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2,650,574

FLUID LIFT PUMPING EQUIPMENT

Filed Aug. 4, 1947

4 Sheets-Sheet 1

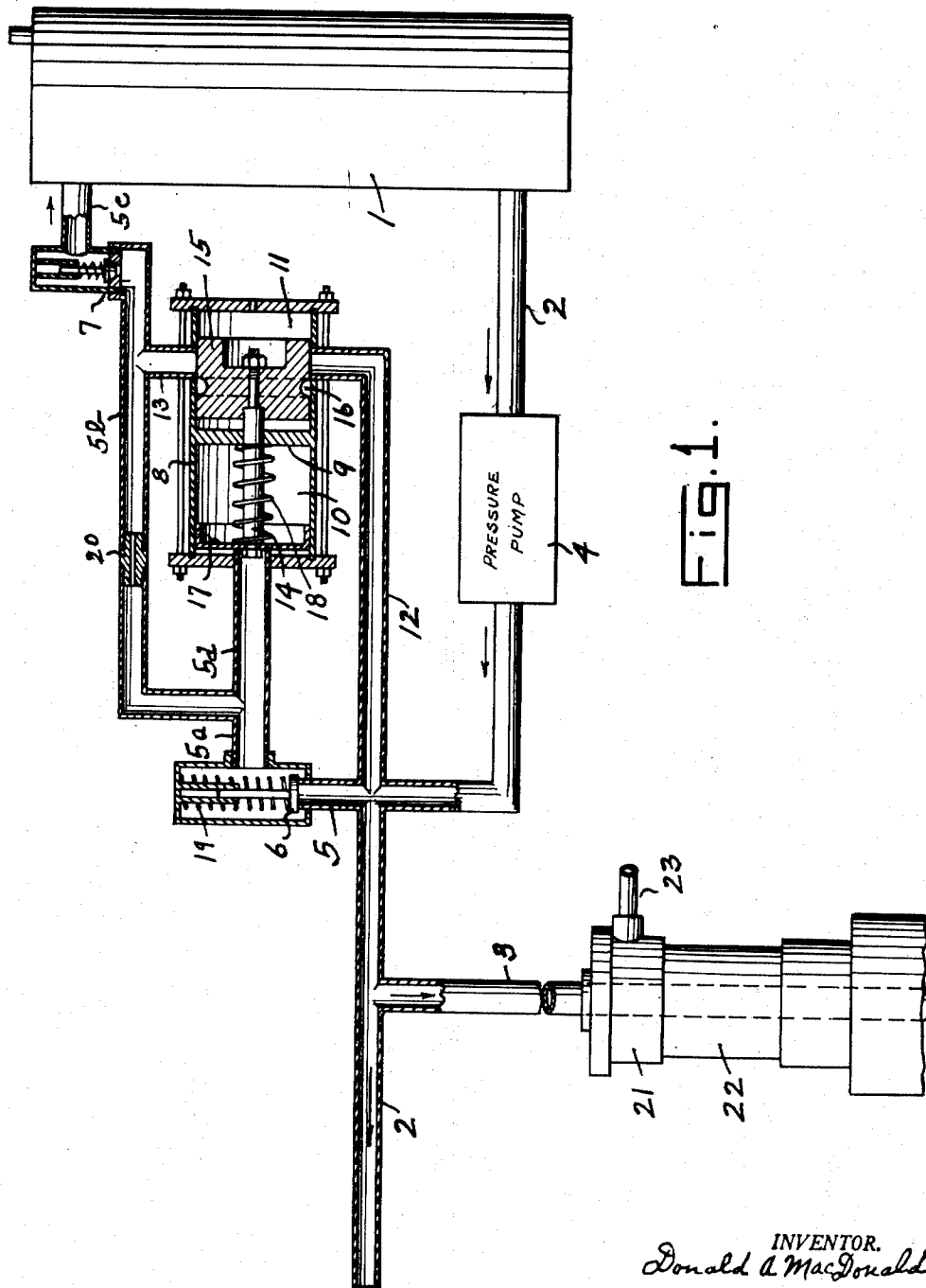


FIG. 1.

