Nov. 3, 1953 J. G. BAKER ET AL 2,657,633

PUMP CONSTRUCTION

Filed June 2, 1948 3 Sheets-Sheet 1

Fig. 1

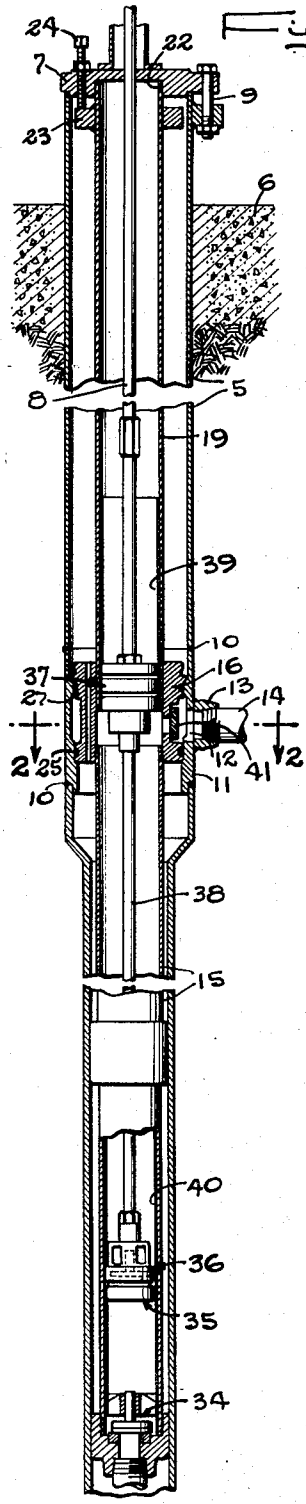


Fig. 2

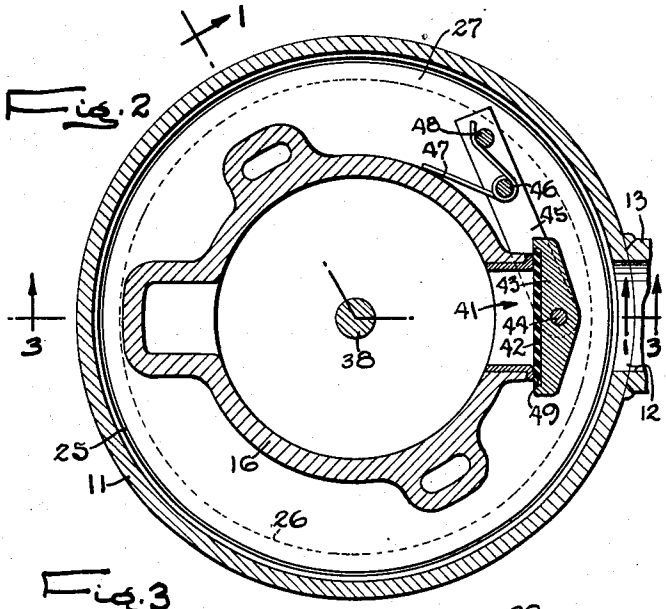
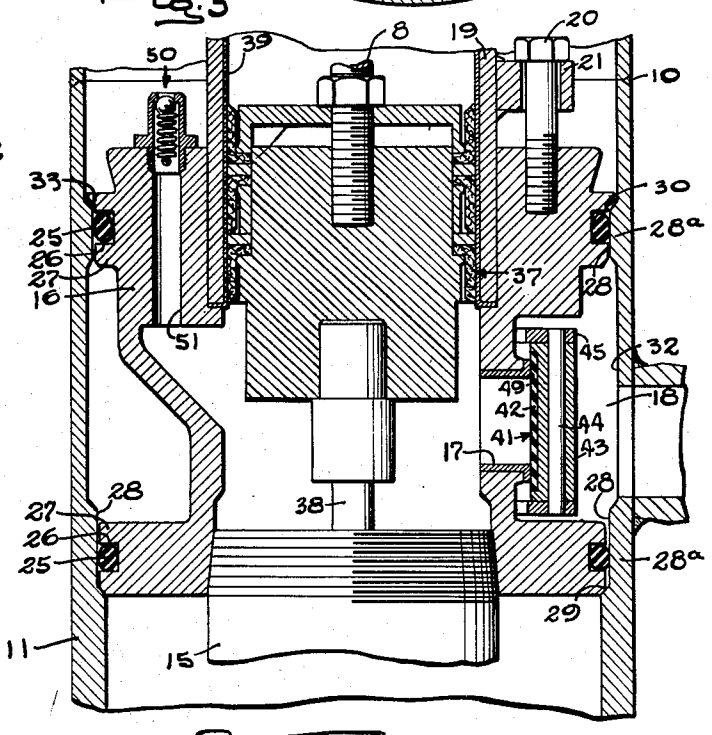


