Oct. 14, 1941. W. H. WINEMAN 2,259,021

APPARATUS FOR PUMPING OIL WELLS

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Fig. 1.

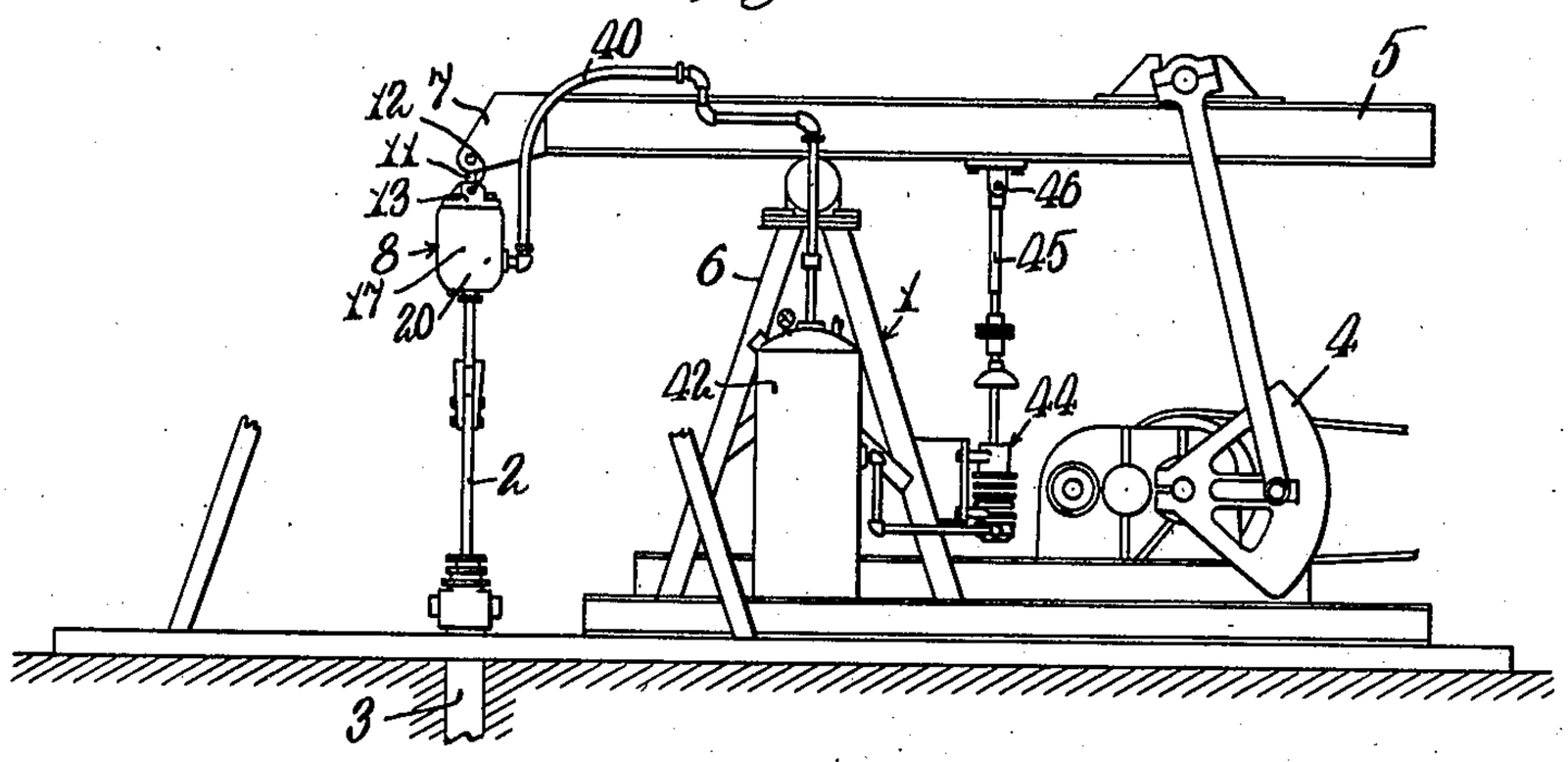


Fig. 2.

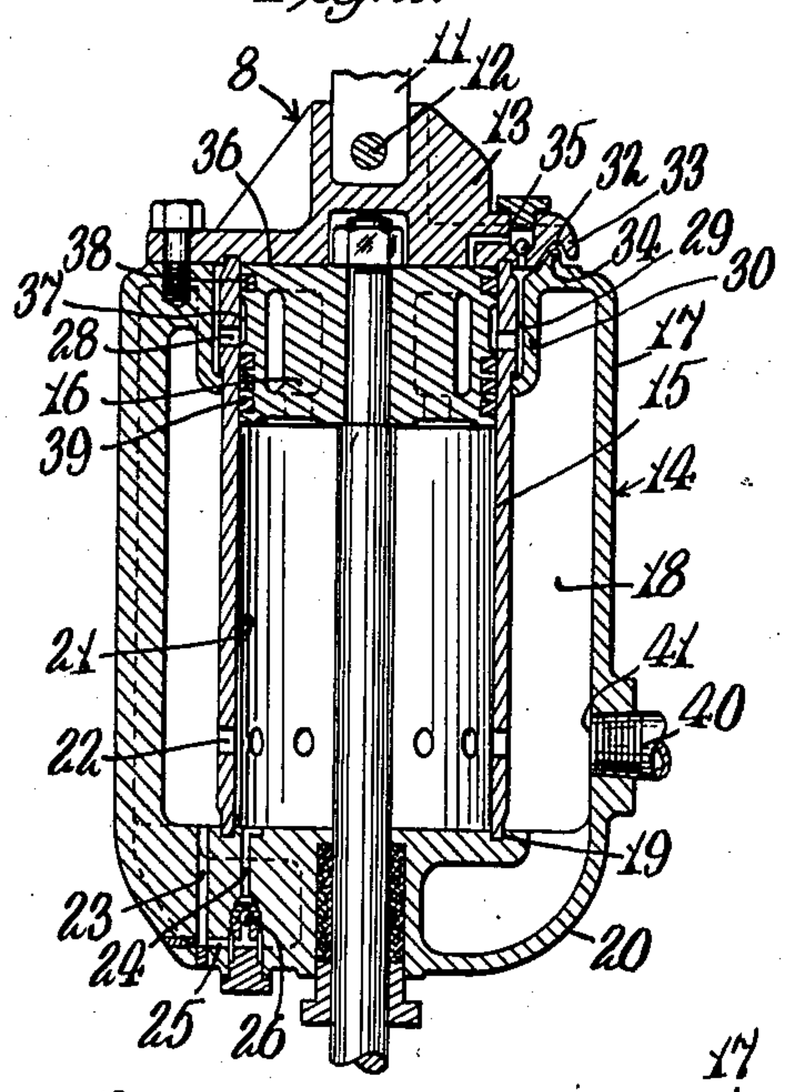
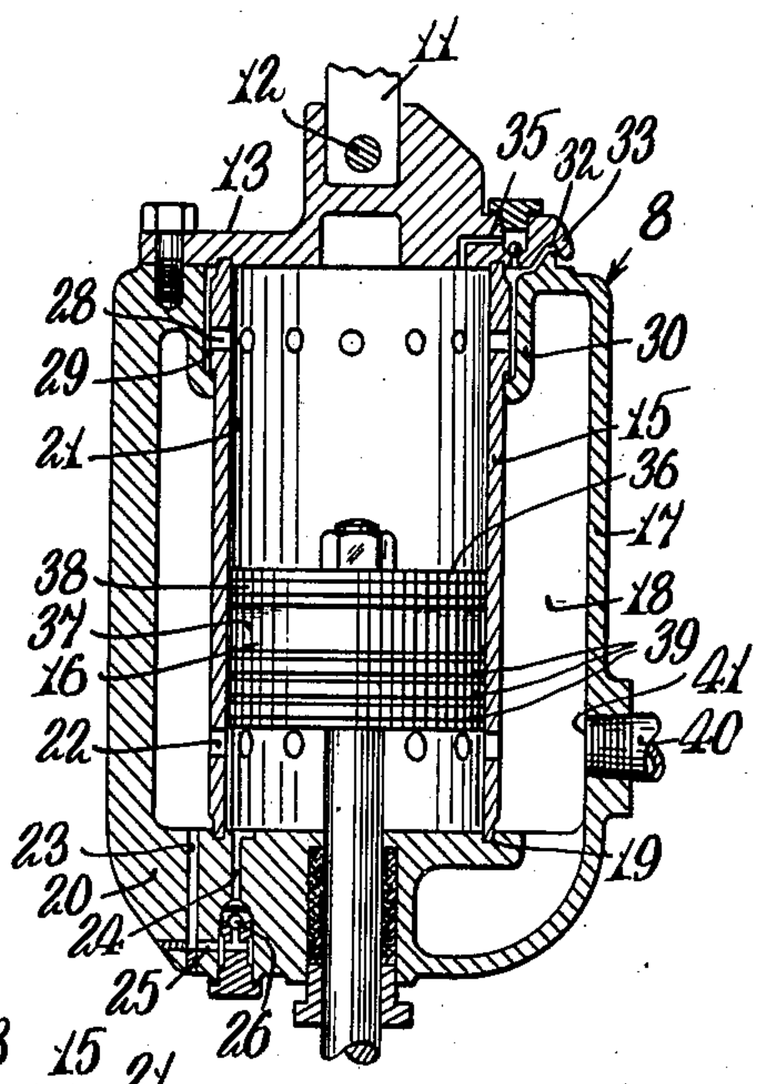


