check valve controlled passage 31 opening into the lower end of the cylinder at one of its own ends and connected with a passage 32 opening into the port 22 at its other end. A check valve 33 associated with this passage permits the delivery of fluid from the lateral supply connection through the passages 32 and 31 to the bottom of the cylinder bore 15 while preventing reverse flow. There is thus assured under all conditions a definite cushion between the lower cylinder head and the piston, and access of fluid below the piston even if the latter should come to rest on the lower cylinder head during some period of shut-down. The upper head 13 of the cylinder is provided with a check valve controlled passage 35 having associated therewith a check valve 36 which permits inflow of fluid from an atmospheric connection 37 to the top end of the cylinder while preventing reverse flow. This insures a cushion at the top end of the cylinder and renders this cushioning not dependent on leakage past the piston 16.

The cylinder is provided at a point relatively near the longitudinal center thereof with a lateral port 45 provided with a spring-loaded relief valve 46 controlling the efflux of air from the cylinder bore to the atmosphere through the port 45, and preventing a reverse flow through the port 45. This may be loaded to a pressure, say, from five to fifteen pounds per square inch, and as will later be apparent serves to regulate the cushioning in the top of the cylinder and the relative movement of the piston upwardly.

The effective area of the lower side of the piston 16 will be so determined as to provide, with the pressure which is to be maintained in the lower end of the cylinder bore, an adequate force to balance the normal rod load with the piston in a position slightly below the port 45. The volume of the air between its source of supply and the bottom of the piston 16, will be so determined that the relative upward movement of the cylinder with respect to the piston during the raising of the sucker rod line will, materially before the piston approaches closely the lower head of the cylinder, cause the building up of a pressure sufficient to sustain the maximum load imposed by the weight of the rod line, the work of accelerating the latter and the work of raising the oil that is pumped. It will be evident that with such a construction as is described, the piston 16 will, at a point perhaps half-way in the upward movement of the beam hanger 5, occupy a position possibly as far down as that shown in Fig. 3; while during the downward movement of the beam hanger 5, the piston may move upward momentarily as far as the relative position shown in Fig. 2, although it is unlikely that it will occupy a position higher than necessary merely to crack or partially uncover the port 45, provided the rate of air supply is properly controlled.

It will be evident from what has been said that the rate of air supply should be rather precisely controlled with this apparatus, and for this purpose I have provided a pump or compressor operated in synchronism with the movements of the stress-reducing device and adapted to furnish pressure fluid in desired quantity to the space in communication with the volume beneath the piston 16 once during each complete cycle. For this purpose, the compressor or pump mentioned, which is, as above noted, generally designated 29, is shown as of the beam-actuated, air-cooled type and includes a cylinder 50 in which a trunk piston 51 is reciprocable. A suitable mounting for the cylinder, by means of the legs 52 and holding bolts 53, is provided upon a frame 54, herein shown as secured to the side of the Sampson post 7. The piston 51 has a wrist pin 55, connected by a connecting rod 56 of adjustable length pivotally with a block 57 removably held by bolts 58 to the beam 6. The connecting rod 56 is made up of a lower portion 60 having a splined connection at 61 with a reduced end 62a of a member 62 which is bolted at 63 to an upper tubular portion 64 pinned at 65 to a pivot member 66 pivotally supported on a pin 67 carried by the block 57. A rain shield 68 is adjustably mounted on the rod section 60, and the effective length of the connecting rod may be varied to vary the clearance volume of the compressor by the turnbuckle element 70 threadedly engaging the upper end of the rod portion 60 and an intermediate threaded portion 62b of the rod element 62. A lock nut 71 to maintain the parts in adjusted position is provided. The compressor may be provided with any suitable inlet and discharge mechanism and is herein shown as hav-

ing a poppet-type inlet valve 75 held closed by a spring 76 and a poppet-type discharge valve 77 held closed by a spring 78. The construction is such as to provide a minimum clearance, so that a high ratio of compression can be obtained. A supply connection 79 communicates with the inlet valve 75, and a discharge chamber 80 communicates with the compressor discharge line 28. Lubrication of the compressor piston, cylinder, wrist pin, and connecting rod bearing may be effected by maintaining a suitable quantity of oil upon the top of the piston within the upwardly extending skirt of the cylinder. The speed of reciprocation of the piston, frequently less than 50 feet per minute, is insufficient to create any danger of throwing the oil out of the top of the cylinder. By the adjusting mechanism 70, the quantity of fluid delivered can be regulated, and if desired, it is of course possible to bleed off from the system, at a point short of the cylinder 12, any quantity of fluid in excess of the needed amount. However, with a proper adjustment of the parts, it will be found that the venting of the fluid which will normally occur in small quantity during each cycle when the port 45 is uncovered by the lower end of the piston 16, will adequately care for the disposal of any excess pressure pumped by the compressor 29. The provision of the clearance tank 27 enables the increasing of the volume of fluid within the system if desired, but ordinarily this is not requisite.