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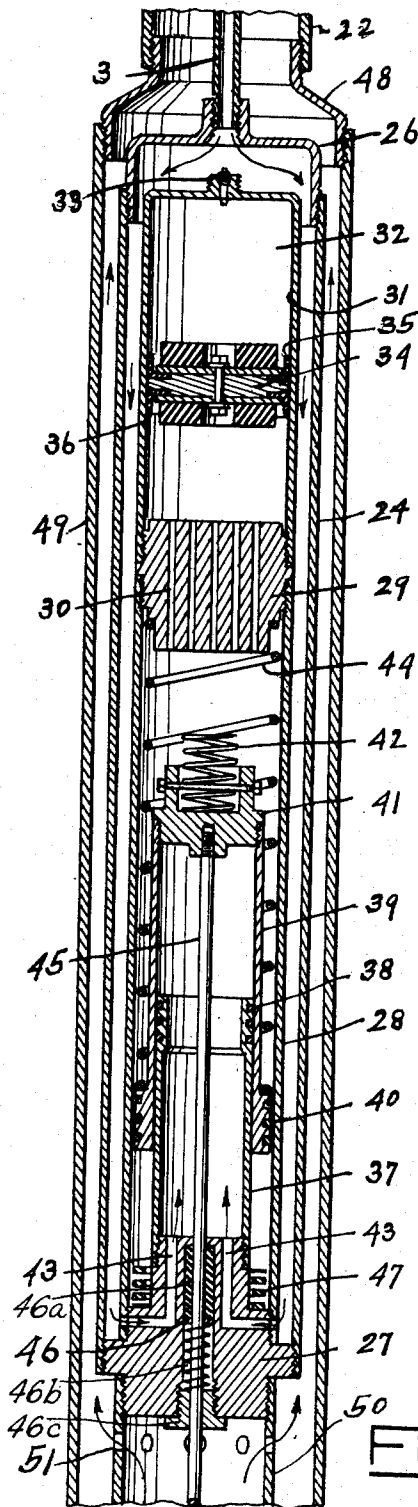


Fig. 2.

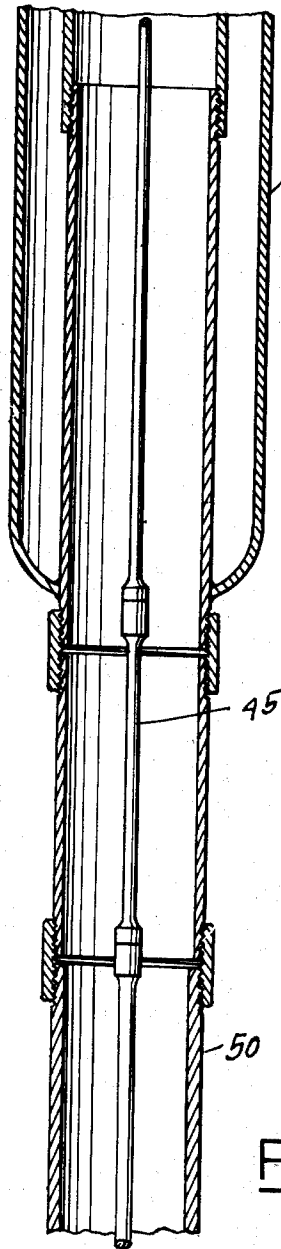


Fig. 3.

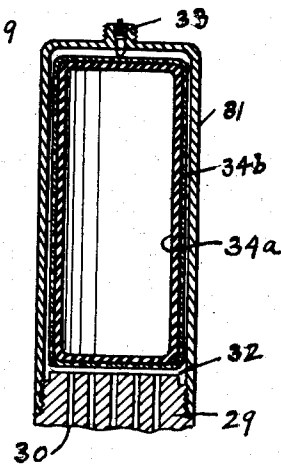


Fig. 4.