Fig. 3.



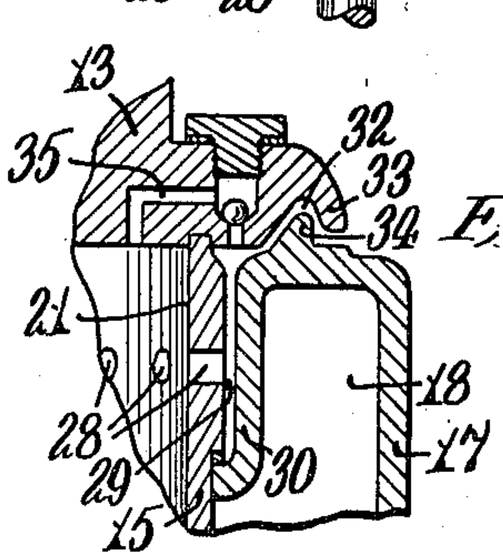


Fig. 4.

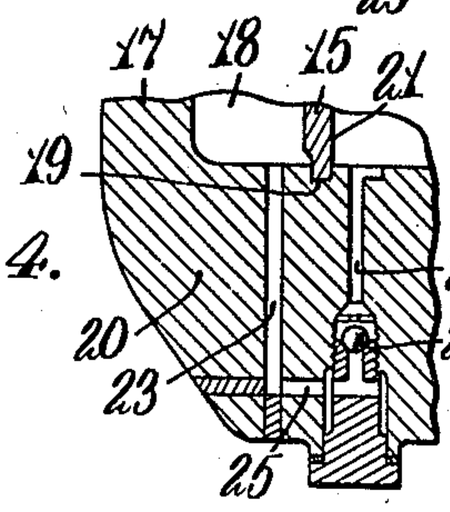


Fig. 5.

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Fig. 6.

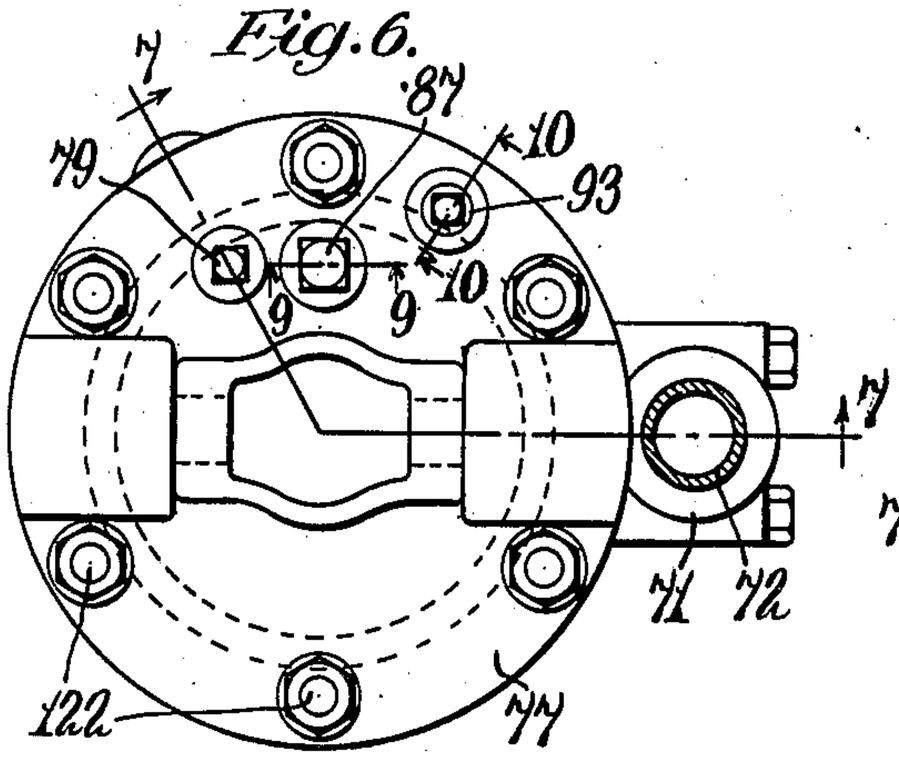
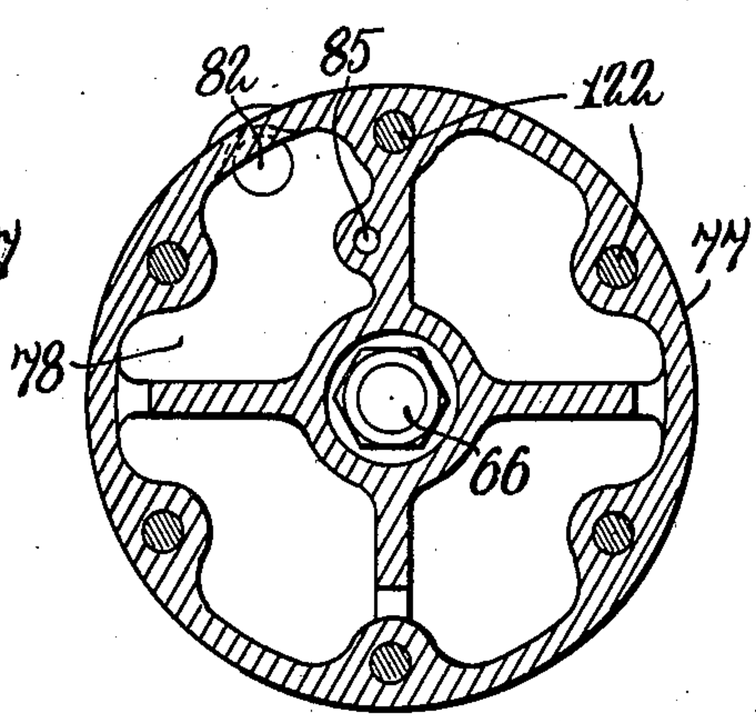


Fig. 8.