Fig. 3



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Nov. 3, 1953 J. G. BAKER ET AL 2,657,633

PUMP CONSTRUCTION

Filed June 2, 1948 3 Sheets-Sheet 2

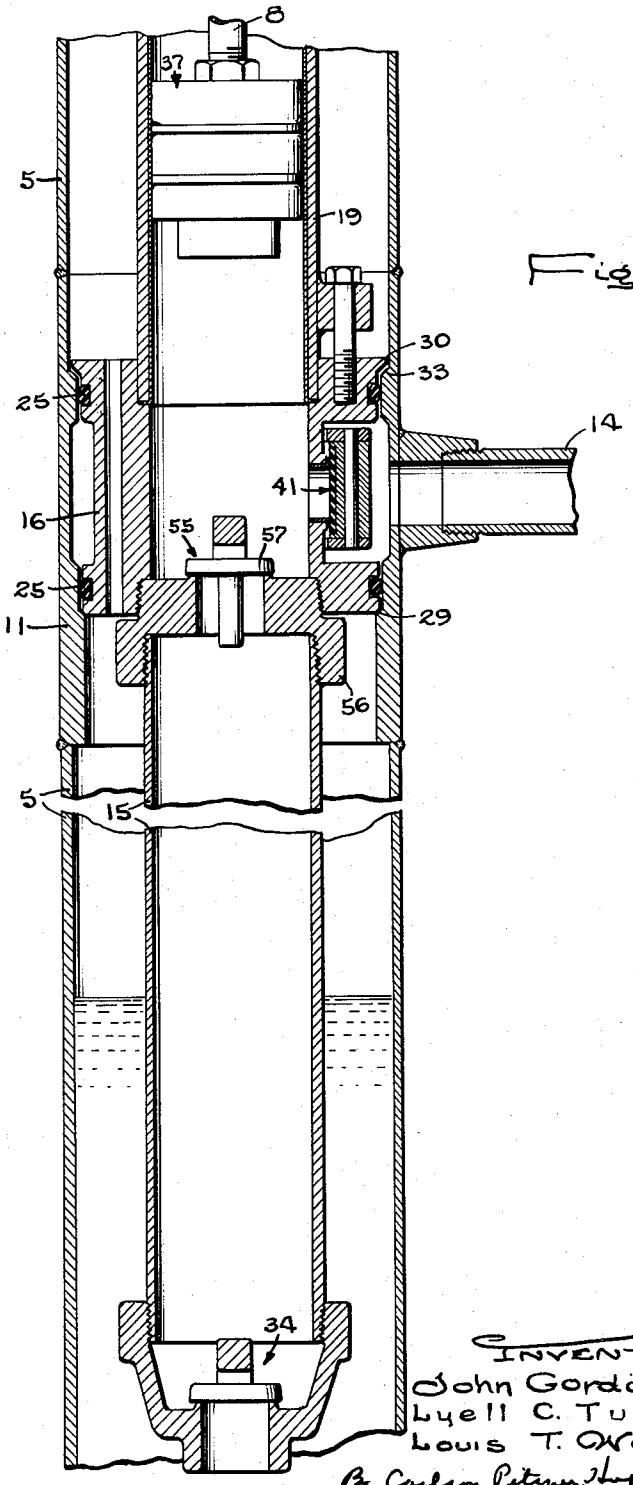

Fig. 4

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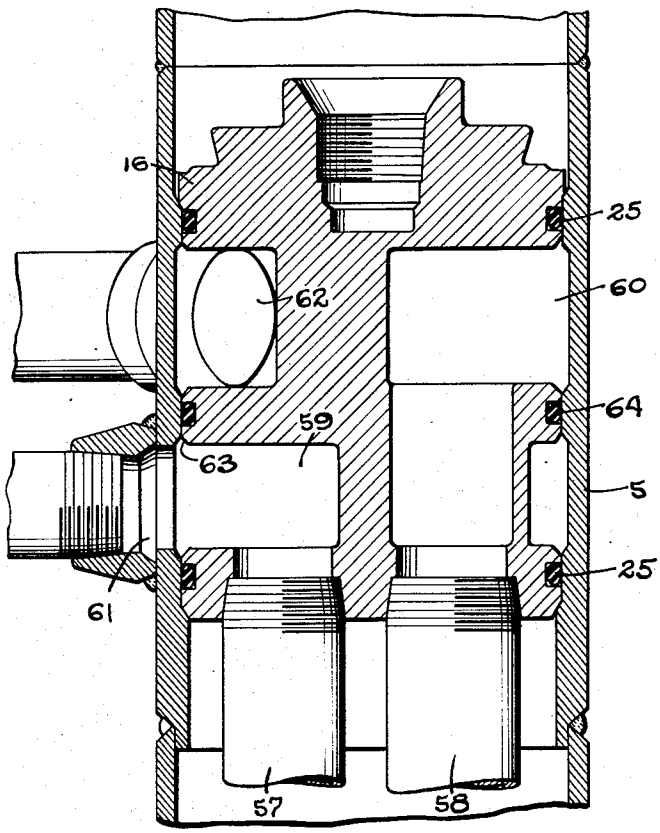
Nov. 3, 1953 J. G. BAKER ET AL 2,657,633

PUMP CONSTRUCTION

Filed June 2, 1948 3 Sheets-Sheet 3

Fig. 5



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Patented Nov. 3, 1953

2,657,633

UNITED STATES PATENT OFFICE

2,657,633

PUMP CONSTRUCTION

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Application July 2, 1948, Serial No. 36,654

12 Claims. (Cl. 103—8)

1

This invention relates to water pumps of the so-called pitless type in which all of the operating parts of the pump proper are assembled in a unit which may be inserted in and withdrawn from the well casing which extends upwardly above the ground surface. In such pumps, the water is discharged laterally through an opening in the casing and the internal surfaces of the latter above and below the opening are sealed against the exterior of a discharge head which is removable from the casing with the pump unit.

The general object is to provide a pump construction of the above character which is substantially cheaper to manufacture and install than prior pitless constructions and which may be removed readily for inspection or repair of all of the operating parts and then replaced in the well casing without danger of damaging any of the sealing surfaces.

Another object is to construct the removable discharge head and the cooperating casing surfaces in a novel manner such as to mechanically protect the seals during insertion or removal of the pump unit.

Still another object is to provide a seal construction which is usable in different types of water pumps including deep well, shallow well, jet, etc., and facilitates ready conversion of a shallow well pump into a deep well pump.

A further object is to provide a deep well type of reciprocating pump in which the load on the power actuator is divided substantially evenly between the two pump strokes, and the proper amount of air is always delivered to the distributing system along with the water.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a fragmentary vertical sectional view of a deep well casing and water pump incorporating the novel features of the present invention, the section being taken along the line 1—1 of Fig. 2.

Fig. 2 is a plan section taken along the line 2—2 of Fig. 1.

Fig. 3 is an enlarged fragmentary section taken along the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary view similar to Fig. 1 showing a shallow well pump installation.

Fig. 5 is a similar view of the installation for a pump of the jet type.

While the invention in its several aspects is applicable to various water pumps including deep well, shallow well, and jet type and is susceptible

2

of various modifications and alternative constructions, we have shown in the drawings and will describe herein preferred embodiments as applied to certain types of pumps. It is to be understood that we do not intend to limit the invention by such disclosure but aim to cover all modifications, alternative constructions, and uses falling within the spirit and scope of the invention as expressed in the appended claims.