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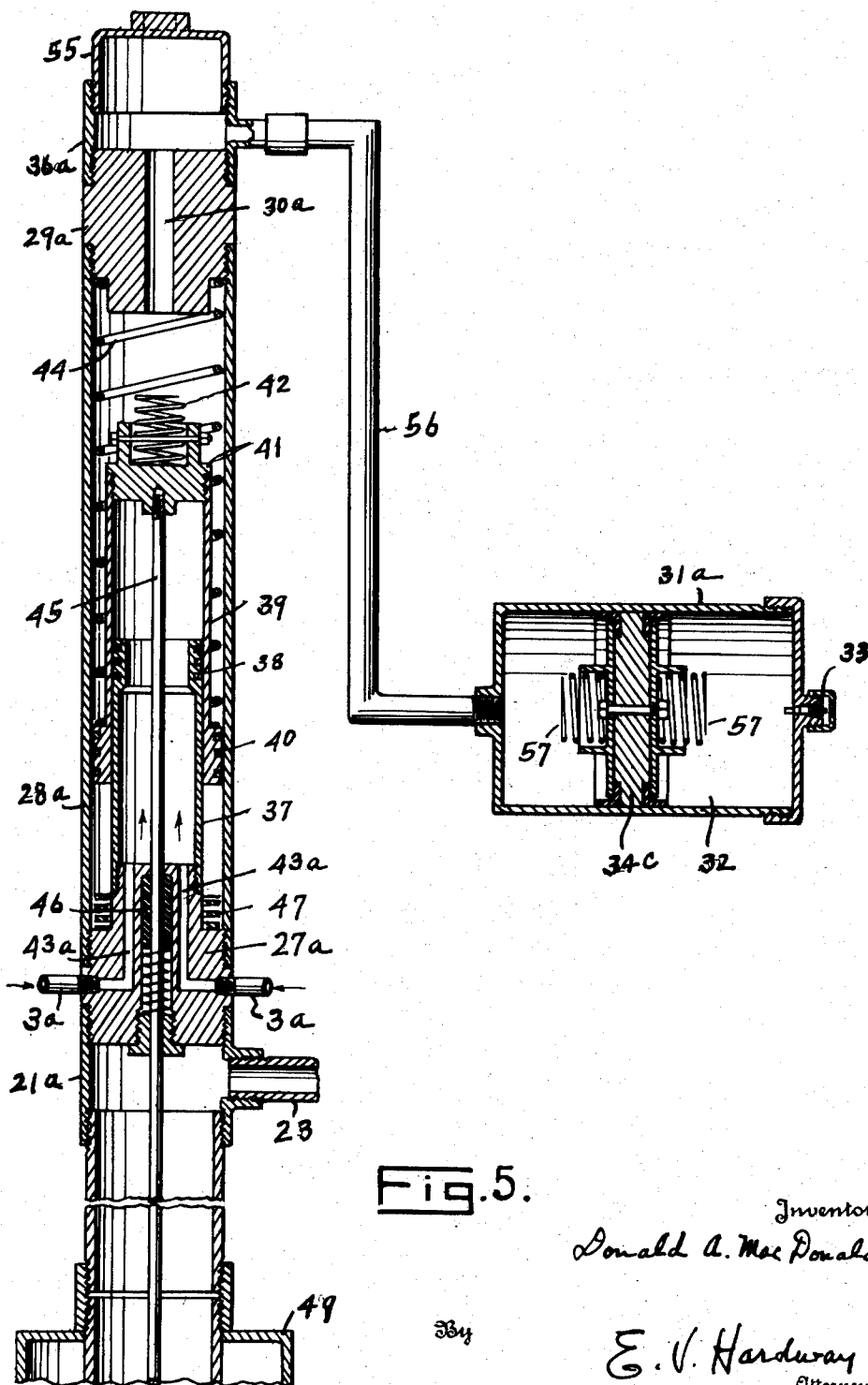
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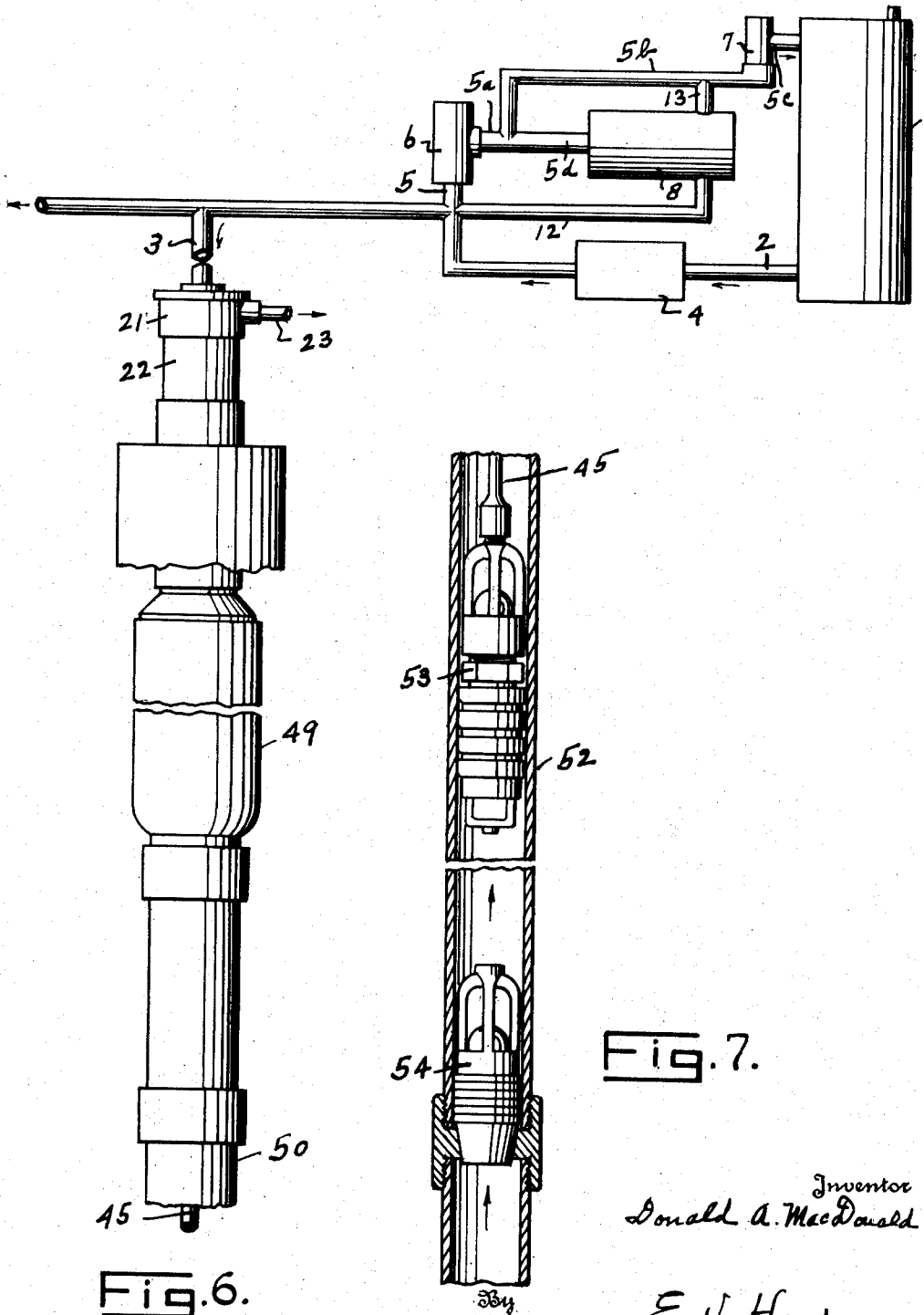
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FLUID LIFT PUMPING EQUIPMENT