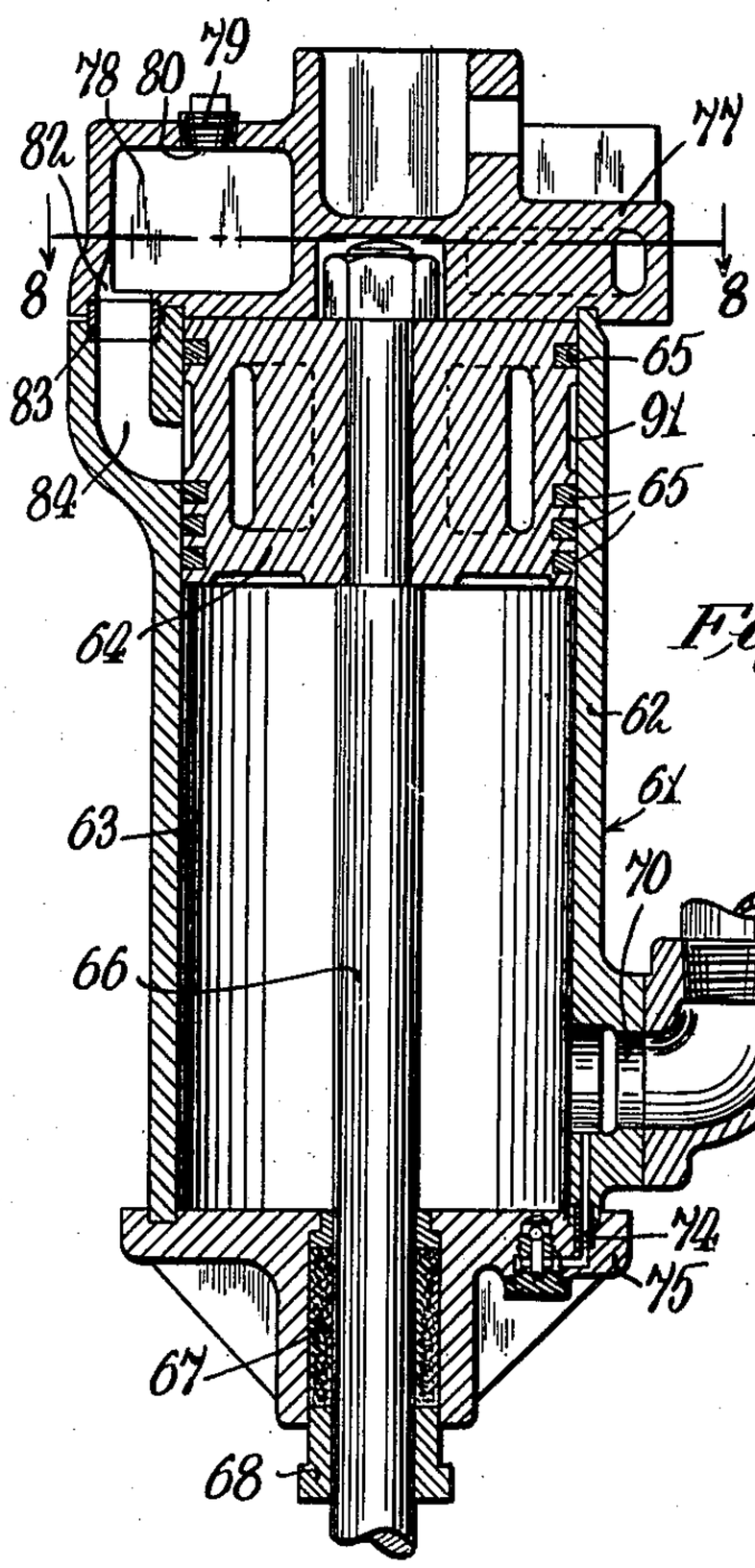


Fig. 7.

Fig. 9.

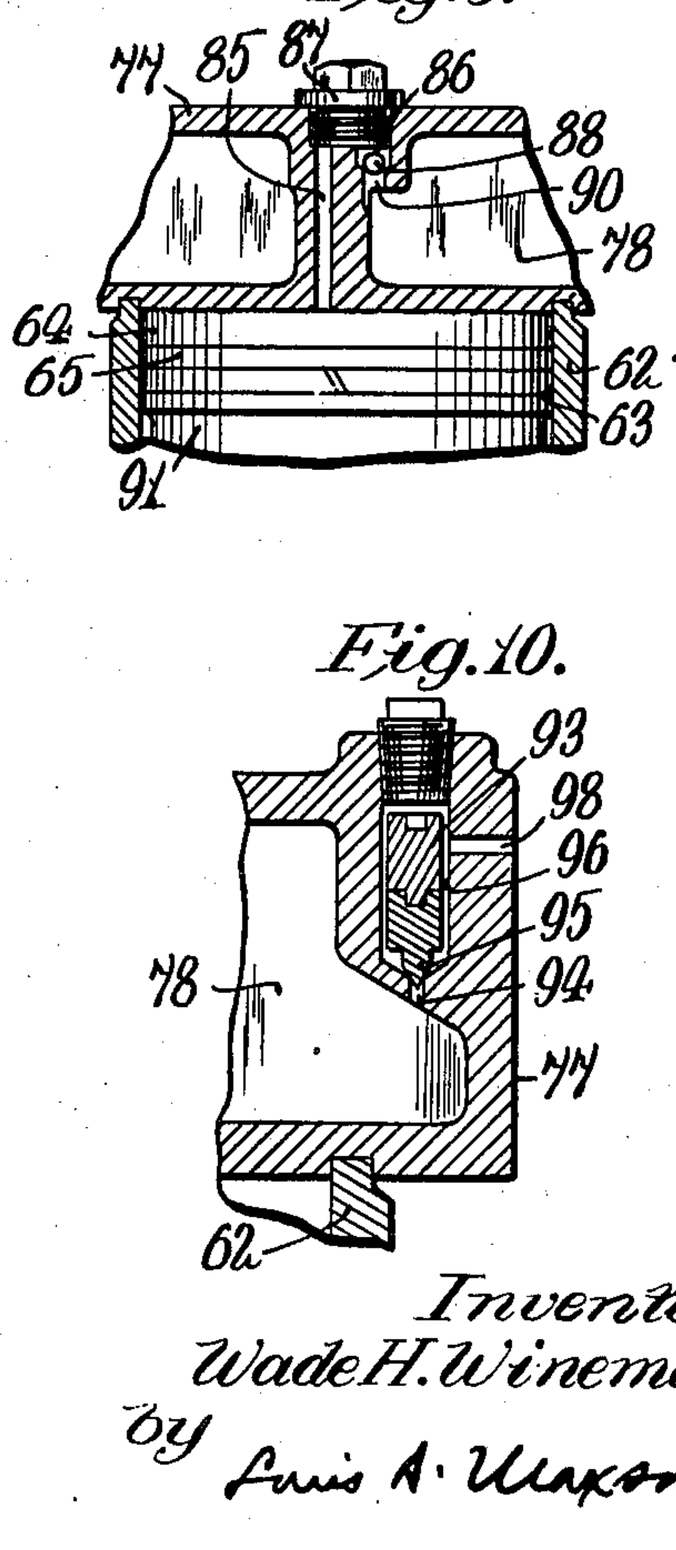


Fig. 10.

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Fig. 11.

