March 24, 1959 E. D. McMURRY 2,878,754

FLUID LIFT PLUNGER FOR WELLS

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Fig. 2

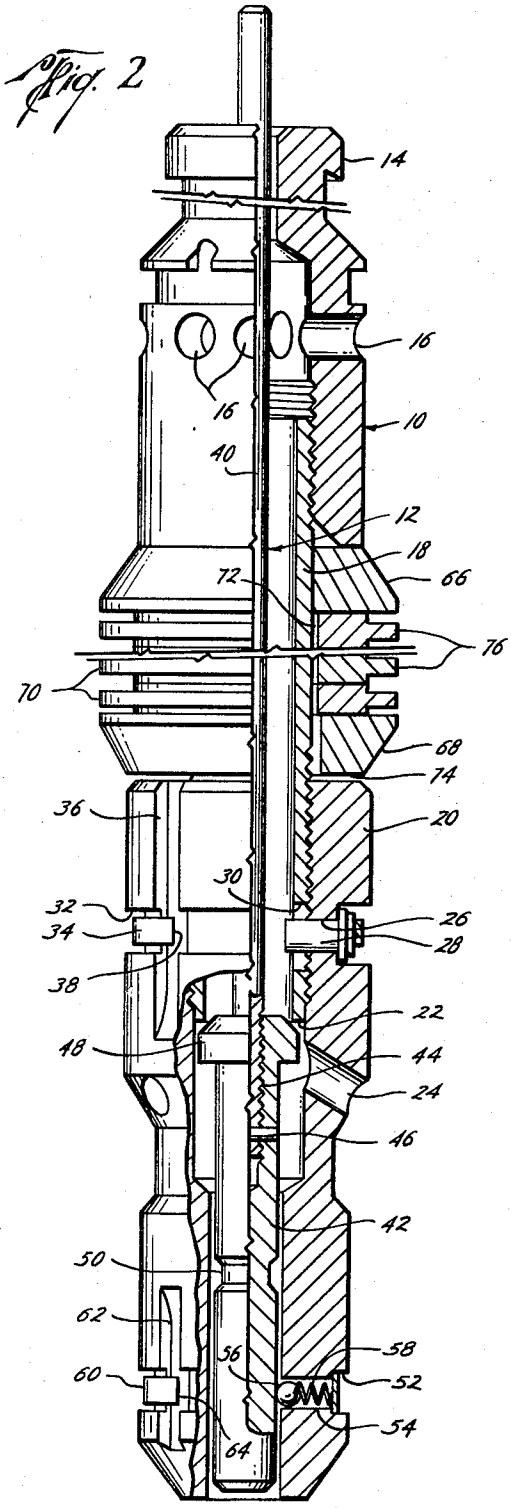
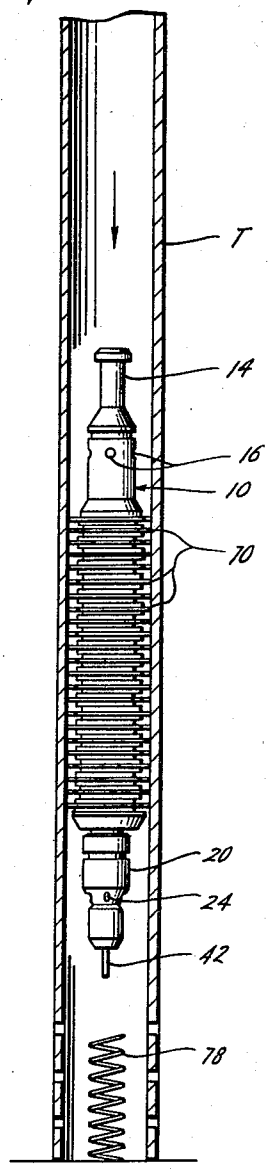


