Aug. 8, 1939. P. CAVINS 2,168,729

SAND PUMP

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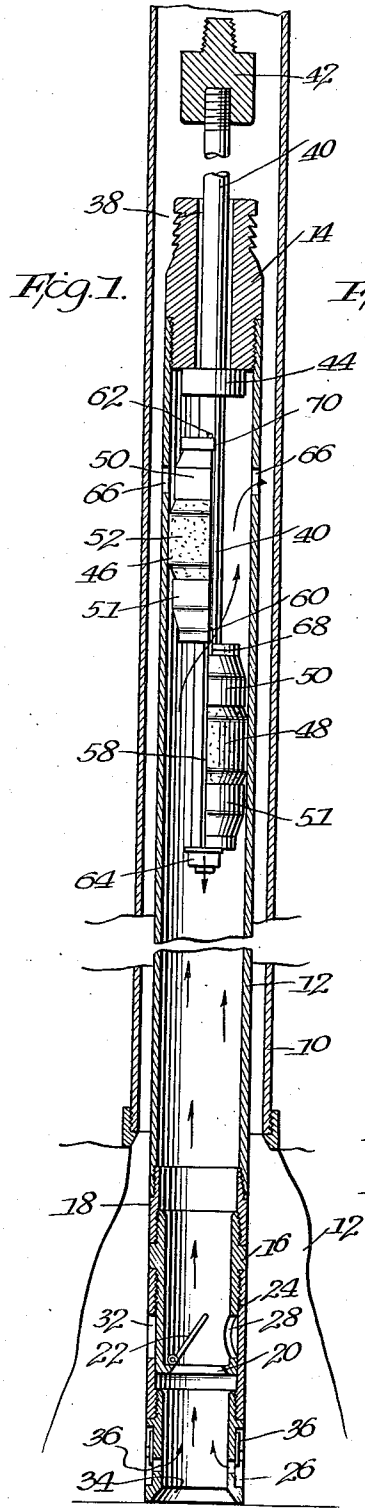

Fig. 1.

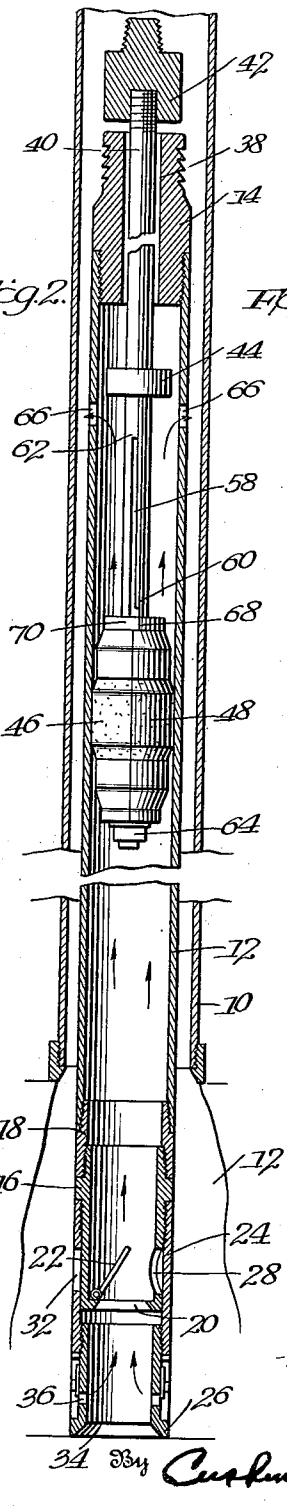

Fig. 2.