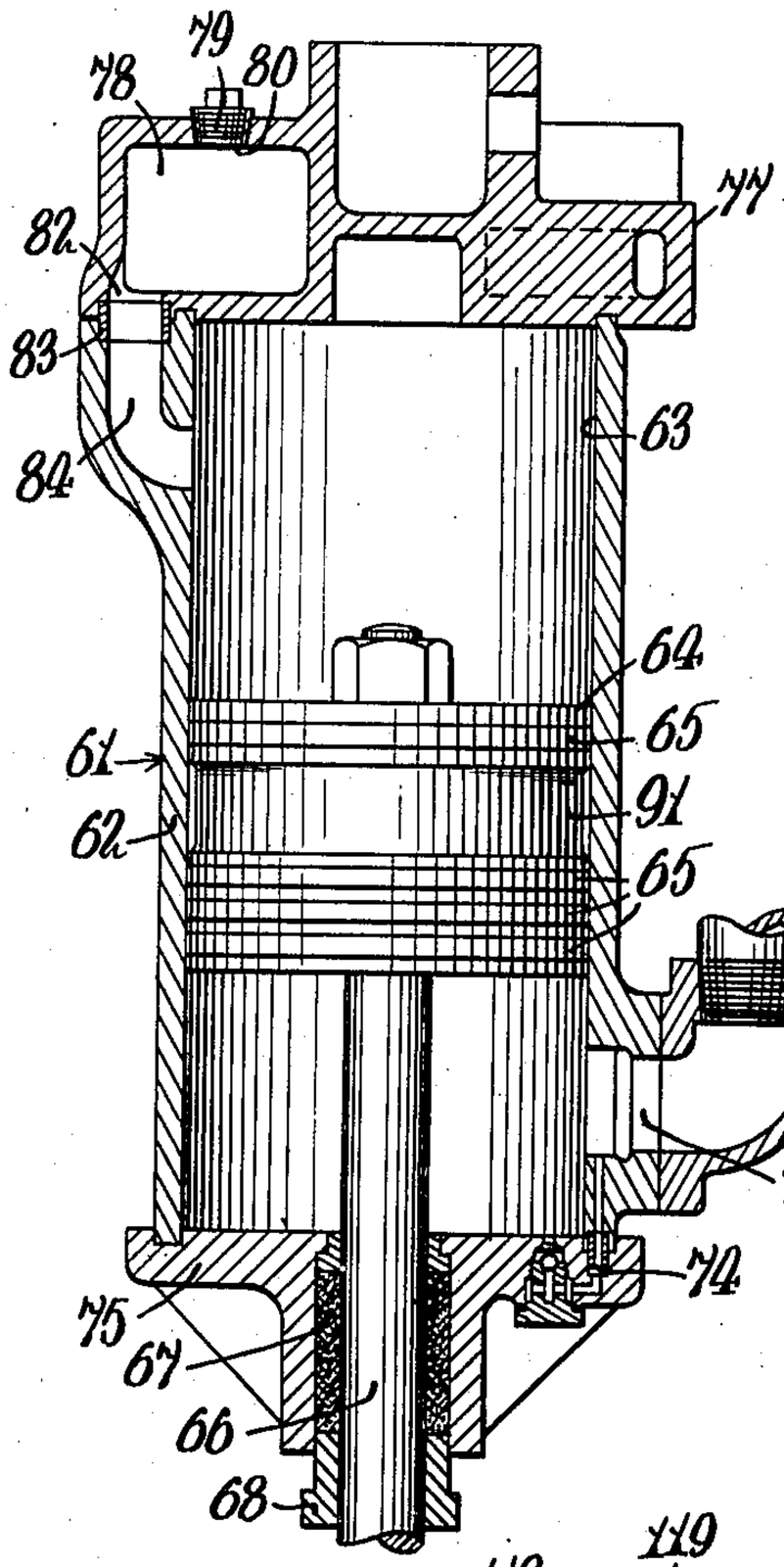


Fig. 13.

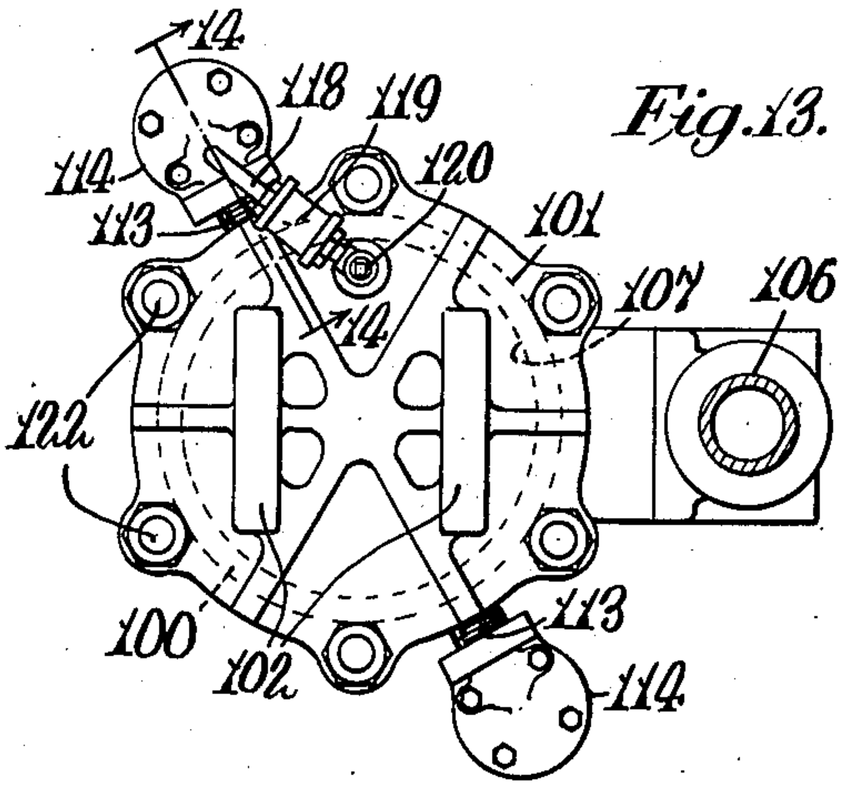


Fig. 12.

