

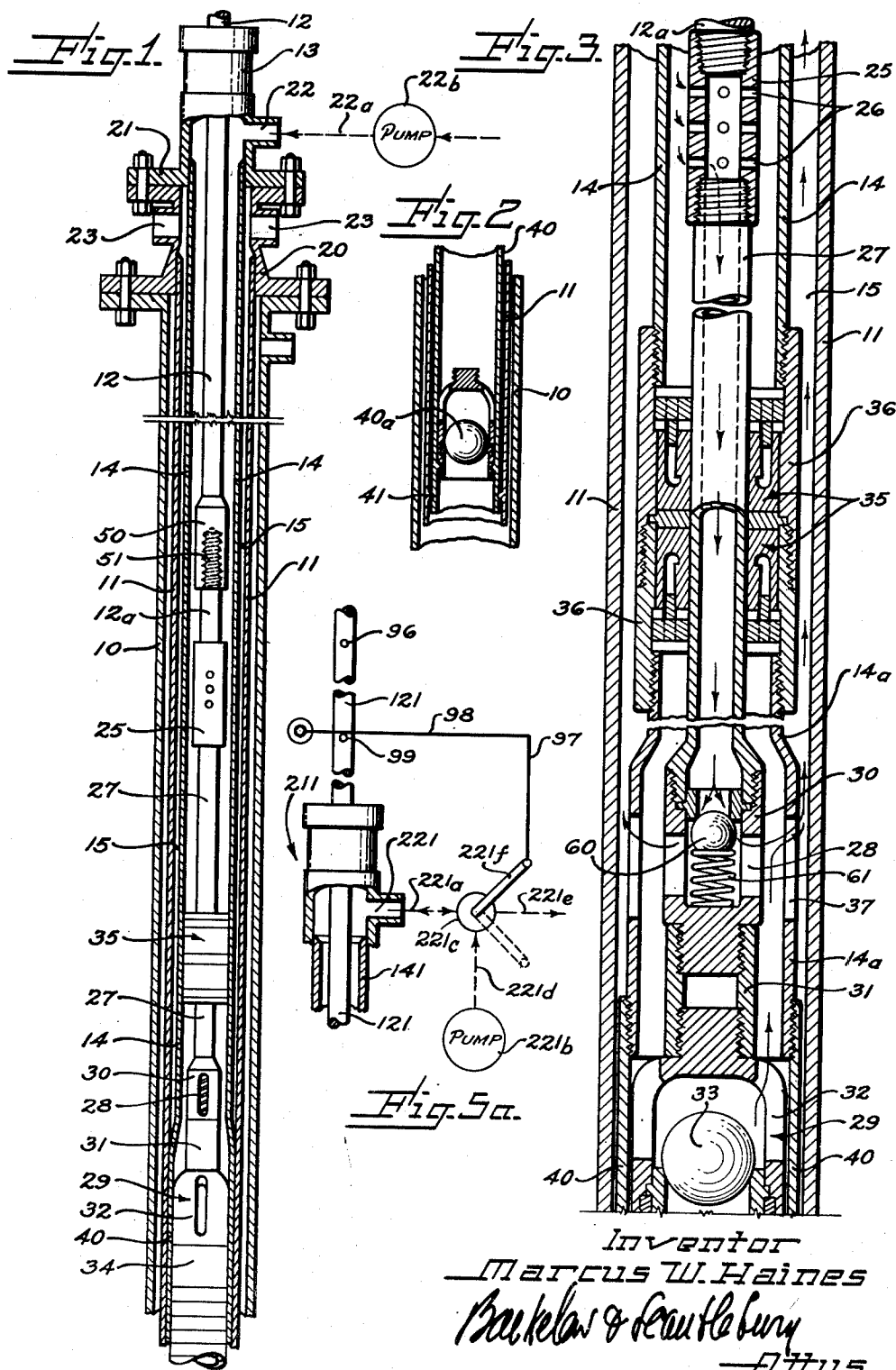
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M. W. HAINES
WELL PUMPING SYSTEM