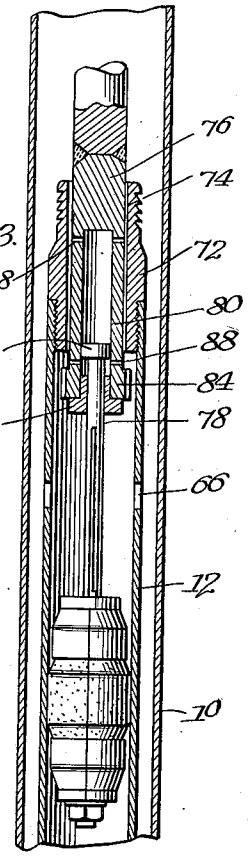

Fig. 3.

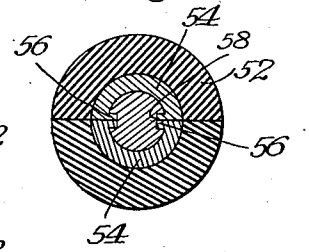

Fig. 8.

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Fig. 4.

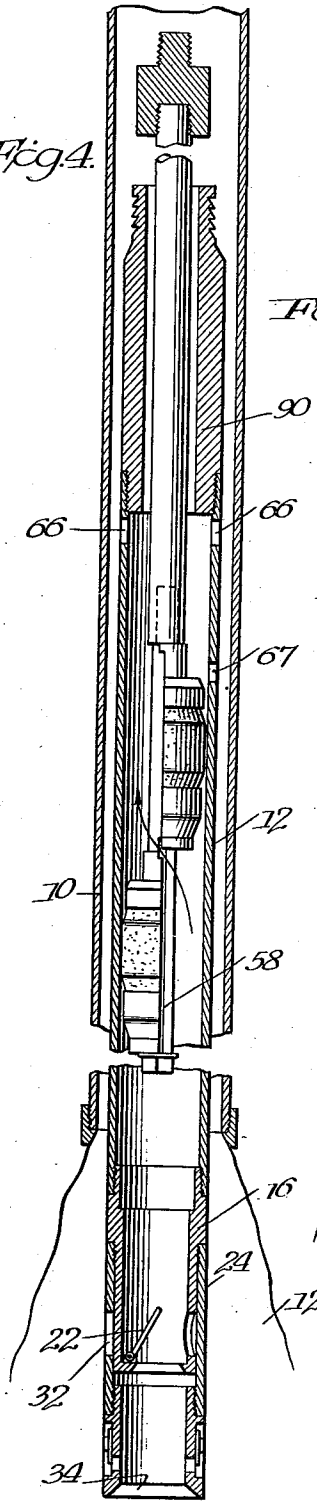


Fig. 5.

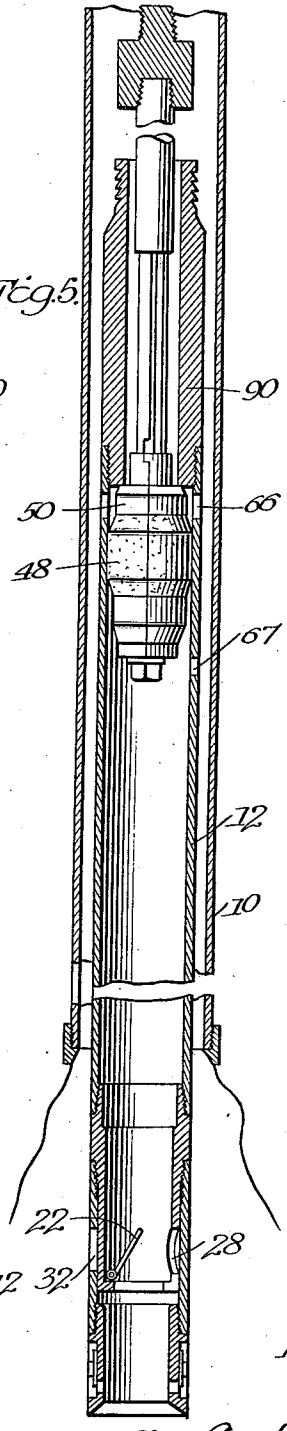
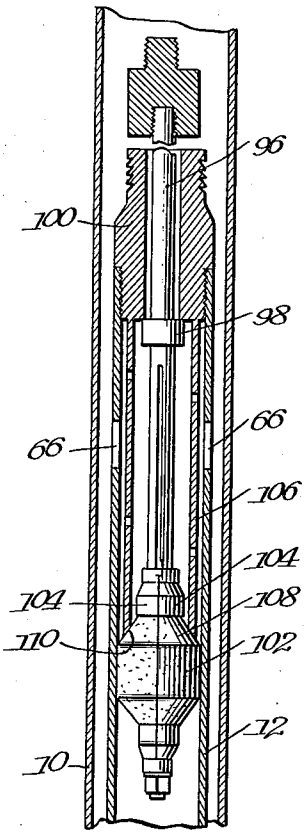