Fig. 1



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Fig. 3A

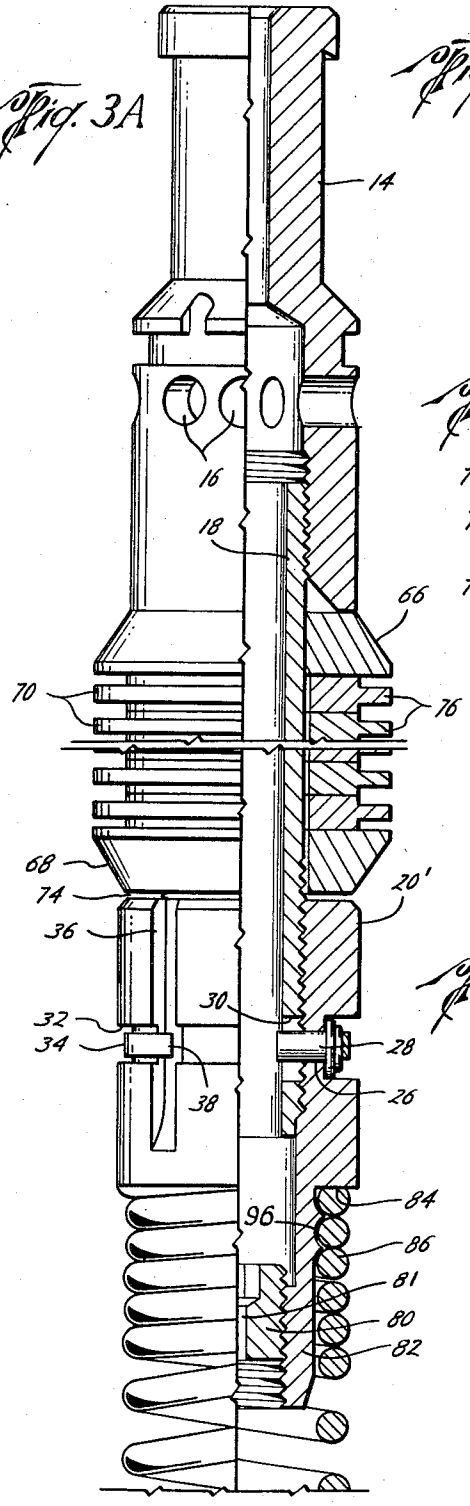


Fig. 3B

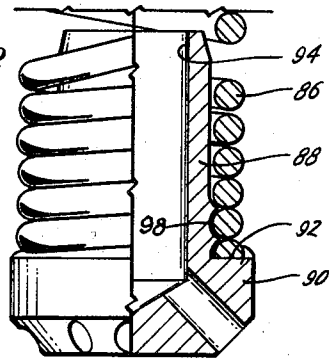


Fig. 4

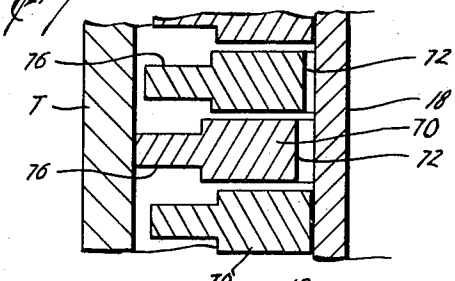
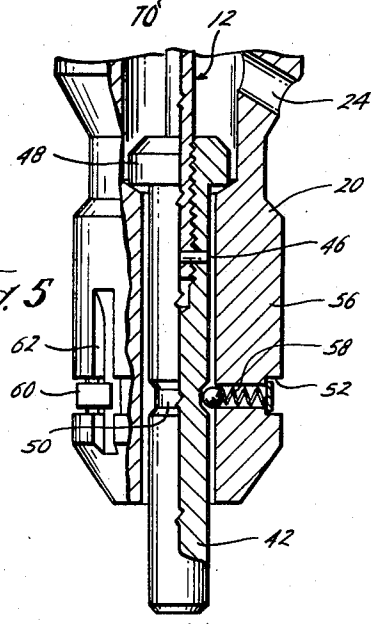


Fig. 5



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FLUID LIFT PLUNGER FOR WELLS

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Application May 18, 1956, Serial No. 585,881

4 Claims. (Cl. 103—52)

This invention relates to a plunger lift of the free piston type for wells and more particularly to a well flowing device which makes use of a well tubing as a cylinder and a plunger as a well-pressure propelled piston for the purpose of assisting the flow of fluid from a well.