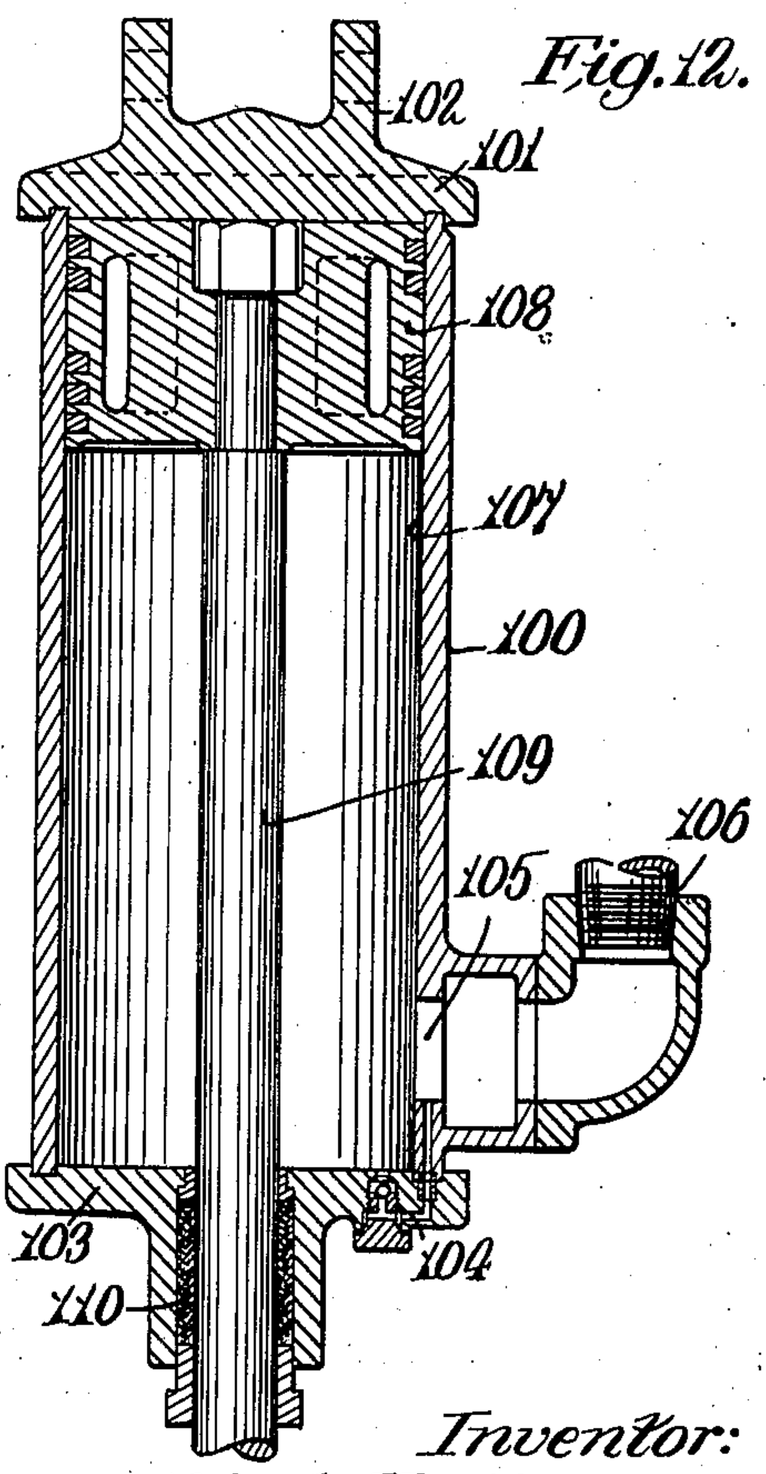
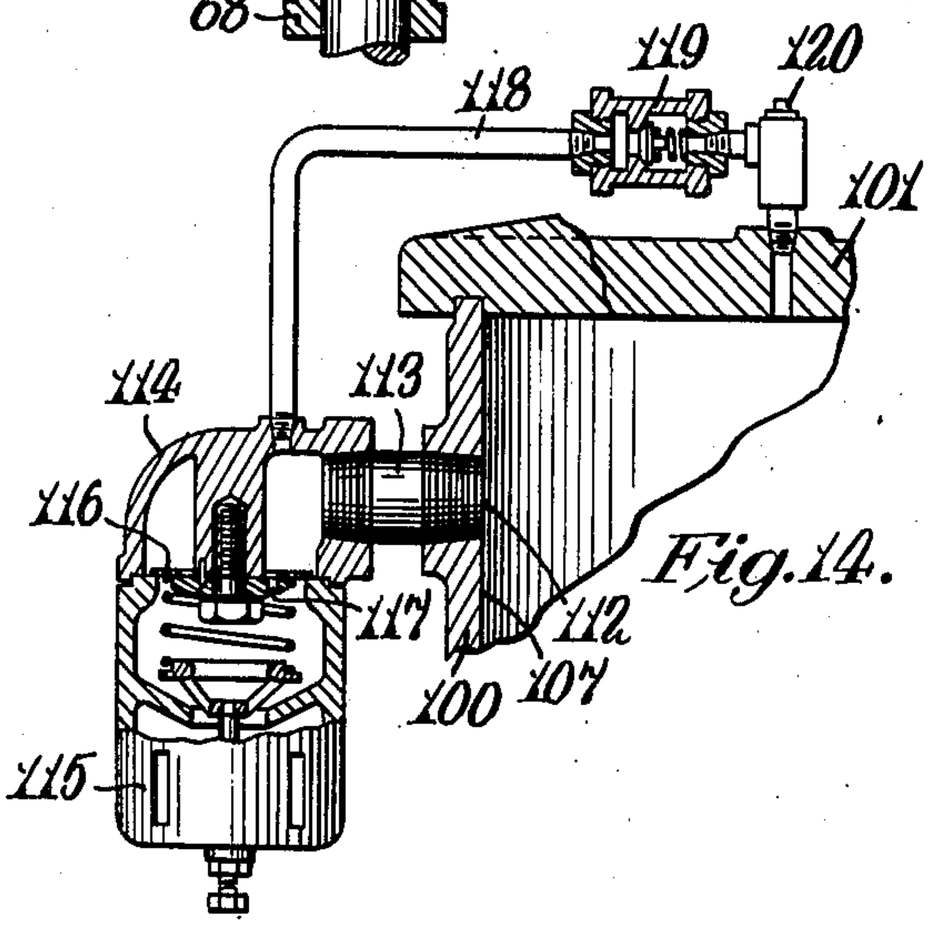


Fig. 14.



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Patented Oct. 14, 1941 2,259,021

UNITED STATES PATENT OFFICE

2,259,021

APPARATUS FOR PUMPING OIL WELLS

Wade H. Wineman, Michigan City, Ind., assignor to Sullivan Machinery Company, a corporation of Massachusetts

Application December 9, 1938, Serial No. 244,784

17 Claims. (Cl. 255—16)

My invention relates to pumping equipment, and more particularly to apparatus for pumping oil wells through the use of a pump in the well, a sucker rod line leading to the surface, and actuating means, and particularly "beam"-type actuating means, upon the surface. From another aspect, my invention relates to devices for reducing stresses in the connections between a source of reciprocating motion and devices reciprocated thereby.

Beam actuation for the sucker rod lines of oil well pumps is by far the most common method of pumping oil wells where natural flow will no longer raise the oil to the surface. With such devices, however, because of the very rapid changes in the stresses to which the sucker rod line is subjected, and the fact that higher stresses are set up than necessary to raise the load actually handled by the pump and imposed by the sucker rod line, the sucker rod lines are very frequently broken; they frequently can be maintained in operation for but short periods between breaks; and considerable expense, both in the repair and replacement of sucker rod lines and in the pulling jobs necessary to make repairs, is encountered.

It is an object of my present invention to provide an improved pumping system. 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 the peak loads to which sucker rod lines are subjected and to minimize the stress ranges imposed by beam-type pumping systems. It is a still further object of my invention to provide an improved arrangement for reducing the stresses between a source of reciprocating motion and the device reciprocated thereby. Other objects and advantages of my invention will hereinafter more fully appear.

In the accompanying drawings, in which, for purposes of illustration, a pumping system in which the illustrative embodiment of my invention is embodied is disclosed, together with certain modifications thereof—

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

Fig. 2 is an enlarged central vertical section through the stress-reducing device shown in Fig. 1.

Fig. 3 is a similar view showing the parts in a different relative position.

Figs. 4 and 5 are enlarged sectional views on the same plane as Figs. 2 and 3, showing details of construction.

Fig. 6 is a top plan view of a modified stress-reducing device.

Fig. 7 is a vertical section on the line 7—7 of Fig. 6 through this modification.

Fig. 8 is a horizontal section on the plane of the line 8—8 of Fig. 7.

Figs. 9 and 10 are detail sectional views respectively on the section lines 9—9 and 10—10 of Fig. 6.

Fig. 11 is a view corresponding generally to Fig. 7 but showing the parts in a different relative position.

Fig. 12 is a central sectional view showing a further modified form of construction.

Fig. 13 is a top plan view of the device of Fig. 12.

Fig. 14 is an enlarged vertical sectional detail view on the plane of line 14—14 of Fig. 13, with parts broken back.

In the accompanying drawings, a pumping apparatus, generally designated 1, is shown for the purpose of reciprocating the polished rod 2, which is connected to a pump-actuating sucker rod line (not shown) in the well 3. A suitable pumping unit of any conventional type as shown at 4 is provided for rocking a walking beam 5 about its pivotal mounting upon a Sampson post 6, and a beam hanger, diagrammatically shown at 7, is adapted to connect, through the improved stress-reducing apparatus generally designated 8, the walking beam 5 with the polished rod 2.

The general principle of the device 8 shown in Figs. 1 to 5 is that of providing a sufficient force to raise the polished rod 2 and the attached sucker rod line without permitting, in the prevention of the building up of excessive stresses, the creation of a sufficient pressure rise to offset, at one point in the working cycle, the advantages gained at other points.