Fig. 6.



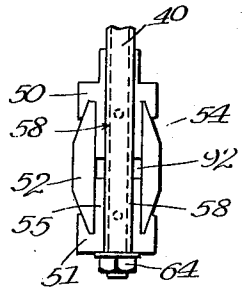


Fig. 7.

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UNITED STATES PATENT OFFICE

2,168,729

SAND PUMP

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Application August 19, 1937, Serial No. 159,947

7 Claims. (Cl. 166—19)

The present invention relates to sand pumps of the type comprising a barrel adapted to be lowered into a well and operated manually to draw a charge into the barrel by suction, and to be removed from the well with the charge retained therein. The invention is to be distinguished from well pumps having a piston adapted to directly engage the casing of a well.

Tools of the character of the present invention are useful in oil well operations to remove liquid or solid matter, such as sand, from the bottom of a well, in order to clean the well. Similar tools of the prior art generally comprise a barrel adapted to be lowered into the well, the barrel having a bottom inlet and a charge-retaining valve above the same, with some form of piston plunger adapted to be manually moved upwardly in the barrel to draw a charge of sand and the like into the barrel past a charge-retaining valve, which keeps the material drawn into the barrel from flowing out through the bottom thereof while the tool is being withdrawn from the well. Prior art pumps of this kind employ a solid one-piece piston operating in the barrel to create the suction for drawing the charge, and usually this piston is equipped with a one-way valve, such as a ball valve, to permit fluid to pass through the piston during its downward stroke, yet preventing passage of fluid through the piston during its upward stroke.

These prior art tools have not been completely effective, principally because the piston valves are inclined to become fouled, resulting from the collection around the same of mud and other debris drawn from the well. The fouling of the valves seriously impairs the effectiveness of the tool, or completely disables it.

One of the principal objects of the invention is to provide a sand pump having a novel form of piston, making unnecessary the employment of a one-way valve or the like to control passage of fluid through the piston.

Another object of the invention is to provide a sand pump having a novel form of sectional piston, the sections of which assume a substantially tandem relation when the piston is being lowered through the barrel of the tool, and a substantially side-by-side relation to seal the piston against the interior of the barrel, when the former is being raised through the barrel to create suction and draw a charge from the well. This type of piston permits a free flow of fluid upwardly in the barrel during its down-stroke, yet completely seals the barrel during up-stroke.

Another principal object of the invention is to provide a tool of the above type equipped with means to positively close off the upper end of the barrel at the termination of the suction stroke of the piston, to retain fluid at substantially bottom-hole pressure therein so that this fluid under pressure may automatically discharge the tool at the surface of the well.

Various other objects and advantages of the invention will become apparent as the specification progresses.

The drawings are illustrative of several forms of the invention and are not intended to be in any sense restrictive.

Figure 1 is a vertical sectional view of the lower end of a well, showing the tool of this invention lowered to charge-taking position therein.

Figure 2 is a view similar to Figure 1, but showing the tool in the condition when a charge is being drawn into the barrel.

Figure 3 is a similar view, showing a modification of the invention.

Figure 4 is a view similar to Figure 1, of a different form of the invention of a type wherein the piston positively closes off the upper end of the barrel.