2,596,146

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3 Sheets-Sheet 1



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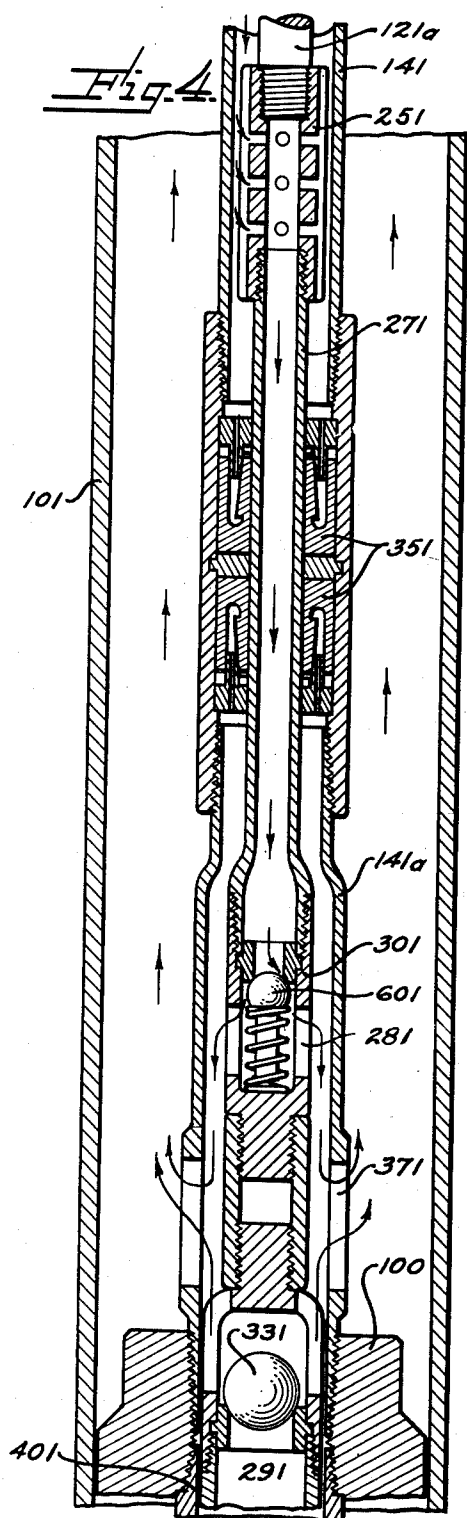
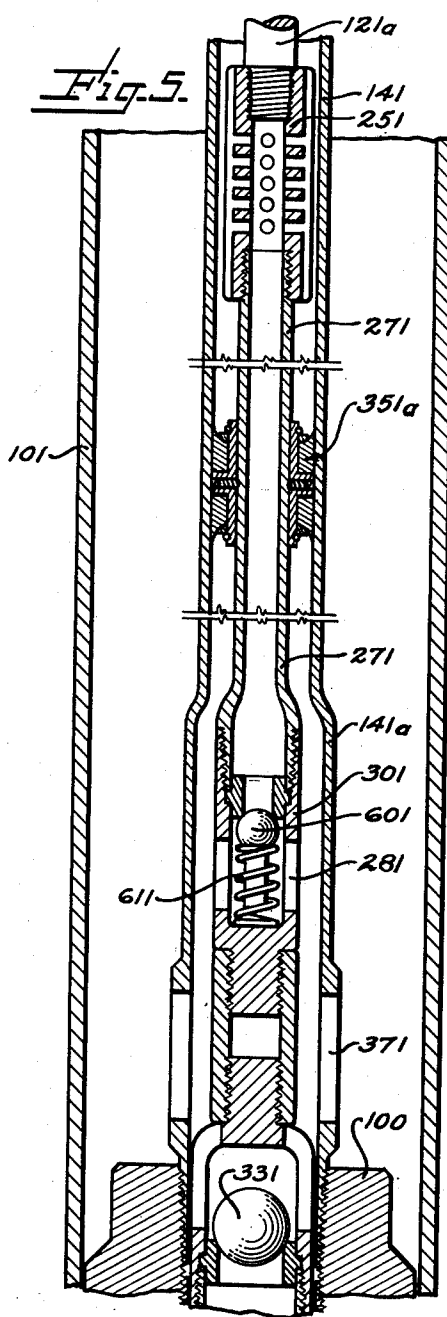
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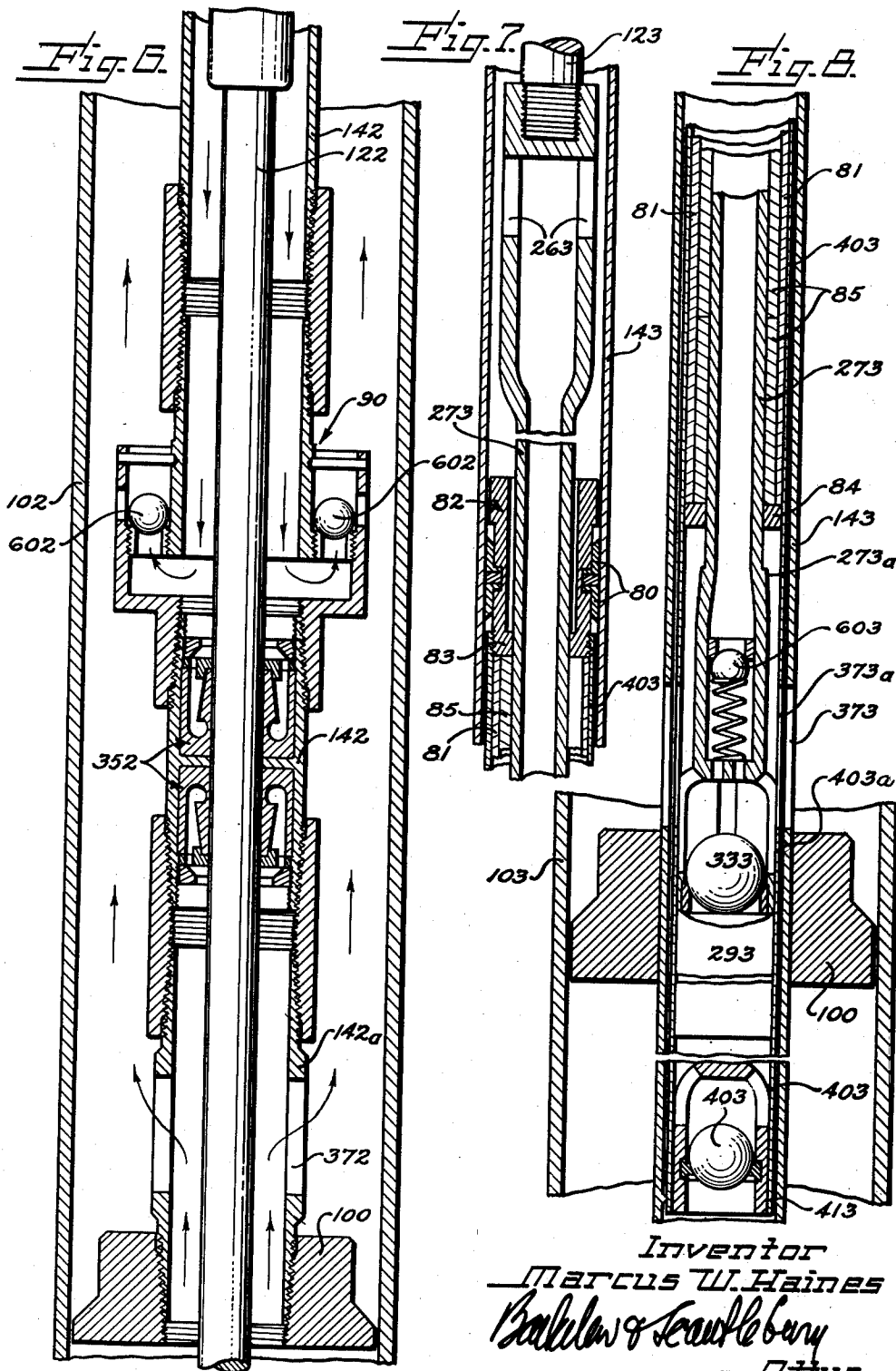
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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WELL PUMPING SYSTEM