In the production of oil and gas wells by ordinary well flowing methods, conditions are often encountered which greatly reduce the amount of fluid which may be recovered, such as weak flowing wells, wells in which there is a high bottom hole pressure but low productivity, and wells with high circulated gas-oil ratios which are small producers. Such conditions at times render further production of the well uneconomical.

The present invention has for an important object the provision of plunger means which is adapted to be inserted in a well tubing and which is operated as a fluid-pressure propelled free piston under the influence of the pressure of fluid in the well to cause an upward flow of fluid in the tubing.

Another object of the invention is to provide a plunger lift for wells comprising a plunger which operates as a fluid-pressure propelled free piston in a well tubing, and having means which functions to permit the flow of well fluid through the plunger during downward movement of the plunger in the tubing, but which operates to close the plunger against the flow of fluid therethrough when the plunger reaches the bottom of the tubing, to cause the plunger to be propelled upwardly by the pressure in the well.

A further object of the invention is the provision of a plunger lift for wells comprising a plunger adapted to be inserted in a well tubing to operate as a piston in the tubing and having means for permitting the flow of fluid through the plunger during downward movement of the plunger, but which operates to restrict such flow to cause the plunger to be moved upwardly in the tubing when the well pressure below the plunger reaches a predetermined value.

Another object of the invention is to provide a plunger lift for wells embodying improved means for forming a seal between the plunger and the interior of a well tubing which does not interfere with the free movement of the plunger longitudinally in the tubing and is capable of adjusting itself to irregularities in the interior surface of the tubing.

A further object of the invention is the provision of a plunger lift for wells having a tubular body adapted to be inserted in a well tubing and a plurality of perforated disks or washers whose outer diameters are smaller than the internal diameter of the well tubing and whose inner diameters are larger than the external diameter of the body, said disks being loosely mounted on the body for lateral movement thereon and being engageable with the body and tubing to substantially prevent the flow of fluid through the tubing around the body.

Another object of the invention is to provide a plunger lift for wells having a tubular body adapted to be inserted in a well tubing and valve means on the body for opening and closing the body and including means for holding the valve in an open position during downward movement of the plunger and means for closing the valve when the plunger reaches its lowermost position in the tubing.

A further object of the invention is the provision of a plunger lift for wells comprising plunger means adapted to be inserted in a well tubing to act as a piston therein and resilient means positioned for engagement with the plunger means as the plunger means approaches the limit of its downward movement in the tubing to arrest such downward movement.

The above and other important objects and advantges of the invention may best be understood from the following detailed description, constituting a specification of the same, when considered in conjunction with the annexed drawings, wherein—

Figure 1 is a side elevational view on a reduced scale illustrating a preferred embodiment of the invention and showing the same in position in a well tubing as the device approaches the limit of its downward movement in the tubing;

Figure 2 is a side elevational view, partly broken away and partly in cross section, of the invention as illustrated in Figure 1 showing details of construction of the same, and the arrangement of the parts in the closed condition of the plunger;

Figures 3A and 3B are fragmentary side elevational views illustrating a somewhat different form of the invention, Figure 3B being a downward continuation of Figure 3A;

Figure 4 is a fragmentary, vertical, central, cross sectional view, on an enlarged scale showing the seal forming means of the invention and the manner in which the same operates when the plunger is in a well tubing to substantially prevent the flow of fluid past the plunger in the tubing; and,

Figure 5 is a fragmentary view similar to that of Figure 2, showing the arrangement of the parts in the open condition of the plunger.