Figure 5 is a view of the tool shown in Figure 4, showing the piston at the termination of its upward stroke.

Figure 6 is a vertical sectional view of the upper end of a modified form of the tool.

Figure 7 is an inside face view of one of the piston sections, showing the same in position on its operating rod, and

Figure 8 is a transverse sectional view of the piston employed in the present invention.

In Figure 1 a tool of the present invention is shown lowered to the bottom of a well casing 10, said casing being perhaps cemented above an open hole 12 from which it is desired to draw sand or other material. However, it will be understood that the tool may be operated at a point completely within the well casing, above the point shown, rather than being operated at a point below the lower end of the casing.

The tool of the present invention comprises a charge-receiving barrel 12 having a head 14 threaded to its upper end and a bottom 16 at its lower end, the bottom being secured to the lower end of the barrel by means of a connecting sub 18. The bottom is provided with an opening 20 controlled by the usual charge-retaining flapper valve 22.

Threaded to and embracing the outer wall of the bottom 16 is a sleeve 24, said sleeve having threaded within the same a shoe 26. The side

wall of the bottom 16 is equipped with a discharge port 28, located above the flapper valve 22. The sleeve 24 is also provided with a corresponding discharge port 32, adapted to be aligned with the port 28 by rotation of the sleeve 24 with respect to the bottom 16 when the tool is withdrawn from the well, to permit discharge of the contents of the barrel through said ports.

The arrangement of the discharge ports is similar to that disclosed in the patent to Candee, No. 1,505,624, August 19, 1924. The shoe 26 is equipped with a bottom inlet 34 and with a plurality of inlets 36 in the side wall thereof which may be controlled by adjustable valves in a manner similar to those shown in Figure 4 of my Patent No. 2,088,151, granted July 27, 1937. The side inlet ports may be provided as an alternative with threads so that any number of the same may be closed to vary the area of lateral flow of fluid into the tool as desired, to accommodate the tool to the type of well bottom encountered.

The top member 14 of the tool has an opening 38 therethrough and passing through this opening is an operating rod 40, said rod being threaded at its upper end into a connector 42 which in turn may be secured as by threads to a bail for the reception of the well-known lowering line.

The rod 40 has fixed thereto a head 44, disposed within the barrel below the top member 14, said head when in engagement with said top member serving to suspend the tool in the well. The head also serves to impact the inner end of the top member 14 as an anvil to dislodge the tool from the well if it becomes stuck. The piston is shown cut into two identical halves in a vertical central plane, to form the two piston sections.

The inner end of the operating rod below the head 44 is equipped with means for supporting the piston sections 46 and 48 in such fashion that they will assume a substantially tandem relation with respect to one another when the piston is moving downwardly in the barrel, and a substantially side-by-side relation with respect to one another when the piston is moving upwardly in the barrel.

By "tandem relation" of the sections I do not necessarily mean to imply a complete disposition of one section above or below the other, but any vertical spacing of the sections with respect to one another to permit fluid to flow past the sections as the tool is being lowered into the well. By "side-by-side relation" of the sections I do not necessarily mean that the sections are in the same horizontal plane, but that they are in close operative disposition with respect to one another, as departed from the inoperative or "tandem" relation.

The piston sections comprise a pair of spaced thimbles 50 and 51 with a packing sleeve 52 of rubber or the like between the same. The piston sections may be made in any suitable manner, and as shown in Figure 7, the upper and lower thimbles 50 and 51 have integral therewith respectively, inner semi-cylindrical sleeves 54 and 55 on which the semi-cylindrical packers are carried. Where the inner faces of the piston sections abut one another, as shown in Figure 8, their sleeves are provided with inwardly directed key members 56 for a purpose hereinafter described.