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UNITED STATES PATENT OFFICE

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FLUID LIFT PUMPING EQUIPMENT

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10 Claims. (Cl. 121-150)

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This invention relates to fluid lift pumping equipment, specially designed for pumping deep wells.

An object of the invention is to provide novel means for applying fluid pressure to, and relieving said pressure from, the plunger operating mechanism of the well pump to effect reciprocation of the pump plunger.

Another object of the invention is to provide a pressure applying unit embodying a supply tank whereby fluid under the required pressure is applied to the pump plunger operating mechanism and any excess pressure developed will be returned into said tank.

It is a further object of the invention to provide, in the equipment, an air pressure chamber wherein the air will be placed under compression by pump operating piston and will form a cushion and shock absorber therefor and will also initiate the down stroke of the piston when it has reached the limit of its upward movement.

Other objects and advantages will be apparent from the following specification which is illustrated by the accompanying drawings, wherein:

Figure 1 is a side view, partly in section, of a fluid pressure applying unit shown connected to the well pumping equipment.

Figure 2 is a vertical, sectional view of the upper portion of said equipment.

Figure 3 is a vertical, sectional view of an intermediate portion thereof.

Figure 4 is a vertical, sectional view of another embodiment of an air pressure chamber.

Figure 5 is a vertical, sectional view of another embodiment of the pumping equipment.

Figure 6 is a side elevational view of the pressure applying unit and the upper portion of the pumping equipment, and

Figure 7 is a vertical, sectional view of the lower end of the pumping equipment as shown in either of the Figures 3, 5 or 6.

Referring now more particularly to the drawings wherein the pressure applying unit shown in Figures 1 and 6 will first be described: This unit includes a supply tank 1 for containing a suitable pressure fluid, preferably in liquid form. Leading from tank 1, preferably near the bottom, there is a pressure line 2 through which fluid is taken from the tank 1 and delivered into the upper end of the small pipe 3 leading down into the well. The fluid is delivered under pressure down into the well by means of a pressure pump 4, of any selected construction and which is connected into the pipe 2. As indicated, the pressure line 2 may lead to one or any number of wells.