The compressor 29 may obviously be arranged either to make its discharge stroke during the up-stroke of the device 4 or to make its discharge stroke during the down-stroke of the latter, it simply being necessary to make appropriate adjustments with respect to the quantity of fluid delivered and available clearance volumes, including the working clearance of the compressor, to take care of the situation. Obviously, with the compressor discharging during the down-stroke of the apparatus 4, the discharge pressure of the compressor 29 will be considerably less than is requisite when the compressor discharges during the raising of the device 4, and so that arrangement is shown in Fig. 1. A position of the compressor at the other side of the Sampson post would result in discharge on the lifting movement of the device 4.

The mode of operation of this device will be clear from what has already been said. The clearance volume between the compressor and the lower side of the piston 16 will be small enough so that there will be a definite rise in pressure over and above that required to balance the rod and fluid load when the beam accelerates on the up-stroke, and while the cylinder moves upward relative to the somewhat retarded piston. The increase in pressure that will take place will be sufficient to raise the sucker rod line and the fluid load. Conversely, when the beam moves on the down-stroke, the piston, if it has not indeed already moved into its highest relative position with respect to the cylinder, will quickly attain to a position uncovering or partially uncovering the port 45, and an amount of air will then pass through the relief valve 46 until the pressure below the piston 16 falls enough so that the piston will again cover the port 45 when subjected only to the weight of the rod line and associated parts. The amount that will pass through the port 45 on each cycle of operation will be governed largely by the output of the make-up compressor supplying the air. As the piston moves above the vent port, any excess volume of air will be discharged through the vent port. When the piston moves below the vent port further escape of fluid will be prevented, and upon the lifting of the cylinder by the beam, the piston will lag behind until the reduction in volume of the fluid in the total clearance space results in the production of a pressure sufficient to lift the rods and their load. During the latter part of the upstroke, the slowing down of the movement of the cylinder and the cessation of the need to supply power to accelerate the rods, etc., and the higher pressure beneath the piston will cause the piston to move faster than the cylinder, and the piston will rise from its position shown in Fig. 3 to that of Fig. 2 probably by the end of the pumping stroke. The valve device 46 will prevent more fluid from escaping than is necessary to maintain the desired volume following upon the introduction of the additional quantity supplied by the working stroke of the piston 51.

It will be apparent that I have provided an arrangement in which the shocks of pumping will be largely eliminated, that the maximum stress will be reduced, that there will be an automatic maintenance of the gaseous-cushion-fluid volume at the necessary quantity, that the structure is adaptable to different pumping conditions, and that the stress-range to which the sucker rod line is subjected will be narrowed.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, and means for controlling the pressure of the fluid in the cylinder at the opposite sides of said piston including automatic check valve means opening inwardly into communication with the cylinder ends for supplying fluid thereto.

2. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston and means for controlling the pressure of the fluid in the cylinder at the opposite sides of said piston, said fluid-controlling means including a piston-controlled port opening to atmosphere and communicating with the cylinder at a point to be overrun by said piston during its travel in either direction of reciprocating movement.

3. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, means for supplying fluid at a relatively high pressure to the lower end of said cylinder at the

lower side of said piston, and means for further controlling the pressure of the fluid in the cylinder at the opposite sides of said piston including automatic check valve means opening inwardly into communication with the cylinder ends for supplying fluid thereto.

4. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, means for controlling the pressure of the fluid in the cylinder at the opposite sides of said piston, said fluid-controlling means including a piston-controlled port opening to atmosphere and communicating with the cylinder at a point to be overrun by said piston during its travel in either direction of reciprocating movement, and means for supplying fluid at a relatively high pressure to the lower end of said cylinder at the lower side of said piston.

5. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston and means for controlling the pressure of the fluid in the cylinder at the opposite sides of said piston, said fluid-controlling means including a piston-controlled port opening to atmosphere and communicating with the cylinder substantially midway between its ends and an outwardly opening check valve for controlling the flow of fluid through said port.

6. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a double-acting pneumatic cushioning device having relatively movable parts one connected to the operating end of said walking beam and another connected to said member to be reciprocated, and means for controlling cushioning pressures including a fluid pressure generator actuated by said walking beam for supplying fluid under pressure to one end of said cushioning device and means for venting said end on a predetermined relative movement of said parts.

7. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a pneumatic cushioning device suspended from the operating end of said walking beam and operatively connected to said member to be reciprocated, said cushioning device comprising a cylinder containing a reciprocatory piston and means for controlling the pressure of the fluid in the ends of said cylinder at the opposite sides of said piston including a valve controlled vent overrun by said piston and a fluid pressure generating device actuated by said walking beam and operatively connected to the latter at the same side of its pivot as said cushioning device for delivering pressure fluid to one end of said cylinder.

8. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a pneumatic cushioning device suspended from the operating end of said walking beam and operatively connected to said member to be reciprocated, said cushioning device comprising a cylinder containing a reciprocatory piston and means for controlling the pressure of the fluid in the ends of said cylinder at the opposite sides of said piston including a valve-controlled vent passage and means for delivering fluid to said cylinder including a fluid pressure generating device actuated by said walking beam and operatively connected to the latter at the same side of its pivot as said cushioning device, said fluid pressure generator comprising a stationary cylinder, a piston reciprocable in said last mentioned cylinder and a pivoted connecting rod connected between said walking beam and said last mentioned piston, and fluid conducting means extending from said last mentioned cylinder to said cylinder of said cushioning device at a point spaced from one end thereof and also at its end, in the last case through a valve controlled passage, said fluid conducting means including a flexible conduit.

9. In a well pumping apparatus, the combination with a polished rod and an oscillating beam, of a pneumatic cylinder and piston mechanism supported by said beam and connected between the latter and the polished rod, means for maintaining continuously a pressure beneath the piston of said mechanism, and means for venting excess pressure automatically from beneath said piston when the same is in a relatively high position with respect to said cylinder.

10. In a well pumping apparatus, the combination with a polished rod and an oscillating beam, of means for operatively connecting said beam and polished rod including a cylinder and piston mechanism, a pressure system including a pump actuated by said beam, means for connecting said pressure system with the cylinder of said cylinder and piston mechanism, said pressure system enclosing a volume of gaseous fluid under pressure sufficient in the relative position of the cylinder and piston during the lifting movement of the beam to start and accelerate the polished rod and during the lowering movement of the beam to drop to a pressure approximating the dead weight of the polished rod and the structure supported thereby and piston controlled means for controlling the pressure in said pressure system.

11. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a pneumatic cushioning device having relatively movable parts and suspended from the operating end of said walking beam and operatively connected to said member to be reciprocated, and a fluid pressure generator actuated by said walking beam and having fluid delivery connections leading therefrom to said pneumatic cushioning device, said pneumatic cushioning device having provision for the venting therefrom of cushioning fluid in a predetermined relative position of its parts and said fluid pressure generator delivering during each cycle of beam movement make-up fluid to said cushioning device.

12. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of operative connections between said beam and member including a pneumatic cushioning device having relatively movable parts and a beam-actuated source of pressure fluid operatively connected thereto, the volume within said device and in the connections between the same and said source of pressure fluid so small that substantial pressure changes attend relative movements of the parts of said cushioning device, said cushioning device having pressure venting

means made effective in certain relative positions of its parts and said source of pressure providing make-up fluid during each cycle of beam operation.

13. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a pneumatic cushioning device suspended from the operating end of the walking beam and operatively connected to said member to be reciprocated, and a fluid pump actuated by said walking beam and operatively connected to the latter, said cushioning device having means for the discharge of fluid therefrom during each cycle of operation of the beam and said pump delivering to said cushioning device make-up fluid during each cycle of operation of the beam.

14. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, means for supplying pressure fluid to the lower end of said cylinder at the lower side of said piston, and means for controlling the pressure of the fluid in the cylinder at the opposite sides of said piston including automatic check valve means opening inwardly into communication with each end of said cylinder, said check valve means at one end of said cylinder controlling communication of said cylinder with atmosphere and said check valve means at the opposite end of said cylinder controlling communication of said cylinder with a source of pressure fluid.

15. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, means for supplying fluid at a relatively high pressure to the lower end of said cylinder at the lower side of said piston, said last mentioned means including a valve controlled passage communicating with the lower end of said cylinder and a further passage communicating with said cylinder at a point spaced from the lower end thereof, and means for controlling the pressure in the lower end of said cylinder including a port opening to atmosphere and communicating with said cylinder at a point overrun by said piston.

16. In an apparatus of the character described, the combination with a member to be reciprocated and a walking beam for reciprocating said member, of a fluid cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a reciprocatory piston, means for supplying fluid at a relatively high pressure to the lower end of said cylinder at the lower side of said piston, said last mentioned means including a passage communicating with the lower end of said cylinder and a further passage communicating with said cylinder at a point spaced from the lower end thereof, automatic check valve means opening inwardly for controlling fluid flow through said passage communicating with the lower end of said cylinder, and means for controlling the pressure in the lower end of said cylinder including a piston-controlled port opening to atmosphere and communicating with said cylinder substantially midway between its ends and an outwardly opening check valve for controlling the flow of fluid through said port.

17. In combination, a member to be reciprocated, a walking beam for reciprocating said member, and fluid-cushioning means connected between the operating end of said walking beam and said member to be reciprocated and including a cylinder containing a piston, said cylinder and piston relatively reciprocable, means for supplying pressure fluid to the lower end of said cylinder including a connection for pressure fluid opening into the side of the cylinder at a point above the bottom of the latter and a passage extending from said connection into communication with the bottom of said cylinder, said passage having a check valve therein opening towards the bottom of the cylinder, and a passage in communication with the upper end of said cylinder, said last mentioned passage having associated therewith check valve means opening towards the cylinder bore.

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