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4 Claims. (Cl. 103—5)

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This invention has reference to the pumping of deep wells by rod operated pumps. The general object, and other further particular objects, and corresponding accomplishments, will appear from the following preliminary observations and, in greater particular, from the then following detailed descriptions of preferred forms of apparatus for my pumping system.

When oil is being pumped from a deep well by a rod actuated pump, and particularly when the oil is heavy and viscous, the pump rods sometimes sink in the oil so slowly that the rate of pumping is very much restricted. In the ordinarily used pumping system the rods are located inside the tubing through which the oil is being pumped to the surface, with the rods in direct contact with the pumping column. Attempts have been made to somewhat overcome the difficulty by applying force to the upper end of the rods to force them down; but no great amount of downward force can be applied to the long slender rod without buckling the rod; so that this attempted solution does not effectually cure the difficulty.

To completely overcome the difficulty, I provide in my system that the pumping rod shall be kept entirely out of contact with the pumping column, by utilizing a tube which immediately surrounds the rod, with the pumping column outside that tube. Then, a fluid of low relative viscosity may be maintained in the rod-surrounding tube, either merely for the purpose of preventing entry of the well fluid to the tube, or for the purpose of lubricating the rod, or for both of those purposes. Broadly speaking, the fluid may be either gaseous or liquid, heated or cold, and the body of such fluid may be maintained statically in the tube around the rod or it may be constantly forced into the upper end of the tube at such pressure and in such quantity as to continuously force some of the lubricating fluid out into the pumping column, with various beneficial results. In this description I will speak of the rod-surrounding fluid as the "lubricating" fluid to verbally distinguish it from the well fluid, although in some cases (e. g. where the fluid is a gas) it does not in itself have any positive lubricating quality; but it can be said to have a relative lubricating quality compared with the heavy and viscous well fluid. Generally speaking, the rod-surrounding fluid may be more accurately defined as a fluid of relatively low viscosity.