This pressure unit also includes a pressure return control line 5, 5a, 5b, 5c which leads from the line 2, beyond the pump discharge, and enters the upper end of the tank 1. This control line,

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near its respective ends, is equipped with a high pressure relief valve 6 and a low pressure valve 7, the latter being located near the discharge end of said control line. There is a valve cylinder 8 which is divided by a transverse partition 9 thus forming a pressure chamber 10 and a valve chamber 11. The control line, above described, is connected into chamber 10 by the extension 5d, of said line. There is also a pressure relief line 12 leading from pressure line 2, beyond the discharge end of the pump, and entering the chamber 11. A tubular nipple 13 leads from chamber 11 and enters said pressure return control line between the valves 6 and 7 and this nipple is, preferably, transversely aligned with the discharge end of the pressure relief line 12. A piston rod 14 works through a central bearing in the partition 9 and fixed on the forward end of this rod there is a piston-valve 15 which fits closely in the cylinder 8 and which has an external annular groove 16 therearound. When the valve is open the groove 16 is aligned with adjacent ends of pipe 12 and nipple 13 so that excess pressure built up by pump 4 can escape through the low pressure valve 7 back into tank 1. On the other end of piston rod 14 there is a piston 17 fitted closely in cylinder 8. A strong coil spring 18 surrounds the piston rod 14 and is interposed between the partition 9 and the piston 17 and normally holds the piston-valve 15 closed, that is with the groove 16 out of communication with the pressure relief line 12 and the nipple 13. In case the pressure of the fluid delivered from the pump 4 exceeds a selected limit the high pressure valve 6 will be opened, overcoming the pressure of the spring 19, which normally holds it closed, and the pressure of the fluid against the piston 17 will move the piston valve 15 to open position, that is with the groove 16 aligned with the relief line 12 and the nipple 13 and the excess pressure will pass on through the low pressure valve 7 and back into the tank 1. This will relieve the pressure in the pressure conducting lines and upon the opening of the valve 15 to allow relief of said excess pressure, the high pressure valve will close. Incorporated into the line 5b there is a choke 20 which is provided so that upon the opening of the high pressure valve 6 the surge of fluid passing said valve will be sufficient to move the piston valve 15 to open position and yet to provide for the flow of the high pressure fluid into the tank 1 so as to prevent the locking of the valve 15 in open position.

The numeral 21 designates a conventional type of well head which is secured to the upper end of the well tubing 22 and this well head is provided with an outflow line 23 through which the well liquid being pumped is discharged.

The numeral 24 designates what may be termed an inner shell whose upper end carries a re-

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ducting nipple 26 into which the lower end of the pipe 3 is connected and screwed into the lower end of said inner shell there is a head 27.

Spaced within the inner shell 24 with its lower end screwed onto the upper end of the head 27 there is a cylinder 28 and screwed into the upper end of said cylinder 28 there is a head block 29 having vertical passageways 30 therethrough.

Screwed into the upper end of the head block 29 and spaced inwardly from the inner shell and reducing nipple 26 there is a cylinder 31 enclosing a pressure chamber 32 and the upper end of this cylinder 31 is provided with a conventional air inlet valve 33.

Mounted to reciprocate in the cylinder 31 there is a piston 34 which is preferably formed with external cap rings, as 35, 36, the former of which opens upwardly and the latter of which opens downwardly. The upper and lower ends of this piston are preferably formed of resilient material forming shock absorbers. The piston 34 moves freely up and down in the cylinder 31 as the pumping operation proceeds.

Spaced within the cylinder 28 and secured to and upstanding from the head 27 there is a stationary tubular sleeve 37 whose upper end is provided with external seal rings 38 and fitted over this sleeve there is a tubular piston 39. The lower end of this piston is enlarged externally and provided with external seal rings 40. The seal rings 38 form a seal between the sleeve 37 and the piston 39 and the seal rings 40 form a seal between the piston 39 and the cylinder 28.

Secured on the upper end of the piston head 41 which, in the present illustration, is shown with a shock absorber 42, in the form of a coil spring, mounted on, and extended above, its upper end.

Leading from the spaces between the inner shell 24 and the cylinders 28, 31 and entering the lower end of the sleeve 37 there are the fluid conducting channels 43 through which the pressure fluid may reach the piston 39 to elevate it.

Surrounding the piston 39 and interposed between the lower end of the block 29 and enlarged lower end of the piston 39 there is a strong coil spring 44, the function of which will be hereinafter explained.

It is to be noted that the head 27 has an axial bearing and the pump sucker 45 works through this bearing and its upper end is attached to the piston head 41.