Referring now to the drawings in greater detail, the invention is illustrated in its application to the flowing of an oil well having the usual tubing string T, which extends to the ground level, suitable well head apparatus, not shown, being provided for controlling the flow of fluid from the well, which apparatus may include well lubricator equipment of conventional design, by which the plunger mechanism of the invention may be inserted into or removed from the well tubing, and with which the plunger cooperates to control the reciprocating movements of the plunger. The plunger mechanism of the invention, as illustrated in Figures 1, 2, 4 and 5, comprises an outer tubular housing or body **10**, within which an inner mandrel or valve stem **12** is mounted for longitudinal movement, there being valve means on the housing and stem within the housing positioned for co-action to close the housing against flow of fluid therethrough when the mandrel is in one position of longitudinal movement relative to the housing and to open the housing to such flow when the mandrel is in another longitudinal position relative to the housing, and the housing being provided with external means to form a seal between the housing and the interior of the tubing.

The housing **10** may be formed at its upper end with a fishing head element **14**, whereby the plunger mechanism may be recovered from the well by suitable grappling means, should this become necessary, which element is provided with one or more openings **16**, in communication with the interior of the plunger and leading to the exterior thereof. The element **14** is internally threaded at its lower end for the connection thereto

of the externally threaded upper end of an intermediate tubular section **18** of reduced diameter, whose lower end is externally threaded and extends into an internally threaded counterbore in the upper end portion of a lower housing element or valve body **20** to connect the same thereto.

Within the valve body **20** the lower end of the section **18** forms an internal valve seat **22**, beneath which the lower element is provided with one or more openings **24**, in communication with the interior of the plunger, and leading to the exterior thereof. The lower element or valve body **20** is also provided with an opening **26** for the reception of a pin **28**, which extends inwardly through an opening **30** in the lower end portion of the intermediate section **18**. The opening **30** may be of somewhat larger diameter than the opening **26** whereby the openings may be easily brought into registration to permit the insertion of the pin **28** therethrough, and the valve body is provided with an external annular groove **32**, within which a retaining spring **34** is positioned, which spring extends over the outer end of the pin **28**, to hold the pin in place in the openings **26** and **30**.

The valve body may have an external longitudinal groove **36**, which intersects the annular groove **32**, and is of substantially greater depth than the latter and the retainer spring **34** may have an inturned end portion **38**, extending into the groove **36**, to hold the spring against rotation relative to the valve body. The retainer spring **34** may be readily removed, if desired, by inserting a suitable implement into the groove **36** to pry the end portion **38** out of the groove.

The valve stem **12** has an overall length substantially greater than the length of the body or housing **10**, and is made up of an upper section **40** and a lower section **42**, which sections are threadably connected together as indicated at **44** and may be additionally secured together by means of a pin **46** to prevent accidental separation of the sections. The lower stem section **42** is formed at its upper end with an enlarged portion **48**, forming a valve positioned for engagement with the valve seat **22**, and the lower section is provided intermediate its ends with an external annular groove **50**.

The valve body **20** also has an external annular groove **52** in its lower end portion, and is provided with an opening **54** in communication with the bottom of the groove **52** and with the interior of the valve body and within which a ball **56** or other detent means is movably positioned, which ball is urged inwardly by a resilient element **58**, in the form of a coil spring positioned in the opening **54**, and retained therein by a retainer spring **60**, similar to the spring **34**, previously described, positioned in the groove **52**. The valve body has an external longitudinal groove **62**, in its lower end portion, which intersects the annular groove **52**, and is of somewhat greater depth than the latter, and the spring **60** has an inturned end portion **64**, which extends into the groove **62** to hold the spring against rotation in the annular groove. The ball **56** is positioned to enter the external groove **50** in the lower stem section **42**, to releasably hold the stem in its downmost position, with the valve **48** open.