It will be observed that the beam hanger is connected by a suitable link 11 to a pivot pin 12 carried by the upper head 13 of the device 8. The device 8 further comprises a cylinder construction, generally designated 14 and comprising an inner cylinder element 15 in which a piston 16 is reciprocably mounted, and an outer, clearance-forming cylinder or shell 17 spaced by the relatively large, approximately annular space 18, from the cylinder element 15. The lower end of the cylinder element 15 is received in a circular groove 19 formed in a lower head member 20, herein shown as formed integral with the cylinder element 17. The cylinder member 15

has its bore 21 continually connected, by an annularly arranged series of holes 22 near its lower end, with the clearance space 18; and to provide for the transmission of pressure fluid from the space 18 to the lower end of the bore 21 at times when the piston 16 may occupy a position below the ports 22, I have provided ports 23 and 24, respectively opening into the clearance space 18 and into the cylinder bore 21, and connecting passage means 25 having a suitable check valve 26 associated therewith for precluding the passage of pressure fluid from the bore 21 to the clearance space 18 but permitting reverse flow of pressure fluid.

The upper end of the cylinder element 15 is provided with another series of annularly arranged ports 28; and these open into a comparatively narrow annular passageway 29 arranged between the outer wall of the cylinder element 15 and an inner downwardly extended wall 30 of the cylinder element 17. The passage 29 is blanked off at its upper end throughout a substantial portion of its outline, by the lower surface of the head 13, but communicates, through a tortuous passage 32 formed by a grooved portion 33 of the upper cylinder head 13 and a lip or projection 34 on the top of the cylinder element 17, with the atmosphere. The ports 28 are spaced materially below the top of the cylinder bore 21, and a one-way, inwardly-opening connection is provided, by means of the ball-check-valve-controlled passageway 35, between the extreme top of the cylinder bore 21 and the top of the passageway 29 adjacent the communication of the latter with the tortuous passage 32.

The construction shown and described will obviously permit, upon relative downward movement of the piston 16 within the cylinder member 15 from the position shown in Figure 2, initially a somewhat restricted flow through the check valve controlled passage 35, between the atmosphere and the upper end of the cylinder bore 21; and after the piston is in a position with its top surface 36 below the ports 28, there will be a freer breathing during relative movement between the cylinder and piston elements, with respect to the surrounding air, into and out of the cylinder bore.

It may be noted that the piston is peripherally grooved, as at 37, and that it has rings 38 and 39 respectively above and below the annular groove 37. The groove 37 prevents, in large measure, leakage of the relatively high pressure which is maintained below the piston, upwardly along the sides thereof to the extreme top of the cylinder bore; and the groove 37 serves to vent, when in communication with the ports 28, any pressure which may leak past the rings 39.

The space 18 is adapted to be connected with any suitable source of gaseous fluid at adequate pressure. For the purpose of furnishing the desired pressure, for purposes of illustration I have shown a flexible connection of comparatively large capacity, indicated at 40, connecting an orifice 41 opening into the space 18, with a storage or clearance volume chamber provided by a receiver or volume tank 42. The tank 42 is supplied with fluid under pressure by any suitable means, and I have herein shown for this purpose a beam-actuated compressor 44 actuated through a pitman 45 pivotally connected at 46 to the beam 5, for delivering air at the necessary pressure.

The clearance space 18, by reason of its free communication through the ports 22 with the cylinder bore 21, and by its very close proximity to and free communication with that bore, tends to reduce the effect of relative movement between the cylinder 15 and piston 16 in the matter of pressure changes. In the device illustrated, the space 18 is not sufficiently large to furnish all of the clearance volume necessary to hold down the pressure rise during upward movements of the beam hanger 7, to the desired extent, but through its presence and its relatively free communication with the lower end of the cylinder bore 21 through the substantial number of ports 22, and through its connection through the device 40 with the clearance chamber 42, the occurrence of substantial pressure rises in the cylinder bore 21 when the cylinder 15 rises more rapidly than the piston 16, is precluded.

The mode of operation of this apparatus may be described as follows. When it is desired to begin the pumping operation, either the device 8 will be disconnected from the beam hanger 7, or the connection between the device 8 and the polished rod line 2 will be interrupted, in order that the walking beam may be operated for a time to cause the compressor 44 to build up the necessary pressure within the receiver or volume tank 42. After the desired pressure has been established in this tank, operative connection between the beam and the polished rod will be established through the device 8, and the subsequent operation will be as follows: Because of the provision of the passages 23, 24 and 25 and the check valve 26, the supply of pressure from the tank 42 through the line 40 and into the clearance space 18 will enable the passage also of pressure fluid into the lower end of the cylinder 21, notwithstanding the fact that the piston 16 may initially rest upon the top surface of the lower head 20. Accordingly, before the actuation of the sucker rod is initiated, the parts may be caused to assume approximately the relative position shown in Fig. 2. Thereafter, upon the starting of the drive of the polished rod 2 by the beam 5, upon the first upward movement of the left-hand end of the beam from its lower position, the cylinder device will move more rapidly during the first portion of its upward travel than the piston 16, and a small increase in pressure over and above the initial pressure within the spaces 21 and 18 will be produced. As the upward motion of the beam continues and the sucker rod line and pump plunger are set in motion, the pressure below the piston 16, which will exceed the amount necessary to raise the load carried by the polished rod, will cause the piston to exceed in upward velocity the cylinder member, and prior to the attainment of the uppermost position of the cylinder the piston will have resumed its position shown in Fig. 2. It will occupy some position, corresponding perhaps to that of Fig. 3, at the point of its maximum lag behind the cylinder. When the piston overtakes the cylinder, there will be no hammering of the piston against the cylinder head 13, because air will be entrapped when the ports 28 are overrun by the top surface 36 of the piston, and a cushion will be provided. If at any time the pressure in the space 18 should for any reason be less than that necessary to sustain the load imposed on the polished rod 2 by the sucker rod line, the pump and the oil, hammering of the lower end of the piston 16 against the lower head 20 will be prevented because of the dashpot effect provided by the arrangement of the ports

22 materially above the bottom of the cylinder element 15 and the one-way communication through the passages 23, 24 and 25 between the cylinder bore 21 and the space 18. The tortuous passage 32 will provide for free breathing between the upper end of the cylinder bore and the surrounding atmosphere at all times when the top surface 36 of the piston is below the annular series of ports 28, and the construction of this passage will prevent the drawing of harmful quantities of dust into the cylinder bore 21. The check-valve-controlled passage 35 will prevent the formation of vacua in the top end of the bore 21 tending to augment the rod line stress as the device 8 is moved in its upward travel.

It will be evident that the stress-reducer so far described will reduce the pressure changes growing out of relatively more rapid upward movement of the cylinder than of the piston, due to the presence of the relatively large clearance immediately surrounding the cylinder 15 and communicating freely with the bore of the latter. Obviously the double check-valve-controlled connections between the cylinder bore and a source from which fluid may be supplied to the cylinder bore will provide an adequate and very desirable cushioning effect. Moreover, this will be further augmented and the operation of the device improved by the arrangement of the ports 28, relatively annular groove or passage 29, the baffled passage 32, etc. The device is self-protective, precludes excessive stresses, and avoids damaging shocks at any time.