Referring first to Figs. 1 to 3, the deep well pump installation there shown includes the usual tubular casing 5 which extends upwardly through the ground to a point above a surface platform 6 and is covered by a cap 7 which supports the power driven actuator (not shown) by which the pump rod 8 is raised and lowered. Herein the cap is clamped removably against the casing end by bolts 9 etxending through lugs on the casing and cap. The casing is composed of upper and lower pipe sections joined below the ground surface as by welds 10 to opposite ends of a distributor head or sleeve 11 formed intermediate its ends with an outlet hole 12 through which the pumped water is delivered under pressure. A ring 13 secured to the exterior of the sleeve around the hole is threaded internally to receive the end of an outlet pipe 14 which extends horizontally through an adjacent building wall to the usual air bell of a water distributing system.

The usual drop pipe 15 is suspended within the casing 5 from a hollow packing head in the form of a spool 16 disposed within the sleeve 11 and removably sealed within the latter both above and below the water outlet 12. The interior of the spool communicates with the casing outlet 12 through a hole in the center or core of the spool and an annular external groove 18 around the core.

Herein, the lower end of the spool is threaded internally for connection with the drop pipe 15, while the upper spool end slidably receives the lower end of an extension pipe 19 which is clamped in the spool by screws 20 entered through external lugs 21. The upper end of the pipe 19 is slidably received in the bore 22 of the cap 7 and an external lug 23 on the pipe bears against an adjustable stop 24 on the cap.

Watertight seals around opposite ends of the spool are formed by so-called "O" rings 25 of yieldable materials such as rubber seated in grooves 26 around the spool flanges 27 and projecting outwardly therefrom against smooth cylindrical surfaces 28 on shallow flanges or ribs 28a formed around the interior of the sleeve 11. The sleeve surfaces are somewhat smaller in di-

ameter than the upper section of the well casing 5 and, after finish machining, are preferably electroplated to provide a smooth corrosion resistant finish against which the seal rings become compressed tightly as the spool is lowered through the upper casing section into position within the sleeve. Herein, this position is determined by engagement of the lower end of the spool itself with an upwardly facing abutment 29 formed on the sleeve 11 and projecting inwardly beyond the lower sealing surface 28.

To prevent the seal rings 25 from rubbing against the rough internal surface of the casing 5 as the spool 16 is being inserted or removed, angularly spaced outwardly projecting centering elements are formed around the upper end of the spool above the upper ring 25 so as to be disposed above the upper sleeve surface 28 when the spool encounters the stop 29. Herein, the lugs or centering elements are joined together and form a rigid continuous peripheral flange 30 which is of larger diameter than the rings 25 when the latter are uncompressed and smaller than the internal diameter of the well casing. Thus, the flange centers the spool in the pipe during insertion of the pump unit thereby holding the sealing material out of rubbing contact with the unmachined surfaces of the well casing.

To protect the lower seal ring 25 against rubbing across the inner end of the outlet 12, the sleeve 11 is bored out as indicated at 32 between the surfaces 28 and across the outlet 12 to a depth greater than the expansion of the rings 25 when the latter are free. Thus, in the movement of the spool into and out of the sleeve 11, the lower seal ring 25 contacts only the smooth cylindrical surfaces 28 and the finished bevels 33 on opposite sides thereof.

As in the case of prior deep well reciprocating pumps, the pump proper comprises generally an automatic foot valve 34 at the lower end of the drop pipe 15 and a lower piston 35 and associated automatic valve 36 and an upper piston 37 which is connected to the lower piston by a rod 38 extending upwardly through the spool 16. The upper piston is connected to the power reciprocated pump rod 8 and, preferably, reciprocates in a cylinder formed by a liner 39 in the lower end portion of the pipe 19. In a similar way, a liner 40 in the drop pipe forms the cylinder for the lower piston 35.

In one of its aspects, the present invention contemplates a novel sizing of the pistons 35 and 37 and the use of a check valve 41 coacting with the pistons to enable the stroke loads on the power actuator to be equalized and to enable the pistons to perform the additional function of an air pump. To this end, the upper piston 37 is made slightly larger than the lower piston 35 so that on the upward stroke of the pump rod 8, the added displacement of the upper piston will cause a desired amount of air to be drawn into the chamber between the pistons and thus discharged along with the water in the next down stroke. The difference in the piston diameters may vary somewhat according to the requirements of a given installation being about ¼ of an inch in the present instance.