It will be apparent that when the valve **48** is closed the upper end of the upper stem section **40** will extend above the upper end of the housing, as seen in Figure 2, and when the valve is in open position the lower end of the stem will project downwardly beyond the lower end of the housing, as shown in Figure 5, the ball **56** then being in the groove **50**, to releasably hold the valve open.

The seal forming means of the invention comprises upper and lower bevelled end washers **66** and **68**, respectively, surrounding the intermediate section **18** of the housing, between which washers a number of seal forming elements in the form of wobble washers **70** are loosely positioned on the intermediate section. Each

of the wobble washers **70** has an opening **72**, which is of larger diameter than the external diameter of the intermediate section **18**, and the external diameter of the washers is somewhat less than the internal diameter of the tubing T, so that the washers may move laterally relative to the housing, whereby each washer will make contact with the interior of the tubing throughout a portion of the outer periphery of the washer and with the exterior of the section **18** throughout a portion of the interior periphery of the washer. The wobble washers are preferably constructed of metallic materials but may also be constructed of non-metallic materials.

In assembling the wobble washers on the section **18** the upper end washer **66** is first placed on the section, a number of wobble washers **70** being then placed on the section and the lower end washer being finally placed in position, whereupon the lower end of the section **18** is threaded into the upper end of the valve body **20**. A slight clearance, as indicated at **74** is provided between the lower end washers **68** and the upper end of the valve body **20**, so that wobble washers are loosely mounted for lateral movement.

The wobble washers may have outer marginal portions **76** of reduced thickness, if desired, whereby the area of contact between the washers and the inner surface of the tubing may be greatly reduced.

It will be apparent that by providing a relatively large number of the wobble washers **70**, which are mounted for limited movement laterally and longitudinally on the plunger, portions of the outer peripheries of the washers will usually be in engagement with portions of the inner surface of tubing T, while, at the same time, portions of the inner peripheries of the washers will be in engagement with portions of the outer surface of the plunger. As a result of their loose mounting random orientation of the washers about the plunger will ordinarily occur and will be effective to cause sufficient overlapping of the washer portions engaging the inner surface of the tubing and the outer surface of the plunger as to produce engagement substantially throughout the entire circumferences of both the concentric surfaces engaged by the washers. At the same time, the random displacement of the washers will provide a path of such tortuous form for movement of fluid between the plunger and the tubing wall as to form an effective seal between the plunger and the tubing while permitting free movement of the plunger along the tubing. Moreover, because of the loose mounting of the washers, they will automatically adjust themselves to irregularities in the tubing, whereby to maintain the desired effective sealing engagement while obviating resistance to the movement of the plunger through the tubing.

In the operation of the invention, the plunger is inserted in the well tubing with the parts assembled in the manner shown in Figure 2, the stem **12** being moved downwardly to its lowermost position, as shown in Figure 5 with the lower end of the lower stem section **42** projecting downwardly beyond the lower end of the valve body **20**, and the valve **48** in open position. Downward movement of the plunger in the tubing may take place under the influence of gravity, and fluid in the tubing flowing through the housing during such movement through the openings **24** and **16** and through the valve seat **22**. When the plunger reaches bottom the lower end of the stem will engage the bottom of the hole, forcing the stem upwardly to move the valve **48** into closing contact with the seat **22**, so that the pressure of fluid entering the tubing beneath the plunger will force the plunger upwardly to lift any fluid in the tubing above the plunger to the surface.

During such upward movement of the plunger the upper end of the valve stem will be projecting upwardly above the the upper end of the housing, as seen in Figure 2, and when the plunger reaches the upward limit of its movement in the tubing the upper end of

the stem will be engaged by the well head equipment provided for that purpose to move the stem downwardly to the position shown in Figure 5, to again open the valve 46, to permit the plunger to again move downwardly under the influence of gravity. The plunger is thus caused to reciprocate in the tubing under the influence of gravity and the pressure of fluid entering the lower end of the tubing to cause well fluid to flow upwardly in the tubing.