In Figs. 6 to 11, inclusive, another form of cylinder and piston mechanism of improved construction and providing for effective cushioning and also lubrication, is disclosed. In this series of figures it will be noted that the stress-reducing device 61 comprises a cylinder member 62 having a bore 63 in which a piston 64 is relatively reciprocable. The piston 64 is provided with appropriate rings 65 and has a piston rod 66 extending through a suitable packing 67 and gland 68, and adapted to be connected, as in the first species of the invention, with the polished rod, which is arranged at the upper end of a sucker rod line leading to a pump in the well. The cylinder 62 has a lateral opening 70, spaced somewhat above the lower end thereof so as to insure the provision of a cushion at the bottom of the cylinder; and through a suitable fitting 71 and flexible connection including a pipe 72, communication is maintained between the bore of the cylinder and a clearance or air storage tank, as in the case of the first species of the invention. A suitable check-valve-controlled passage 74 is arranged in the lower head 75 of the cylinder for the purpose of admitting cushion pressure to the bottom end of the cylinder and for the purpose, further, of insuring the admission of the volume tank pressure to the bottom of the cylinder even though the piston may, at the starting of the device, be at its lower end slightly below the bottom of the opening 70. The upper end of the cylinder 62 is provided with a head 77, and this head is provided with a chamber 78 of substantial volume—a volume so determined as to prevent the formation of a substantial vacuum upon the movement of the top head of the cylinder away from the piston 64 on the up strokes of the walking beam. The space 78 serves not only to provide an enlarged clearance at the top end of the cylinder, but also as a lubricant reservoir, and a filler plug 79 closes an opening 80 through which a quart or more of lubricant in the form of a suitable oil, can be introduced into the chamber 78. The bottom of the chamber 78 is connected, through an opening 82, a push nipple 83, and a passage 84 opening into the upper end of the cylinder 62 at a point materially spaced below the top thereof, with the bore of the cylinder 62. Except in the position of the piston shown in Fig. 7, or other positions in which the top end of the piston is high enough to close the communication of the passage 84 with the cylinder bore, the top end of the cylinder bore is in free communication with the space 78; and when the piston is below the mouth at the lower end of the passage 84 the lubricant from the chamber 78 will flow freely into the cylinder bore and rest upon the top of the piston 64. In order that pressure may be admitted to the space in the top end of the cylinder 62 under all circumstances, there is provided a passage 85 connecting a small clearance space 86 lying beneath a plug 87 with the top end of the cylinder; and a check valve 88, opening from the clearance space 78 towards (in the direction of flow) the cylinder bore, controls the communication of a passage 90, opening into the space 78, with the space 86, and so with the top end of the cylinder. With the location of the passage 84 and the passage arrangement just described, it will be evident that the clearance chamber 78 will communicate freely through the passage 84 with the upper end of the cylinder bore when the piston 64 is in one of its relatively lower positions, while when the piston is in one of its upper positions communication will be established through the passage 90, space 86 and passage 85, between the chamber 78 and the top of the cylinder bore, whenever the pressure in the space 78 exceeds that in the cylinder bore. Thus, for example, upon initial relative downward movement of the piston with respect to the cylinder, from the position of the parts shown in Fig. 7, formation of a vacuum in the cylinder bore is avoided by the flow of pressure fluid from the chamber 78 through the passage 90, space 86 and passage 85, to the upper end of the cylinder bore.

It may be noted that the piston 64 is grooved between its ends at 91, and that in the top position of the piston in the cylinder this groove communicates with the lower end of the passage 84, so that any pressure leaking past the lower series of rings 65 upwardly along the piston will be intercepted by the groove 91, and the leaking fluid will be conducted through the passage 84 to the clearance space 78. To prevent the development of an excess pressure in the clearance space 78, I have provided a weight-loaded relief valve device 93; shown in Fig. 10, where it will be observed a passage 94 opening from the space 78 is connectible, under the control of a valve 95, with a chamber 96, in which the weighted valve device is arranged, and fluid entering the chamber 96 upon unseating of the valve element 95 may pass around the sides of the weighted valve structure and to a vent port 98. The loading of the valve 95 will be, desirably, such that no substantial vacuum will be produced in the space above the piston even when the piston and cylinder are in the relative position shown in Fig. 11—a position which may be assumed when the walking beam is perhaps midway of its lifting movement.

The structure illustrated in Figs. 6 to 11 will obviously cushion very effectually the upward movements of the piston in the cylinder, will provide assured lubrication, will preclude on the one hand excessive pressures above the piston

and on the other inadequate cushioning, and, like other devices operating upon its general principle, will greatly reduce peak stresses and the range of stresses undergone by the sucker rod line.

In Figs. 12, 13 and 14, another arrangement of the stress-reducing means is disclosed. In this arrangement a cylinder **100** is provided with an upper head **101** having ears **102** for attaching it in any suitable manner to a beam hanger, and the cylinder also has a lower head **103**. The construction of the lower head, in all essential particulars, is the same as in the second species described, and the lower head has a check-valved passage **104** for insuring a cushion at the lower end of the cylinder, as in the constructions heretofore described. Also the cylinder has a lateral connection, spaced somewhat above its bottom, at **105** for the attachment thereto of a connection **106** of substantial size with a supply in relatively large volume of gaseous pressure fluid at a pressure capable of supporting the load upon the polished rod which is actuated through the stress-reducing means. The cylinder **100** has a bore **107** in which a piston **108** is reciprocably mounted, and the piston has a rod **109**, passing through a suitably packed stuffing box **110** in the lower head **103** and adapted to be connected to a polished rod. Lateral openings **112** are formed in the cylinder at a distance below the top of the latter sufficient to insure adequate cushioning when the piston **108** passes above the opening. A suitable connection **113** supports a combined air cleaner and vent-check valve **114** adjacent each opening **112**. The structure of these devices **114** is fully disclosed and claimed in my copending application Serial No. 102,987, now matured into Patent No. 2,195,205, granted Mar. 26, 1940. It will suffice, therefore, to point out here that it includes a lower, centrifugal-type spirally-slotted, dust separating portion **115**, a normally-open, inwardly-opening, outward-flow-closable valve **116**, and a constantly-open port **117** which closure of the valve **116** will not interrupt. This device prevents excessively rapid outflow of air from the cylinder **100**, permits the latter to "breathe" normally at its upper end, and reduces the access of dirt or dust to the cylinder, and if there should be a parting of the sucker rod line would aid in preventing damage due to the sudden upward surge of the piston **108** in the cylinder bore **107**, operating to this effect by providing an earlier cushion. A connection **118** extends between the top of one device **114** and the upper end of the cylinder, and a check-valve **119** is provided to permit flow of air from the cleaner to the cylinder top, but to prevent reverse flow, thus assuring cushioning and preventing vacuum formation in the upper end of the cylinder. A connection at **120** is shown for any suitable form of lubricating means (not shown).

The mode of operation of this embodiment of my invention requires little further description. When the cylinder **100** is raised through the connection to the beam with its upper head, the piston **108** will, due to the weight of its suspended load, the inertia thereof, and the fact that it will take some time to accelerate the load, move upwardly less rapidly than the cylinder. During the later part of the up-stroke, the cylinder will decelerate and the piston will return substantially to the position shown in Fig. 12, being prevented from engagement with the head **101** by the cushion provided by the arrangements hereinabove described. During the down-stroke of the beam, the cylinder and piston will move in unison with the piston substantially at the top of the cylinder. If the piston ever moves to the bottom of the cylinder the valved passage **104** will deliver air to effect raising of it to a position opening port **105**, when air pressure is delivered through connection **106**, and if this connection should break, or the air pressure fail for any reason, shock due to the piston's striking the bottom head **103** would be prevented by the dash-pot arrangement described.

It will be understood that in each of the species of the invention described the parts of the cylinder assembly: cylinder, top head and bottom head, may be held together in any suitable way, in Fig. 2 the lower head being integral with the outer cylinder member, and in the later species side rods and nuts, numbered **122** in Figs. 6, 8, and 13, being used for the purpose of maintaining the parts assembled.