For several reasons, the check valve 41 is mounted on the spool 16 and disposed in the annular recess 18. The valve comprises a disk 42 of somewhat yieldable material mounted for bodily movement into and out of abutting engagement with a seat 49 machined on the spool core at the outer end of the passage 17 therethrough.

To minimize the over-all radial dimensions of the mouting, the valve disk 42 is carried by a plate 43 pivotally connected by a vertical pin 44 to the arms of a yoke 45 which in turn is supported on a pivot pin 46 connecting the spool flanges 27 and angularly spaced around the core from the pivot 44. While the valve 41 naturally tends to close at the proper time in the pumping cycle, it is preferred to provide a spring 47 normally urging the valve disk toward closed position. Herein, the spring comprises a wire wrapped around the pin 46 acting in torsion between the spool core and a pin 48 on the yoke 45 to urge the latter and the valve disk 42 toward the seat 48. The valve 41 is closed when the pressure within the pump chamber is equal to or lower than that in the water distributing system.

Air is admitted to the pump chamber through a check valve 50 which may as shown be of the ball type and located in a passage 51 extending through the upper flange 27 of the spool 16 into the interior of the latter.

During the up stroke of the pump rod 8 in the deep well installation described above, water from the well is drawn into the lower end of the drop pipe through the valve 34 as the lower piston 35 rises. The valve 36 is closed so that the head of water above the piston 35 is raised. Owing to the larger displacement of the upper piston 37, the pressure in the pump chamber is reduced below the atmospheric pressure so that the check valve 50 opens to admit air to the pump chamber corresponding in an amount corresponding to the difference in the piston areas. The water check valve 41 is of course closed at this time.

In the downward stroke, the foot valve 34 closes off the lower end of the drop pipe and the valve 36 opens to permit lowering of the piston 35. The upper piston 37 thus acts to place the water and air in the pump chamber under pressure forcing the same out through the valve 41 which thus opens automatically, the air inlet valve 50 remaining closed.

The delivery of water to the distributing system during only the down stroke of the pistons is advantageous for several reasons. First, the load on the power actuator is equalized in most deep well installations because the work required to deliver water to the distributing system is substantially equal to that of lifting the water head during the up stroke. That is to say, the pressure to be maintained in the distributing system may in many installations be correlated with the depth of the well so as to substantially balance the water head to be lifted during the up stroke of the pump. This is contrasted with many prior systems in which the delivery of water on the up stroke as well as during the down stroke results in a greater burden on the power actuator during the up stroke than during the down stroke.

Secondly, it is possible to utilize the pistons of the water pump proper to deliver the required amount of air along with the water thereby avoiding the necessity of providing a separate air pump. In this connection, it will be observed that the combined air and water check valve 41 is located close to the pump chamber proper so as to provide a low clearance volume between the air pump and the air outlet valve. As a result, the internal pressure within the pump chamber will always be reduced below atmospheric pressure and thus enable air to be drawn in through the valve 50. The location of the check valve 41 on the spool 16 is further advantageous in that

it is readily accessible for inspection or repair along with the other operating parts of the pump.

The novel construction and mounting of the spool 16 and the associated water check valve as described above may be utilized advantageously in shallow well pumps as illustrated in Fig. 4 in which the parts bear the same reference numbers as the corresponding parts previously described. For this use, the air inlet valve 50 would ordinarily be omitted but other well known means may be provided, if necessary, for the introduction of air into the water delivered to the distributing system. Also, the piston 35 and the associated valve of the deep well pump shown in Fig. 1 are omitted and a valve 55 is provided within the spool at the upper end of the drop pipe 15. To accomplish this, the drop pipe is supported by a fitting 56 screwed into the lower end of the spool and providing a seat for the disk 57 of the valve 55. With this arrangement, water will be drawn upwardly through the valves 34 and 55 on the up stroke of the piston 37 during which the outlet valve 41 will be held closed. On the down stroke, the valves 34 and 55 close automatically and water is forced through the valve 41 to the distributing system.