Suitable means, such as a coil spring 78 may be positioned in bottom of the well to cushion the downward movement of the plunger as the plunger approaches the bottom.

A somewhat modified form of the invention is illustrated in Figures 3A and 3B, wherein the upper portion of the plunger is of similar construction to that previously described, while the lower housing element 20' is differently constructed than the element 20 of the previously described structure, and the valve mechanism of the plunger is omitted.

In this form of the invention the element 20' is internally threaded at its lower end to receive a choke 80 having a restricted bore 81, by which the flow of fluid through the plunger is restricted, and the element is formed with an externally reduced lower end portion 82 to provide a downwardly facing, external, annular shoulder 84 against which the upper end of a coil spring 86 bears. A tail piece 88 is provided, having an external enlargement 90 at its lower end forming an upwardly facing shoulder 92 against which the lower end of the spring 86 bears. The tail piece is provided with an internal, upwardly opening bore 94 and has one or more openings 96 which are in communication with the bore and with the exterior of the tail piece. In other respects the construction of this modified form of the invention is similar to that shown in Figures 1, 2, 4 and 5.

In the operation of the modified form of the invention, the plunger is inserted in the tubing T and allowed to move downwardly therein by gravity, fluid in the tubing passing through the bore 81 of the choke 80 during such downward movement.

When the tail piece 88 reaches bottom the downward force of the plunger will be cushioned by the spring 86 and the pressure of fluid beneath the plunger may then cause the plunger to move upwardly in the tubing due to the restricted flow of fluid through the choke 80.

Reduced portion 82 and tail piece 88 are each provided adjacent the respective shoulders 84 and 92 with sections carrying helical grooves 96 and 98, respectively, which are complementary in size and pitch to function as threads adapted to threadedly receive the opposite ends of coil spring 86, the convolutions of which will thus function as mating threads. This arrangement provides means for readily releasably securing the spring to the plunger and the tail piece and provides reinforcement for the ends of the spring.

The invention provides a well plunger which is operated automatically by well pressure and having seal forming means which is capable of adjusting itself to irregularities in the shape or condition of the well tubing and by which frictional resistance to the movement of the plunger is substantially reduced.

The invention has been disclosed herein in connection with certain specific embodiments of the same, but it will be understood that these are intended by way of illustration only, and that various changes can be made in the construction and arrangement of the parts within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a well plunger having a body adapted to be inserted in a well tubing for longitudinal movement therein, a plurality of substantially flat washer-like elements loosely mounted on the body in position for lateral movement relative to the axis of the tubing to substantially close the space between the exterior of the body and the interior of the tubing, each of said elements having external and internal peripheral surfaces shaped for engagement respectively with the interior surface of the tubing and the exterior surface of the body, said external peripheral surface of each of said elements comprising a single axially continuous marginal portion of lesser thickness than said internal peripheral surface.

2. A well plunger of the free piston type comprising, a tubular body adapted to be inserted in a well tubing for longitudinal movement therein, control means in the bore of the body to control passage of fluid therethrough, and seal means forming a sliding seal between the body and the inner wall of the tubing, said seal means comprising a plurality of flat axially abutting annular washer elements loosely mounted about the body with a limited degree of annular clearance sufficient to permit free lateral movement thereof into engagement with the inner wall of the tubing, each of said elements having concentric external and internal annular peripheral surfaces shaped for engagement respectively with the interior surface of said tubing and the exterior surface of said body, said external peripheral surface of each of said elements comprising a single axially continuous marginal portion of lesser thickness than said internal peripheral surface.

3. A well plunger according to claim 2 wherein said control means comprises a choke member having a flow passage of restricted area therethrough.

4. A well plunger according to claim 2 wherein said control means comprises, valve means mounted in the bore of the body and operable in response to engagement of the body with an obstruction in the tubing to open and close said bore.

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