The lubricating fluid will, in general, be more fluid, or lighter and considerably less viscous

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than the well fluid, and its admixture with the well fluid tends to lighten the pumping column and render it less viscous and therefore easier to pump. If a gaseous fluid is used, its admixture with the well fluid forms a pumping column which is lightened and acts, pro tanto, like a gas lift. And furthermore, if the fluid is pumped down the tube in heated condition, it tends to fluidize the pumping column by raising its temperature.

The apparatus for my system may take various forms. For instance, a relatively small tube may directly and fairly closely surround the pump rods, inside the ordinary tubing; and the pumping column may then be pumped upwardly in the tubing outside the lubricating tube. On the other hand the usual tubing, or a pipe which takes its place, may be used as the lubricating tube, and the pumping column may then be pumped up to the top between the tubing and the well pipe. Such variations of the apparatus, as well as other variations of apparatus and functions are set out in typical and preferred forms in the following detailed description, referring to the accompanying drawings in which,

Fig. 1 is a longitudinal section, with parts in elevation, showing my pumping system as it may be applied to a well, utilizing the special inner lubricating tube;

Fig. 2 is a lower continuation of the parts shown in Fig. 1;

Fig. 3 is an enlarged longitudinal section of certain portions of the apparatus shown in Fig. 1;

Fig. 4 is a similar longitudinal section showing a modified form of apparatus in which the well fluid is pumped up through the well pipe externally of the tubing;

Fig. 5 is a similar section showing further modifications;

Fig. 5a is a diagram showing means for controlling the application of pressure to the lubricating fluid;

Fig. 6 is a similar section showing further modifications;

Figs. 7 and 8 are longitudinal sections showing the upper and lower parts of another modified form of apparatus.

It may be noted that, for clarity of illustration, the sectional views of Figs. 3 to 6 are somewhat distorted, as compared with the relative dimensions of my working designs, the length dimension of the parts as shown in those figures being shown at a smaller scale than the transverse dimensions.

Referring first to Fig. 1, 10 designates a well

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pipe or well casing within which the ordinary tubing 11 is shown. The pump rods are shown at 12 entering the upper end of the well through stuffing box 13. For purposes of simplicity, none of the usual joints are shown for any of these parts, nor for the inner tube which directly surrounds the pump rod, and it will be understood that whenever I refer to a pump rod, I mean to include that element whether solid or hollow, and also to include cable which is sometimes used. The inner tube is shown at 14, surrounding the pump rods more or less closely, and the space 15 between tube 14 and tubing 11 is, in this design, the space through which the well fluid is pumped to the top. The upper end of tubing 11 is hung from a cap 20 which closes the upper end of the well pipe, and the upper end of inner tube 14 is hung from an upper part of cap 20, or from another cap 21 seated on cap 20. The upper cap 21 has a pipe connection opening 22 through which the rod-surrounding fluid is introduced under suitable pressure; and the lower cap 20 has pipe connection openings 23, communicating with the space between tube 14 and tubing 11, to carry away the pumped oil. Fluid under regulated pressure and in regulated quantity may be introduced at 22 through the line indicated diagrammatically at 22a from the pump indicated diagrammatically at 22b.

Reference is now had more particularly to Fig. 3 which is an enlarged section showing the apparatus from a level just below the lower end of the pump rod proper down to the pump plunger and its working valve. The well casing is not shown in this enlarged view. The lower end of pump rod 12 is shown as connected with a special tubular connector 25, having perforations 26 so that the fluid which is forced down tube 14 under pressure, may enter the interior of connector 25. Extending downwardly from connector 25 there is tubular rod 27 through which the fluid may pass on downwardly to a valve controlled outlet 29 at the lower end of tubular rod 27 and preferably just above the upper end of pump plunger 29. As typically illustrated here the outlets 28 are formed in a valve cage 30 which is attached to the lower end of tubular rod 27, and pump plunger 29 is attached to the lower end of valve cage 30 by the connection sleeve 31. The pump plunger may be of any suitable kind; it is here illustrated as one which has the cage 32 for working valve 33 at the top of the tubular portion 34 of the plunger.