Mounting of the water check valve 41 directly on the spool 16 is also advantageous in a shallow well pump for reasons other than to facilitate inspection and repair. In this location, the volume of the space subjected to sub-atmospheric pressure during the suction stroke is reduced to a minimum, thereby providing for an optimum pressure reduction during this stroke. Such a small volume is also advantageous in facilitating priming of the pump and the maintenance of the prime in service operation.

It will be observed that, except for the provision of the air inlet valve 50 in the deep well pump, the construction of the spool 16 and its mounting are identical and therefore may be used alternatively in the deep and shallow well pumps above described. This not only reduces the initial cost of an installation but simplifies and minimizes the cost of conversion in the event that the initial water level in the well falls enough to necessitate the use of a deep well type of pump.

In some water pumps, particularly those of the shallow well reciprocating and jet types, the pumping mechanism proper may be located outside of the well casing and within an adjacent building. For these installations, the check valve 41 and other parts would be omitted on the spool 16 which would be cored out to provide the necessary passages. For example, in one type of jet pump as shown in Fig. 5, parallel drop pipes 57 and 58 supported by the spool 16 would communicate with separate chambers 59 and 60 cored in the spool and opening outwardly in registry with separate outlet pipes 61 and 62 leading laterally from the well casing 5 to pumping apparatus located at a remote point. In this case, an additional land 63 intermediate the ends of the spool 16 and between the outlets 61 and 62 is formed with a groove in which a seal ring 64 is seated. As in the case of the seal rings 25, the ring 64 becomes compressed against an internal cylindrical surface 65 on the spool 16 and thus provides a seal separating the two passages through the spool which is removable from the well casing and replaceable therein the same as in the constructions first described.

In each of the pump constructions described above the parts which ordinarily require inspection or repair during the service life of a pump

are mounted on the spool 16 within the outermost diameter of the seal rings 25 so that the entire assembly may be withdrawn upwardly and removed from the well casing. This is accomplished by removing the cap 7 after releasing the bolts 9 and applying the lifting force to the lugs 23. In the upward movement of the unit, the spool 16 is centered in the pipe 5 by the flange 30 so that the seal rings 25 are held out of rubbing contact with the rough wall of the pipe. The rings are protected in the same way during the original insertion and the replacement of the unit in the casing. Since the downward movement of the unit is limited by engagement of the spool itself with the abutment 29, none of the parts need to be dimensioned accurately in the lengthwise direction. After such replacement, it is only necessary to turn the screw 24 down against the lug 23 so as to lock the unit positively against upward movement.

We claim as our invention:

1. In a pitless pump construction, the combination of, a tubular casing having upper and lower sections connected by a sleeve with a laterally opening water outlet therein, axially spaced internal cylindrical surfaces in said sleeve smaller in diameter than the interior of said upper casing section and disposed above and below said outlet, an abutment in said sleeve facing axially and upwardly, a drop pipe, a spool supporting said pipe and received in said sleeve against said abutment so as to be supported thereby, seal rings of yieldable material extending around said spool and respectively engageable with said surfaces when the spool engages said abutment, and centering means rigid with said spool above said seal rings projecting outwardly therefrom beyond the outer periphery of the rings but short of the wall of the upper casing section so as to engage the casing wall during insertion and removal of the spool whereby to prevent rubbing of said seal rings against the casing wall.

2. In a pitless pump construction, the combination of, a sleeve forming a part of a well casing and having axially spaced inwardly extending flange projections intermediate its ends presenting smooth internal cylindrical surfaces, said sleeve having an outlet opening between said surfaces, a drop pipe, a spool supporting said drop pipe and having external flanges smaller than and spaced to fit within said sleeve projections, seal rings of yieldable material seated in said spool flanges and respectively engageable on said projecting surfaces, means on said spool projecting outwardly therefrom beyond the outer periphery of said rings and engageable with the internal wall of said casing during insertion and removal of said spool to hold said seal rings out of rubbing contact with the wall, and an internal abutment rigid with said sleeve and engageable with the end of said spool to locate said seal rings opposite said projections.