Within the axial bearing of the head 27 and around said sucker rod there is a suitable seal which, in the present illustration, is a conventional stuffing box, as 46, within which suitable packing 46a surrounding the rod and against which one end of a coil spring 46b bears. A gland nut 46c is threaded into the stuffing box and against which the other end of the spring 46b bears so that endwise pressure is applied to the packing 46a to expand the same into sealing engagement with the rod and the head surrounding the reduced upper end of said head there is a yieldable bumper 47 to absorb the shock of the downward stroke of the piston 39.

Connected to the lower end of the well tubing 22, by means of a reducing nipple 48 there is an outer shell 49 which is spaced from the inner shell 24 and the lower end of this outer shell is reduced and secured around the well tubing 50, preferably by welding as is illustrated in Figures 2, 3 and 6.

The upper end of this well tubing 50 is secured

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to the lower end of the head 27 and is provided with the required number of outlet ports 51 through which the well liquid may flow from within the tubing 50 up into the outer shell and thence up through the tubing 22 and out through the outflow line 23. The space within the cylinders 28 and 31 between the pistons 39 and 34 is filled with a suitable pressure fluid, such as air.

Connected to the lower end of the tubing 50 there is a pump working barrel 52 wherein the travelling valve 53 of the pump reciprocates, this travelling valve being connected to the lower end of the pump sucker rod 45.

At the bottom of the working barrel 52 there is the conventional standing valve 54. These valves operate in the usual manner; that is upon down stroke of the travelling valve the standing valve will close and the fluid beneath the travelling valve will pass above it; and on up stroke the fluid in the working barrel above the travelling valve will be forced on upwardly and an additional charge will be drawn in from the well through the standing valve.

As illustrated in Figure 4 in lieu of the piston 34 there is a collapsible container 34a formed of rubber or other elastic material which is surrounded and protected by a perforated shell 34b. In other respects the pneumatic chamber shown in Figure 4 is the same as that shown in Figure 2.

The equipment for operating the pump as illustrated in Figure 2 will usually be located down in the well any selected distance below the ground surface, but as illustrated in Figure 5 it can be located above the ground surface. In this illustration shown in Figure 5 the numeral 21a will be termed the well head and from it leads the outflow line 23 for the discharge of the well fluid. In this embodiment the numeral 21a designates a head which is screwed into the upper end of the well head 21a. This head 27a is provided with the fluid conducting channels 43a corresponding to the channels 43 as shown in Figure 2 and the pressure line, or lines, 3a are connected into the outer ends of these channels.

On the head 27a there is the tubular sleeve 37 similar to the corresponding sleeve shown in Figure 2 and operating over this sleeve there is the tubular piston 39 similar to the piston 39 shown in Figure 2. Attached to the upper end of the piston 39 there is a piston head 41 which, in the present illustration, is shown with the shock absorber 42 mounted thereon and extended thereabove.

In the illustration shown in Figure 5 the sucker rod 45 is connected, at its upper end, to head 41 and works through the stuffing box 46 in the head 27a.

Mounted on the head 27a there is the shock absorber 47 as shown in Figure 2.

Screwed onto the upper end of the head 27a there is the cylinder 28a in which the piston 39 works and attached to the upper end of the cylinder 28a there is a head block 29a having an axial passageway 30a therethrough.

Connected to the upper end of the block 29a there is a coupling 36a whose upper end is closed by a cap 55.

In this illustration shown in Figure 5 the pneumatic cylinder 31a is connected into the coupling 36a by means of a suitable pipe such as 56. The cylinder 31a has a chamber therein similar to the chamber 32 of Figure 2 and mounted in the cylinder 31a there is a piston 34c similar to the piston 34 in essential respects by having the

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spring bumpers 57, 57 one on each end in lieu of the type of shock absorber shown in Figure 1.

The sucker rod 45 in this form is connected to the same type of pumping mechanism as used in the other forms and as illustrated in Figure 7 and the chamber 32 is provided with the air inlet valve 33 as is shown in Figure 2.

In operation the operating fluid will be forced, by the pump 4, through the pipe 3 into the inner shell 24 and thence through the channels 43 into the sleeve 37 and this pressure fluid will elevate the piston 39, sucker rod 45 and travelling valve 53 on power stroke, thus discharging additional well liquid through the ports 51 and on up through the outer shell 49, the tubing 22 and out through the outflow line 23. At the same time additional well liquid will be drawn into the working barrel 52 through the standing valve 54. Air in the pneumatic chamber 32, and the spring 44 will, at the same time, be placed under compression.