Tubular rod 27 forms in effect a downward continuation of pump rod 12. At some suitable point above valve cage 30, and preferably close to the valve cage, tubular rod 27 passes through a double packing unit 35 which, in this form of the device, is stationarily mounted in the inner tube 14. As shown in detail in Fig. 3 this packing unit is mounted in a special collar member 36 which is connected between the upper portion 14a of the inner tube and a lower portion 14b which extends on downwardly from collar member 36. Seeing that collar member 36 is merely structural, and forms in effect a part of tube 14, the collar is not shown in Fig. 1, tube 14 being there shown simply as extending continuously past packing 35. The lower portion of tube 14, specifically the part 14a, as shown in Fig. 3, has openings 37 through its wall to form passages leading from the inside of the tube to the pumping column space between the tube and tubing 11. This lower part 14a of tube 14

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is preferably locally enlarged as illustrated and at its lower end it preferably carries the pump barrel 40. The pump barrel seats, as usual, at its lower end on a suitable seating 41 which is carried by tubing 11. Pump barrel 40 carries the usual standing valve 40a. For simplicity, in Fig. 1 pump barrel 40 is shown as if it were simply a downward continuation of the lower part of tube 14. The reason for so mounting the pump barrel on the lower end of tube 14 is to make provision for lowering the pump barrel, the pump plunger, and the tubular rod 27 assembled in packing 35, all together as one unit when the inner tube 14 is lowered into the well. After those parts are lowered and the pump barrel seated, then the pump rods may be lowered inside tube 14. A special rod joint is provided so that the lower end of the pump rod may then be effectively connected to the lower tubular rod 27. As shown in Fig. 1, a special connector member 50 is mounted on the lower end of the pump rod proper 12, equipped with a special thread 51 which takes a similar thread at the upper end of the short piece of pump rod 12a which is immediately connected with fitting 25.

Assuming that the pump rods and pump plunger are being reciprocated vertically, the well fluid is taken in at the lower end of the pump barrel past valve 40a and is pumped upwardly in the usual manner by the plunger valve 33. This upwardly moving pumping column first passes upwardly into the interior of lower tube 14a and then out through openings 37 into the pumping column space 15 between tube 14 and tubing 11, and thus to the top of the well. The pumping column may be prevented from entering the inner tube 14 simply by the pressure which is maintained on the fluid in that tube. Assuming for instance that packing 35 is not used, so that the interior of lower tube 14a is directly open to the upper portion 14 of that tube (instead of being open to it through tubular rod 27 and valve cage 30), then if the fluid in tube 14 is maintained under sufficient pressure, the pumping column cannot move upward through tube 14 but must move upwardly outside that tube. And the same thing is true if packing 35 is used and the fluid is maintained in tube 14 and in tubular rod 27, and if no valve is used in valve cage 30. Under any such condition, if a static body of fluid is maintained in tube 14 under a pressure just equal to the pressure of the pumping column at or just above openings 37, the pumping column cannot move upwardly through tube 14. And, under those conditions, the lower end of the statically maintained fluid body will not materially flow out into the well fluid of the pumping column.

The same general operating conditions (preventing the pumping column from moving upwardly through tube 14) may of course be attained by not providing a passage for the lubricating fluid downwardly through rod 27 past packing 35; or by providing what amounts to the same thing, an upwardly closing valve 60 in valve cage 30. In either such arrangement, the pumping column is prevented from moving up through tube 14 by the fact that rod 27 passes through packing 35 and is itself closed against upward flow of fluid. In any such arrangement leakage of the well fluid past packing 35 is prevented by the statically maintained fluid pressure above the packing. Aside from preventing that leakage it would not be necessary to maintain a pressure on the fluid in tube 14.

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Of all such arrangements I prefer at present to utilize one which provides a downwardly opening valve through which the lubricating fluid may be forced out in lesser or greater amounts into the pumping column. So I preferably provide the downwardly opening valve 60, closed upwardly by spring 61, in valve cage 30. In effect this valve prohibits upward passage of pumping column fluid from lower tube 14a into the upper tube portion 14. And thus, in functional effect the valve 60 is the equivalent of a downwardly opening annular valve which would control the annular passage which packing 35 seals off, assuming that rod 27 were solid. I prefer however to make the arrangement as shown in Fig. 3 because of the simplicity and reliability of the valvular means thereby provided.

One of the reasons for using an upwardly closing valve, such as that shown at 60, or one which will perform the same functions as above outlined, and particularly for using a valve which is closed upwardly by some spring pressure, is to control the discharge of the lubricating fluid into the pumping column. Assuming for instance that spring 61 puts an equivalent pressure of 25 lbs. per sq. in. on valve 60, then valve 60 will only open downwardly if the pressure on the lubricating fluid is raised to a point equal to the pressure of the pumping column at the valve plus 25 lbs. per sq. in. or more. Thus, if it is not desired to discharge any of the lubricating fluid into the pumping column, the lubricating fluid may be maintained at a pressure (at the valve) which is either equal to the pressure of the pumping column at that point, or in excess of that pressure by an amount less than 25 lbs. per sq. in. The spring pressure imposed on the valve thus provides for variations or inaccuracies of the lubricating fluid pressure with relation to the pumping column pressure, the latter being of course subject to variation in the pumping operation.