3. In a pitless pump construction, the combination of, a tubular sleeve forming a part of a well casing and having a discharge outlet intermediate its ends, axially spaced and peripherally continuous surfaces formed around the interior of said sleeve, said surfaces being smaller in diameter than the interior of the upper part of said casing and disposed above and below said outlet, a pipe, a spool supporting said pipe and having end flanges adapted to be received in said sleeve in opposite relation with respect to said surfaces, seal rings of yieldable material extending around said flanges and respectively engageable with said

surfaces, at least the upper one of said internal surfaces facing radially inwardly and the ring engaging such surface extending around the outer periphery of the upper flange of said spool, and centering means rigid with said spool above said rings projecting outwardly from the spool flanges beyond the outer periphery of the upper ring but short of the casing wall and engageable with the latter during insertion and removal of the spool whereby to prevent rubbing of said upper seal ring against said casing wall.

4. In a pitless pump construction, the combination of, a tubular sleeve forming part of a well casing and having axially spaced internal cylindrical surfaces intermediate its ends set inwardly from the internal sleeve wall, said sleeve having an outlet opening between said surfaces, a drop pipe, a hollow spool supporting said drop pipe and disposed within said surfaces, seal rings of yieldable material seated in and exteding around said spool and respectively engageable with said surfaces, and an external projection of larger radius than the upper one of said rings rigid with said spool above the latter ring and engageable with the casing wall during insertion and removal of the spool to hold said seal rings out of rubbing contact with the wall.

5. In a pitless pump construction, the combination of, a tubular sleeve forming part of a well casing and having axially spaced internal cylindrical surfaces intermediate its ends of smaller diameter than the inside diameter of the casing above the surfaces, said sleeve having an outlet opening between said surfaces, a drop pipe, a hollow spool supporting said drop pipe and disposed within said surfaces, seal rings of yieldable material seated in and extending around said spool and respectively engageable with said surfaces, and means rigid with said spool above said rings and projecting outwardly therefrom beyond the outer peripheries of said rings for engagement with said casing wall during insertion and removal of the spool whereby to hold said seal rings out of rubbing contact with the wall, the wall of said sleeve between said surfaces being undercut around said opening to a radius large enough to prevent damage to said rings when passing said outlet opening during insertion or removal of said spool.

6. A pitless pump construction having, in combination, a well casing having a water outlet opening laterally therefrom and intermediate the ends of the casing, a drop pipe having a pump cylinder therein, a piston reciprocable in said cylinder, a spool with axially spaced flanges supporting said drop pipe and insertable endwise in said casing, means providing on opposite sides of said outlet, fluid tight seals between said flanges and the interior of said casing, said spool having an opening through the core thereof between said seals and terminating in an outwardly facing valve seat, a valve member, an arm pivoted on the exterior of said spool core to swing about an axis paralleling the spool axis and angularly spaced from said valve seat, means pivotally supporting said valve member on the end of said arm to swing about an axis parallel to said first axis, and a spring acting on said arm to swing the latter and said valve member toward and into engagement with said valve seat, said spring, said arm and said valve member being disposed within a projection of said spool flanges whereby to permit endwise insertion of the spool into and removal of the same from said casing.

7. A pitless pump construction having, in combination, a well casing including an intermediate sleeve having a water outlet opening laterally therefrom, a pipe, a hollow spool supporting said pipe and received in said sleeve, means providing above and below said outlet fluid tight seals between the exterior of said spool and the interior of said sleeve permitting endwise insertion of said spool into and removal thereof from said sleeve, said spool having an external recess communicating with said outlet, means on said spool providing a passage connecting said recess with the interior of the spool and the upper end of said pipe and terminating in an outwardly facing annular valve seat, a valve member mounted on said spool within said recess and movable toward and away from said seat into and out of engagement with the latter, said seat and said valve member being disposed when closed within a radius smaller than the upper one of said seals and within the space defined by a projection of said spool flanges, pumping means supported by said pipe within said casing and operable to deliver water upwardly through the pipe and outwardly through said spool passage and said valve, and means normally urging said valve member against said seat to maintain the valve closed when the pumping means is idle.