When the piston 39 has reached the limit of its upward movement the pressure in the discharge end of the pipe 2 will immediately increase thus eventually opening valve 6 to admit pressure to piston 17 and the piston valve 15 will be opened to allow the return of the fluid under pressure through valves 15 and 7 back into tank 1 and valve 6 will close.

The pressure beneath the piston 39 now being relieved said piston and pump travelling valve 53 will be forced downwardly by gravity, by the pressure of air in chamber 32 and by the spring 44 thus causing down stroke of the pump. When the piston 39 lands on the head 27 there will be no pressure exerted, by the air in chamber 32 and by the spring 44, on the operating fluid in the pressure line.

The purpose of the low pressure valve 7 is to insure sufficient pressure on piston 17 to hold valve 15 open until the down stroke of the pump travelling valve has been completed and thereupon the spring 13 will cause piston valve 15 to close.

The choke 20 has been provided so that the surge of operating fluid, upon opening of the valve 6, will act on piston 17 to open piston-valve 15 and yet to allow flow of fluid into tank 1 and eventually reduce the pressure against piston 17 so as to prevent the locking of said valve 15 in open position.

With the valves 6 and 15 now closed the pressure of the operating fluid will now be exerted against piston 39 to effect the next succeeding upstroke of the well pump and the cycle will be repeated.

What I claim is:

1. A fluid lift motor comprising actuating means including a main cylinder, a power piston in said main cylinder and means for connecting said piston to a load, means for applying an operating fluid to said piston, means applying pressure to said operating fluid to cause a power stroke of the piston, a head block fixedly mounted in said cylinder, a pneumatic cylinder adjacent said head block, a floating piston mounted in said pneumatic cylinder, a pressure fluid between said pistons, channels through said head block through which said pressure fluid flows under pressure upon upstroke of the power piston, means for releasing the pressure on said operating fluid when its pressure exceeds a predetermined limit to relieve the pressure of the operating fluid from the power piston to allow a back stroke of the actuating means.

2. A fluid lift motor comprising actuating

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means including a cylinder, a power piston in the cylinder and means for connecting the piston to a load, means having a channel for applying an operating fluid to said piston; means applying pressure to said operating fluid to cause a power stroke of the piston; means for releasing the pressure on said operating fluid, when its pressure exceeds a predetermined limit, to relieve the pressure of the operating fluid from the piston to allow a back stroke of the actuating means, and means for initiating such backstroke upon relief of said pressure comprising a head block in said cylinder, a pneumatic cylinder adjacent said head block, an air inlet in said pneumatic cylinder, a floating piston in said pneumatic cylinder and air in said pneumatic cylinder on one side of said floating piston and a pressure fluid on the other side, passageways through said head block whereby said pressure fluid will be placed under pressure upon upstroke of the power piston.

3. A fluid motor comprising actuating means including a cylinder, a power piston in the cylinder and means for connecting the piston to a load, means having a channel for applying an operating fluid to said piston; means applying pressure to said operating fluid to cause a power stroke of the piston; means for releasing the pressure on said operating fluid, when its pressure exceeds a predetermined limit, to relieve the pressure of the operating fluid from the piston to allow a back stroke of the actuating means, and means for initiating such downstroke upon relief of said pressure comprising a head block in said cylinder, a pneumatic cylinder adjacent said head block, an air inlet in said pneumatic cylinder, a floating piston in said pneumatic cylinder and air in said pneumatic cylinder on one side of said floating piston and a pressure fluid on the other side, passageways through said head block whereby said pressure fluid will be placed under pressure upon upstroke of the power piston and yieldable means cooperable with said head block and said power piston and urging said power piston downwardly in said main cylinder.

4. A fluid motor comprising, an outer shell having a closed lower end, means connecting with the upper end of the outer shell in communication with an upper section of a well tubing, an inner shell within and spaced inwardly of the outer shell, means connecting the upper end of said inner shell in communication with a source of pressure fluid, a cylinder within and spaced inwardly of said inner shell and closed at its upper end, a head closing the lower ends of said cylinder and said inner shell and connecting the same to a lower section of the well tubing, said lower tubing section having an opening in communication with the interior of said outer shell, a tubular sleeve within and spaced inwardly of the cylinder and closed at its lower end by said head, a tubular piston fitted over the sleeve, a pump sucker rod connected to said piston for reciprocation therewith and extending through said head, said head having a passageway in communication with the interior of said inner shell and with said sleeve, and means cooperable with said cylinder and said piston to urge the piston downwardly.