On the other hand, if it is desired to discharge lubricating fluid into the pumping column in any quantity, large or small, the pressure on the lubricating fluid is raised to a point sufficient to open valve 60. If it is desired merely to maintain tube 14 full of lubricating fluid, it may be desirable to raise the pressure to the point where a small amount of that fluid is constantly or intermittently discharged past valve 60, in order to be assured that tube 14 is filled with the fluid. Maintenance of a higher pressure on the lubricating fluid, and introduction of a commensurate volume of that fluid, will cause a discharge past valve 60 of a correspondingly larger volume of that fluid into the pumping column.

As I have stated before, the lubricating fluid may be either gaseous or liquid. If it is gaseous, and introduced under sufficient pressure and in sufficient quantity to discharge into the pumping column in any appreciable volume, it will act to lighten the pumping column as well as to fluidize it, and in fact it will, in proportion to the volume of introduction act like a gas lift on the pumping column.

On the other hand, a suitable lubricating liquid of relatively low viscosity will, if discharged in any appreciable quantity in the pumping column, tend to fluidize the pumping column. Suitable lubricating liquid for the purpose may be for instance oils which are more fluid or lighter and less viscous than the well fluid; or the lubricating liquid may be any suitable low viscosity liquid, preferably but not necessarily, miscible with the well fluid, and which has the function of render-

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ing the well fluid more liquid and less viscous. Generally speaking, a liquid of lower viscosity than the well fluid, and miscible with it, or forming a more fluid solution with it, is suitable.

With any kind of lubricating fluid, pumped down the lubricating tube in any substantial quantity, heat may be carried to the pumping column to reduce its viscosity. For that purpose, a lubricating liquid is preferable to gas, having a greater heat carrying capacity than a gas. If such a liquid is heated to a fairly high temperature and is pumped down and into the pumping column in fairly large quantity, the pumping column may be appreciably heated and reduced in viscosity throughout its length by rise in temperature alone. The heat may be transferred to the pumping column by conduction and radiation through and from the inner tube 14, and by conduction when the lubricating fluid finally discharges into the pumping column.

In the preceding discussions of operation of my system it has been assumed that the discharge of the lubricating fluid or gas into the pump column is close to the pump. The level at which that takes place is determined, in the apparatus form of Fig. 3, by the relative position of openings 37. That level may be at any suitable or desired distance above the pump.

Fig. 4 shows a modification which is, in general structure, similar to the structure shown in Figs. 1 and 3, but in which the well fluid is pumped out in the annular space immediately inside the well pipe 101. In this arrangement the pumping column immediately surrounds the tube or tubing which carries the lubricating fluid; and that tube or tubing may be of any suitable size. For instance it may be the same pipe or the same size pipe which is ordinarily used as tubing in a well, or it may be a pipe of special or smaller than tubing size. The lubricating tube 141 shown in Fig. 4 will communicate at its upper end to the fluid introduction opening 22 of Fig. 1. The rod (corresponding to rod 12a) is shown at 121a, the tubular perforated connector is shown at 251 and the tubular rod extension at 271 passing through the packing 351, all substantially similar to the corresponding parts in Fig. 3. The valve cage at the lower end of tubular rod 271 is shown at 301 with its upwardly seating ball valve 601 and discharge opening 281. The lower end of tube 141a carries a packer 100, illustrated here diagrammatically, of any suitable type to tightly and sealingly engage the inner wall surface of well pipe 101. The pump plunger is shown at 291, carrying the plunger valve 331, and connected to the lower end of valve cage 301 in the same manner as before described. The pump barrel 401 is in effect carried by the lower end of tube 141a, being shown here as carried by the packer unit 100 which is carried by that tube.

The operation of this form is substantially the same as that of Fig. 3 except that, from the practical standpoint, the pumping column is moved upwardly inside the pipe which is ordinarily the tubing. The lubricating fluid is introduced into and maintained in, or is pumped down, the lubricating tube 141 in the same manner as before described, and out past valve 601 into the space between 301 and 141a, and thus into the upwardly moving well fluid which is moving out through openings 371. In fact, the mode of operation of the form shown in Fig. 4 is exactly the same as that shown in Figs. 1, 2 and 3, as tube 141 is functionally the same as tube 14, and well pipe 101 is functionally

the same as tubing 11 of Figs. 1 to 3. The only marked structural difference between the two forms is the structure by which the lower end of the space between the outer and inner pipes is sealed off. In Figs. 1 and 3 the lower end of the space between tube 14 and tubing 11 is sealed off by the fact that pump barrel 40 sealingly fits or seats in the tubing. In Fig. 4 the sealing of the lower end of the pump column space between tube 141 and well pipe 101, or the sealing between pump barrel 401 and well pipe 101, is accomplished by packing 100.