8. A pump construction having, in combination, a well casing having a water outlet opening laterally therefrom, a drop pipe providing an upper cylinder and a lower cylinder of smaller diameter than said upper cylinder, pistons reciprocable in said cylinders and rigidly connected by a rod extending through the chamber defined by said drop pipe between the pistons, a hollow spool supporting said drop pipe and received in said casing opposite said outlet, means above and below said outlet providing fluid tight seals between the exterior of said spool and the interior of the casing permitting endwise insertion of said spool into and removal thereof from said casing, said spool having a passage therethrough disposed between said seals and communicating with said chamber, a valve including a member mounted on said spool and movable to permit the outflow of fluid from said passage to said outlet, and a valve operable automatically in response to a pressure fall in said chamber to a predetermined value to admit air into the chamber at a point between said first valve and said drop pipe.

9. A pump construction having, in combination, a tubular member defining an upper cylinder, a lower cylinder of smaller diameter than the upper cylinder, and an intervening chamber between the cylinders, pistons slidable in the respective cylinders, a rod rigidly connecting said pistons and projecting axially from said member for connection to a power actuator, said member having an outlet opening extending outwardly through the member and communicating with said chamber at a point disposed between said pistons, a check valve mounted on said member and closing said opening during one stroke of said rod while permitting an outflow of fluid during the other piston stroke, and member having a second passage extending therethrough for admitting air to said chamber, and a second normally closed check valve disposed in said second passage to control the flow of air therethrough and adapted to open automatically in response to a fall in pressure within said chamber to a predetermined value, said member, said pistons, and said valves constituting a unitary assembly adapted for endwise

insertion into and removal from a well casing.

10. In a pitless well construction, the combination of, a tubular sleeve forming part of a well casing and having a discharge opening intermediate its ends, a hollow spool having spaced flanges and an opening therebetween, said spool being disposed within said sleeve with said openings communicating with each other, a pipe supported by said spool and communicating with the interior thereof, means defining a fluid tight seal between the interior of said sleeve and the lower flange of said spool, the coacting elements of said seal being brought into engagement during lowering of the spool and pipe into said sleeve, a ring of yieldable material encircling the upper spool flange and engaging an internal surface on said sleeve to form a fluid tight seal, and centering means on said spool above said seals and projecting outwardly from the spool beyond the outer periphery of said ring but short of the internal wall of said sleeve so as to engage said wall during insertion and removal of the spool and prevent rubbing of said ring against the wall.

11. A pitless pump construction having, in combination, a well casing having a water outlet opening laterally therefrom and intermediate the ends of the casing, a spool having flanges at opposite ends of a hollow core and a passage extending outwardly from the interior of the core and having an annular valve seat formed therein, a pipe suspended from the lower end of said spool in communication with the interior of said core, said spool with said pipe supported thereon being insertable endwise in said casing to bring said passage into communication with said casing outlet, means providing fluid tight seals between the flanges of said spool and the internal wall of said casing above and below said outlet opening whereby to confine the flow of water from said pipe into the interior of said spool and outwardly through said passage to said outlet opening, pumping means supported on said pipe within said casing and operable to deliver liquid upwardly through the pipe and spool to said outlet, a valve member carried by said spool within the periphery of one of said flanges and movable toward and away from said seat so as to be opened automatically in response to the delivery of water upwardly through said pipe into said core, and means urging said valve member toward said seat to maintain the valve closed when said pumping means is idle.

12. A pitless pump construction having, in combination, a well casing having a water outlet opening laterally therefrom and intermediate the ends of the casing, a spool having flanges at opposite ends of a hollow core and a recess around said core and between said flanges, a pipe suspended from the lower end of said spool in communication with the interior of said core, said spool with said pipe supported thereon being insertable endwise in said casing to bring said recess into communication with said casing outlet, a valve seat surface located in an upright plane in said recess of said spool core and facing outwardly from the core but spaced inwardly from said well casing, means providing fluid tight seals between the flanges of said spool and the internal wall of said casing above and below said outlet opening whereby to confine the flow of water from said pipe into the interior of said spool and outwardly through said passage to said outlet opening, pumping means supported on said pipe within said casing and operable to deliver liquid upwardly through the pipe to the interior of said spool core, there being at least one passage extending through said spool core and said seat surface to establish communication between said pipe and said outlet when the passage is uncovered, a valve member carried by said spool and movable within said recess toward and away from said seat surface to cover said passage and be opened automatically in response to the delivery of water upwardly through said pipe into said core, and means urging said valve member toward said seat to maintain the valve closed when said pumping means is idle.

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