5. A fluid motor comprising, an outer shell having a closed lower end, means connecting the upper end of the outer shell in communication with an upper section of a well tubing, an inner shell within and spaced inwardly of said outer shell, means connecting the upper end of said inner shell in communication with a source of pressure fluid, a cylinder within and spaced in-

wardly of said inner shell and closed at its upper end, a head closing the lower ends of said cylinder and inner shell and connecting the same to a lower section of the well tubing, said lower tubing section having an opening in communication with the interior of said outer shell, a tubular sleeve within and spaced inwardly of the cylinder and closed at its lower end by said head, a tubular piston fitted over said sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, said head having a passageway in communication with the interior of said inner shell and with said sleeve, yieldable means cooperable with said cylinder and piston and urging the piston downwardly, and means in said cylinder above said piston and adapted to compress air in said cylinder upon upward movement of said piston.

6. A fluid motor comprising, inner and outer concentrically arranged shells, means connecting the outer shell in communication with an upper section of a well tubing, means connecting the upper end of said inner shell in communication with a source of pressure fluid, a cylinder within and spaced inwardly of said inner shell and closed at its upper end, a head closing the lower ends of said inner shell and said cylinder, tubular means closing the lower end of said outer shell and connecting said outer shell in communication with a lower section of the well tubing, a tubular sleeve within and spaced inwardly of the cylinder and closed at its lower end by said head, said head having a passageway in communication with the interior of the inner shell and said sleeve, a tubular piston fitted over the sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, means cooperable with said piston and cylinder and urging said cylinder downwardly and a head block in said cylinder above the piston and having passageways there-through in communication with said cylinder above and beneath the block.

7. A fluid motor comprising, an outer shell having a closed lower end, means connected to the upper end of the shell and connecting the same in communication with an upper section of a well tubing, an inner shell within and spaced inwardly of the outer shell, means connected to the upper end of the inner shell and connecting the same in communication with a source of pressure fluid, a cylinder within and spaced inwardly of the inner shell and closed at its upper end, a head closing the lower ends of the inner shell and the cylinder, a tubular sleeve having an open upper end and whose lower end is closed by said head within and spaced inwardly of said cylinder, a tubular piston fitted over said sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, said head having a passageway opening at one end within said sleeve and in communication at its other end with the interior of the cylinder, tubular means connected to said head and to a lower section of the well casing beneath the lower end of said outer shell and providing communication between said lower tubing section and the interior of said outer shell, a head block in said cylinder above said piston and having a passageway in communication with the cylinder above and beneath said block, and a floating piston in said cylinder above the head block.

8. A fluid motor comprising, an outer shell having a closed lower end, means connected to

the upper end of the shell and connecting the same in communication with an upper section of a well tubing, an inner shell within and spaced inwardly of the outer shell, means connected to the upper end of the inner shell and connecting the same in communication with a source of pressure fluid, a cylinder within and spaced inwardly of the inner shell and closed at its upper end, a head closing the lower ends of the inner shell and the cylinder, a tubular sleeve having an open upper end and whose lower end is closed by said head within and spaced inwardly of said cylinder, a tubular piston fitted over said sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, said head having a passageway opening at one end within said sleeve and in communication at its other end with interior of the cylinder, tubular means connected to said head to a lower section of the well casing beneath the lower end of said outer shell and providing communication between said lower tubing section and the interior of said outer shell, a head block in said cylinder above said piston and having a passageway in communication with the cylinder above and beneath said block, and a collapsible container in said cylinder above said block and filled with a compressible fluid.

9. In a fluid motor, a cylinder having a closed upper end, a tubular sleeve within and spaced inwardly of said cylinder, a head closing the lower ends of the cylinder and sleeve, a tubular piston in the cylinder fitted over said sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, means for applying an operating fluid to the interior of said sleeve from outside of said cylinder to move the piston upwardly, and means cooperable with the cylinder and said piston and urging the piston downwardly.

10. In a fluid motor, a cylinder having a closed upper end, a tubular sleeve within and spaced inwardly of said cylinder, a head closing the lower ends of the cylinder and sleeve, a tubular piston in the cylinder fitted over said sleeve, a pump sucker rod connected to the piston for reciprocation therewith and extending through said head, means for applying an operating fluid to the interior of said sleeve from outside of said cylinder to move the piston upwardly, and means in the cylinder above the piston for compressing air in the cylinder upon upward movement of said piston.

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