The structure of Fig. 5 is in the main the same as that shown in Fig. 4, with the exception of the packing, so the other parts of Fig. 5 are designated with the same numerals as applied to Fig. 4.

Instead of utilizing the packing which is stationarily set in tube 141 as in Fig. 4, the device of Fig. 5 utilizes a packing unit in the form of a piston 351a which is fixed on tubular rod 271 and moves through the pumping stroke with that rod. The result is that the pressure of the lubricating fluid is maintained downwardly on the piston and thus exerts a force tending to move the pump plunger downwardly and tending to stretch the rods. The amount of that positive downward force depends upon the effective area of piston 351a and also on the pressure which is maintained on the lubricating fluid. That pressure may be considerably higher than the well fluid pressure, being controlled by the strength of spring 611. Due to the presence of valve 601, the effective area on which the downward pressure of the lubricating fluid is exerted, is equal to the total area of a circle whose diameter is the diameter of packing piston 351a minus the cross-sectional area of pump rod 121a.

This downwardly exerted force may be utilized simply for keeping the rod in stretched condition and to accelerate the downward movement of the rods and pump; or it may be utilized to operate a double-acting pump on the downward stroke. Double-acting pumps are well known and need no particular description here. In general, they are pumps with special valvular arrangements in their plungers, so that they pump fluid upwardly on the down stroke as well as the up stroke. To pump on the down stroke the plunger of course must be forced down, and the downward pressure on packing 351a may be utilized for that function. This form of my apparatus also facilitates the use of a cable as the pump rod.

Also, in the arrangement of Fig. 5, the pressure on the lubricating fluid may either be maintained constantly or may be applied at the top of the well only during the downward stroke, being relieved during the upward stroke. Fig. 5a shows diagrammatically how this may be accomplished. In that figure the pump rod is represented at 121 and the upper end of tube 141 is shown as hanging from the head 211 so that opening 221 communicates with the tube. Fluid supply line 221a is controlled by a two-way valve 221c which takes pressure fluid from pump 221b. The valve, when actuated through say a 90° throw alternately connects the line 221a with pump pressure line 221d and with an exhaust outlet line 221e. As an illustration, valve arm 221f will be in the position shown in full lines to connect line 221a with pressure line 221d during the down stroke of the rod. The rods are shown, for instance, at the upper end of the stroke where a pin or lug 99 has contacted and raised the lever arm 98, connected by link 97 to valve arm 221f, to raise it to

the full line position at the end of the upstroke. On the down stroke the valve remains in that position until, at the end of the down stroke, the rod lug 96 contacts lever 98 and moves it down to throw the valve to the dotted line position.

Fig. 6 shows another variant which may be applied to any of the forms hereinbefore described; the modification having to do solely with the location of the valve which relieves the lubricating fluid into the pumping column. The outer pipe, is in this instance shown as well pipe 102. The inner tube is shown at 142 and the lower part of the pump rod, solid in this instance, is shown at 122. A special fitting 90 is inserted in the length of tube 142 and carries valvular means 602 which opens to allow passage of lubricating fluid from the tube 142 into the pumping column in pipe 102; but closes against passage of fluid in the opposite direction. This valvular means is inserted in tube 142 above the packing unit 352. Below the packing unit the lower extension 142a of the tube has the opening 372 and carries the packer 100. The remainder of the pumping mechanism is not here illustrated as it is or may be the same as shown for instance in Fig. 4.

All of the foregoing apparatus designs have been designed in particulars to suit a pump of the type known as a tubing pump; that is, one in which the pump barrel is lowered with the tube which surrounds the rods—or in usual pumping practice is lowered with the tubing. Figs. 7 and 8 show a design of my apparatus specifically adapted for utilizing a pump of the type known as an insert pump—where the whole pump apparatus, including the pump barrel, is lowered with the pump rod.

In Fig. 8 the outer pipe 103 is shown as if it were the well pipe, and packer 100 packs off the annular space between that pipe and the inner tube 143. The pump barrel or liner 403 is downwardly seatable at its lower end on a seat indicated at 413 in tube 143. Within the pump barrel there is the usual foot valve 403a and the reciprocating pump plunger 293 with its working valve 333. At a point above the upper end of the plunger stroke tube 143 has the openings 373 through which the pump column passes out into the space between pipe 103 and tube 143. The pump barrel or liner 403, in this form of the apparatus, extends on upwardly as illustrated, and it has openings 373a registering with openings 373.

Hollow pump rod 273, equipped with the downwardly opening valve 603 which acts like that of Figs. 3 and 4, extends upwardly from pump plunger 293 for some distance and at its upper end, where it has the openings or perforations 263, it is joined to the pump rod 123.