The operating rod is provided with diametrically opposed key slots 58 extending from its lower end, said slots being wide enough to receive the key members of both of the piston sections 46 and 48 for a distance from the lower end of said rod substantially equal to the length of the piston sections, and above this point for a further distance of substantially the length of a piston section, said slot is only wide enough to receive the key members of the piston section 46, which is thereby mounted for vertical movement on the operating rod. Thus, the slot 58 has a relatively wide lower portion terminating in a stop shoulder 60 to retain the piston section 48 in fixed relation to the operating rod 40, and a relatively narrow upper portion terminating at 62 to permit the piston section 46 to assume a substantially tandem relation with respect to section 48.

The piston section 48 is retained in a substantially fixed position on the lower end of the operating rod 40 by means of the nut 64, but the piston section 46 is permitted to move up and down on the operating rod with its key members 56 riding in the slots 58 to assume either a tandem or side-by-side relation with respect to the piston section 48. By removing the nut 64, both of the piston sections may be taken off of the operating rod 40 for replacement of their packers, when the latter become worn.

The barrel of the tool is provided with a plurality of relief openings 66 adjacent the upper end thereof below the top member 14, in order that fluid above the piston may be discharged from the barrel during the suction stroke of the piston.

In the operation of this device, the tool is lowered into the well as shown in Figure 1, and when well fluid is encountered, it will pass upwardly through the barrel past the flapper valve 22 and the pressure of this fluid will move the piston section 46 upwardly with respect to the piston section 48, until said sections are in substantially tandem relation with respect to one another. This disposition of the sections will permit the well fluid to flow past the piston and outwardly through the relief ports 66 as the tool is being lowered into the well, and thus the lowering of the tool will not be retarded when fluid is encountered, so that the tool may be lowered completely to the bottom of the well in position to take a charge as shown in Figure 1. During lowering of the tool, it is suspended by the operating rod 40, through the engagement of the head 44 with the anvil 14.

When well bottom is encountered, the tool will be arrested, and the slack in the lowering line will permit the piston sections to move downwardly in the barrel in substantially tandem relation as shown in Figure 1 until the connector 42 lands upon the upper side of the top member 14. At this time, the fixed piston section 48 will be as far down in the barrel as desired, and will be closely adjacent the connecting sub 18.

To draw a charge from the well, the operating rod is then pulled upwardly, and the pressure of the fluid above the piston section 46 will cause it to drop down into substantially side-by-side relation with respect to the piston section 48, as shown in Figure 2, and thus the piston sections with their packers 52 will form a seal with the barrel of the tool, creating suction during the upward movement of the piston to draw a charge of fluid, sand, debris and the like into the barrel through the bottom inlet 34 or the side inlets 36 past the charge-retaining flapper valve 22. During upward movement of the piston, fluid will be expelled from the barrel above the piston through the relief outlets 66. When the upward movement of the piston is terminated, the head 44 will engage the inner end of the top member 14, and subsequent upward movement of the lowering

line will result in the withdrawing of the tool from the well, with the tool suspended on the lowering line. It will be apparent that the charge drawn by suction into the barrel will be retained by the flapper valve 22, which will close by reason of the weight of the charge within the barrel when the tool is lifted from the bottom of the well.

The upper end of the top thimble of the piston section 48 is provided with a slot 68 to receive a projection 70 on the top thimble of the piston section 46 when the sections are in substantially side-by-side relation, so that said sections will be accurately aligned with one another to form a seal with the barrel of the tool.

In Figure 3, an adaptation of the invention is shown which will permit relative movement between the operating rod and head carried thereby and the piston, to permit jarring the tool to dislodge it when it becomes stuck in the well, without the necessity of exerting sufficient force to move the piston, and without breaking the seal provided by the piston in its engagement with the wall of the barrel when the piston sections are in side-by-side relation.

The top member 72 of the barrel has a relatively wide opening 74 therethrough, through which an operating rod 76 extends. The operating rod is formed in two sections, and includes a lower section 78 within the barrel, constructed in a manner similar to the rod 40 described in connection with the embodiment of Figure 1, in order to retain the piston thereon, in such fashion that the sections of the piston may assume the tandem and side-by-side relations with respect to one another as previously described.