In view of the descriptions of the general system and of the individual structures heretofore given, it is sufficient here to state, in conclusion, that the invention will reduce markedly the stresses, and the range of stresses, to which the sucker rod line is subjected, that the desired positioning of the piston is assured without any danger of shocks or breakage through lack of cushioning, that lubrication is advantageously effected in one of the species disclosed, that minimizing of pressure changes due to piping restrictions is also secured by another of the species disclosed, and in a third species an additional and very effective guard against damage in the event of sucker rod breakage is provided.

While there are in this application specifically described three forms which my invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be further 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 nature described, a cylinder, a piston therein, a connection with a substantial volume of fluid continuously under pressure exceeding atmospheric and opening through the side of the cylinder at a point spaced from one end of the latter, a lateral opening into said cylinder for the influx and discharge of fluid spaced from the other end of the cylinder a distance less than the length of said piston, and a one-way flow connection between said lateral opening and the adjacent end of said cylinder.

2. In an apparatus of the nature described, a cylinder, a piston therein, means surrounding said cylinder for storing a substantial volume of fluid continuously under pressure exceeding atmospheric, a connection with said substantial volume of fluid continuously under pressure exceeding atmospheric opening through the side of the cylinder at a point spaced from the bottom of the latter less than the length of the piston, and a lateral opening communicating freely with atmosphere for the influx and discharge of fluid spaced from the top of the cylinder less than the length of said piston.

3. In an apparatus of the nature described, the arrangement defined in claim 1 characterized in that a one-way flow connection is provided between the side connection and the adjacent end of the cylinder.

4. In an apparatus of the nature described, a cylinder, a piston therein, a connection with a substantial volume of fluid continuously under pressure exceeding atmospheric, said connection opening through the side of the cylinder at a point spaced from the bottom of the latter less than the length of the piston, a one-way flow connection extending between said side connection and the lower end of the cylinder, and a lateral opening communicating freely with atmosphere for the influx and discharge of fluid spaced from the top of the cylinder less than the length of said piston.

5. In an apparatus of the nature described, a cylinder, a piston therein, a connection with a substantial volume of fluid continuously under pressure exceeding atmospheric and opening through the side of the cylinder at a point spaced from one end of the latter, a lateral opening for the influx and discharge of fluid spaced from the other end of the cylinder a distance less than the length of said piston, and a one-way flow connection between said side connection and the adjacent end of the cylinder.

6. In an apparatus of the nature described, a cylinder, a piston therein, a connection with a substantial volume of fluid continuously under pressure exceeding atmospheric opening through the side of the cylinder at a point spaced from the bottom of the latter less than the length of the piston, a lateral opening communicating freely with atmosphere for the influx and discharge of fluid spaced from the top of the cylinder less than the length of said piston, a one-way flow connection between said side connection and the bottom of the cylinder, and a one-way flow connection between the lateral opening and the top of the cylinder.

7. In an apparatus of the character defined, a stress-reducing device including a cylinder element containing a piston element, one of said elements connected to a beam and the other to a sucker rod, means for maintaining a pressure in the lower end of said cylinder tending to reduce the overall length of said stress-reducing device to a minimum, and means including a chamber having communication with said cylinder at a point spaced from the upper end of said cylinder element for regulating the pressure changes in the upper end of said cylinder element.

8. In an apparatus of the character defined, a stress-reducing device including a cylinder element containing a piston element, one of said elements connected to a beam and the other to a sucker rod, means for maintaining a pressure in the lower end of said cylinder tending to reduce the overall length of said stress-reducing device to a minimum, and means including a chamber having communication with said cylinder at a point spaced from the upper end of said cylinder element a distance less than the length of said piston for regulating the pressure changes in the upper end of said cylinder element and for storing lubricant in free communication with said cylinder.

9. In an apparatus of the character described, a cylinder element, a piston element in said cylinder element, one of said elements connectible to a beam and the other to a sucker rod line, means for providing a pressure in one end of said cylinder element for cushioning the relative movements of said elements during raising of said elements, and breathing and cushioning means for the other end of said cylinder element including a combined air-cleaner and vent-check device in communication with the cylinder through the side of the latter, and a valved passage connecting the interior of said device with the cylinder through one end of the latter.

10. 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 shock absorber pivotally suspended from the operating end of said beam and operatively connected to said member to be reciprocated and comprising a fluid cylinder containing a reciprocable piston and means for controlling the pressure of the fluid in the ends of the cylinder at the opposite sides of said piston, said pressure-controlling means including a chamber fixed to and moving with said fluid cylinder and forming a source of high pressure fluid communicating with the cylinder at the lower side of said piston, and check valve means for controlling the supply of fluid at atmospheric pressure to the cylinder at the upper side of said piston, said points of communication of said high pressure fluid source and said check valve means with said cylinder being spaced from the ends of said cylinder to provide cushioning spaces for said piston.

11. In an apparatus of the nature described, a cylinder, a piston reciprocable therein, a chamber having substantial volume connected to said cylinder at a point spaced from one end of the latter, means for maintaining a substantial pressure in said chamber during reciprocation of said piston, a one-way flow connection between said chamber and the adjacent end of said cylinder and a lateral opening for the influx and discharge of fluid spaced from the other end of the cylinder a distance less than the length of said piston.

12. In an apparatus of the nature described, a cylinder, a piston reciprocable therein, a chamber having substantial volume connected to said cylinder at a point spaced from the bottom of the latter less than the length of said piston, means for maintaining a substantial pressure in said chamber during reciprocation of said piston, a lateral opening into the cylinder for the influx and discharge of fluid spaced from the other end of the cylinder a distance less than the length of said piston, and a one-way flow connection between said lateral opening and the adjacent end of said cylinder.

13. In an apparatus of the character defined, a cylinder, a piston reciprocable therein, a chamber having substantial volume connected to said cylinder at a point spaced from one end of the latter, means for maintaining a pressure in said chamber exceeding atmospheric pressure during reciprocation of said piston, a chamber having substantial volume connected to said cylinder at a point spaced from the other end of said cylinder, and a one-way flow connection between said first mentioned chamber and the adjacent end of the cylinder.

14. In an apparatus of the character defined, a cylinder, a piston reciprocable therein, a chamber having substantial volume connected to said cylinder at a point spaced from one end of the latter, means for maintaining a pressure in said chamber exceeding atmospheric pressure during reciprocation of said piston, a chamber having substantial volume connected to said cylinder at a point spaced from the other end of said cylinder a distance less than the length of said piston, and a one-way flow connection between

said last mentioned chamber and the adjacent end of the cylinder.

15. In an apparatus of the character defined, a stress-reducing device including a cylinder element containing a piston element, a beam, and a polished rod, one of said elements connected to said beam and the other to the rod, means for maintaining a pressure in said cylinder tending to reduce the overall length of said stress-reducing device to a minimum, means including a chamber having communication with said cylinder at its upper end and at a point spaced from its upper end for regulating the pressure changes in the upper end of said cylinder element, and valve means for controlling communication of said chamber with said cylinder at its upper end.

16. In an apparatus of the character defined, a cylinder, a piston reciprocable therein, a chamber connected to said cylinder at a point spaced from one end of the latter, means for maintaining a pressure in said chamber exceeding atmospheric pressure during reciprocation of said piston, a chamber having substantial volume connected to said cylinder at a point spaced from the other end of said cylinder, and means for connecting said last mentioned chamber to atmosphere at a predetermined super-atmospheric pressure therein.

17. In an apparatus of the character defined, a cylinder, a piston reciprocable therein, a chamber connected to said cylinder at a point spaced from one end of the latter, means for maintaining a pressure in said chamber exceeding atmospheric pressure during reciprocation of said piston, a chamber having substantial volume connected to said cylinder at a point spaced from the other end of said cylinder, means including a valve responsive to a predetermined super-atmospheric pressure in said last mentioned chamber for connecting the latter to atmosphere, and a one-way flow connection between said last mentioned chamber and the adjacent end of said cylinder.

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