In this form of the apparatus I provide a packing which forms a seal between the upwardly extended pump liner 403 and rod 273, to perform the same general function which is performed by packing 35 of Fig. 3. In Figs. 7 and 8 however I show a different form of packing. And I also provide another packing or seal to close off the space between pump liner 403 and tube 143 to prevent the lubricating fluid from passing downwardly around liner 403 and thus into the pump column without being controlled by valve 603.

The first mentioned packing is here shown as being in the form of a series of tubular metal liners 85 immediately surrounding pump rod 373 and held endwise between a shoulder ring 84

which is fixed in pump liner 403 and the lower end 83 of a packing carrying fitting 82 which is threaded into the upper end of pump liner 403. The liner sections 85 are held in a sleeve 81 which is also confined endwise in the same manner. Other details of this type of metal liner packing are well known and need no further description.

The fitting 82, at the upper end of the pump liner 403, carries a seal 80 of the well known double flange type which is expanded by pressure. Seals of this type are usually made of metal or leather and are expanded by pressure exerted upon them in either direction. When expanded by the pressure of either the lubricating fluid or of the pumping column, this seal will sealingly engage the inner wall of tube 143; but when the pressures are relieved the seal will be loose so that it, together with the other parts of the apparatus, may be withdrawn upwardly through tube 143.

Some means is provided for limiting the upward movement of the pump rod and plunger above the normal pumping stroke with relation to the pump barrel or liner. For instance, this may be provided by an upwardly facing shoulder 273a on rod 273 adapted to engage shoulder ring 84. To remove the whole pumping apparatus, including the pump barrel from the well, it is only necessary to pull upwardly on the pump rods, and when shoulder 273a engages shoulder ring 84, the pump barrel and all parts connected with it will be lifted off the pump barrel seat 413, so that the whole pump apparatus may be removed from the well on the pump rods. Correspondingly, the whole pump apparatus may be inserted in the well on the pump rods.

One of the characteristics of the several structures described is that the pump (the pump barrel) in operative position is carried or supported on the inner tube and that, regardless of how the pump barrel is so carried, there is an effective seal between the outer tube and the pump barrel. It is that seal that functionally associates the pump (the pump barrel and the standing valve) with the outer pipe by forming a base for the pumping column in the outer pipe. In the several described structures, the seal is formed in different manners. In Figs. 7 and 8 where the pump barrel proper is mounted within a lower extension of the inner tube, the seal between the outer pipe and the pump barrel is physically formed of the seal between the outer pipe and the inner tube, and the seal (or fit) between the inner tube and the pump barrel proper. In Figs. 1 to 3 and 4, 5, where the pump barrel proper forms a lower extension of the inner tube, the seal is a single one directly between the pump barrel (or the tube) below openings 37 or 371. In Figs. 1 to 3, the seal is formed by the pump barrel fitting in the outer pipe (the tubing). In Figs. 4 and 5 the seal is the packer 100. In any of these cases it is only necessary that the seal be below openings 37, 371, 372 or 373, and consequently the seal may actually contact either the pump barrel proper or the lower part of the inner tube. Seeing that the function of the seal

is to associate the barrel with the outer pipe, the seal will be broadly referred to as a seal between the barrel and outer pipe, and for that purpose the barrel will be considered broadly as extending up to the openings 37 etc.

I claim:

1. Apparatus for pumping liquids from wells comprising the combination of, an outer pipe extending from the surface down into the well, a rod-operated pump of the reciprocating displacement member type associated with the outer pipe and adapted to raise a column of well fluid through that pipe to the surface, a pump operating rod extending down within the outer pipe and connected to the displacement member of the pump to operate it by vertical reciprocation, an inner tube immediately surrounding the pump rod throughout a substantial portion of its vertical length, an imperforate piston fixedly mounted on the pump rod to reciprocate with the rod in and near the lower end of the inner tube above the displacement member and exposed on its upper face to the pressure of fluid above it in the inner tube, and means for maintaining a body of relatively non-viscous fluid above the piston in the inner tube around the pump rod at a pressure which at least substantially balances the pressure of the well fluid column at the lower end of the inner tube.

2. Pumping apparatus as defined in claim 1 and also including means for supplying non-viscous fluid under pressure to the upper end of the inner tube, and valvular means operated in consonance with the reciprocation of the pump rod and controlling the supply of said fluid under pressure.

3. Pumping apparatus as defined in claim 2 and in which there is a passage communicating the interior of the inner tube above the piston with the well fluid column in the outer pipe, and a loaded check valve controlling said passage and opening at a predetermined pressure to pass fluid from the interior of the inner tube to the pump column.

4. Pumping apparatus as defined in claim 1 and in which there is a passage communicating the interior of the inner tube above the piston with the well fluid column in the outer pipe, and a loaded check valve controlling said passage and opening at a predetermined pressure to pass fluid from the interior of the inner tube to the pump column.

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