The lower end of the upper section of the operating rod 76 is provided with a bore 80, in which is disposed for sliding movement a head 82 on the upper end of the lower section of the operating rod 78. The lower end of the upper section of the rod 76 forms a head 84, adapted to contact the inner face of the top 72 as an anvil as previously described, and the lower end of the bore 80 of said rod 76 is closed by means of a plug member 86, through which the lower section 78 of the operating rod extends. Suitable openings 88 are provided at the upper and lower ends of the bore 80, to prevent binding during movement of the upper operating rod section with respect to the lower operating rod section as hereinafter described.

The operation of this form of the invention is identical with that described in connection with Figures 1 and 2, except that after the piston is drawn to its upper position to take a charge into the barrel, the upper operating rod section 76 with its head 84 may be moved downwardly and then rapidly upwardly to impact the anvil 72 without this motion being imparted to the piston, so that the jarring operation may be performed with ease without disturbing the sealing engagement of the piston sections with the wall of the barrel, and without the necessity of raising and lowering the piston during the jarring operation, it being obvious that the effectiveness of the jarring operation would be impaired by the binding action of the piston if the lost motion connection was not provided. Furthermore, movement of the piston in the barrel would create further suction, thus more firmly embedding the device in the mud, if this lost motion connection were not provided.

In Figure 4 a modification of the invention is shown wherein the piston may be positively expanded at the termination of its upward stroke in order to close off the upper end of the barrel and retain bottom-hole pressure therein. In this form of the invention, the relief openings 66 in the barrel are disposed closely adjacent the top member 90 and the head element 44 of the Figure 1 embodiment is eliminated.

In operating this form of the invention, the device is lowered into the well, strikes well bottom, and the piston is lowered through the barrel as shown in Figure 4, identical with the operation shown in Figure 1. However, when the piston is elevated in the barrel to take a charge, the upper thimbles 50 of the piston sections contact the inner end of the top member 90 of the barrel as shown in Figure 5, and the weight of the tool is supported on said upper thimbles when the tool is withdrawn from the well.

Referring to Figure 7, it will be noted that the sleeves 54 of the upper thimbles 50 are spaced from the sleeves 55 of the lower thimbles 51 as at 92, and when the ends of the upper thimbles 50 contact the top member 90 and support the weight of the tool, the upper thimbles 50 will be moved downwardly relative to the lower thimbles 55, thus expanding the rubber packer 52 into intimate engagement with the wall of the barrel, positively closing off the upper end of the barrel against escape of pressure therefrom. It will be noted in Figure 5 that the positive seal formed by the packers 52 will be below the relief outlets 66. If desired, a conventional outwardly opening relief valve may be provided in the wall of the barrel in the opening 67 to relieve excessive pressure from the barrel as the latter is being elevated from the well with a charge retained therein.

When the tool of this modification of the invention is elevated from the well, the relatively high bottom-hole pressure will be sealed therein. When the discharge port 32 is aligned with the discharge port 28, the tool will discharge itself under its own pressure, it being evident that the pressure within the barrel will be greatly in excess of atmospheric pressure outside of the barrel.

The advantages of employing a piston of the type disclosed herein to retain a charge in the barrel under pressure will be apparent. A conventional pump piston, with an upwardly opening ball check valve, or equivalent, would not retain the charge at the high well pressure.

In Figure 6, a modified arrangement is disclosed for positively closing off the upper end of the barrel to retain bottom-hole pressure therein when the tool is elevated from the well.

The operating rod 96 is provided with a head 98 within the barrel adapted to engage the inner face of the top member 100 when the tool is withdrawn from the well. The piston sections are generally similar to those disclosed in connection with the previous embodiments, and one of said sections 102 is adapted to move upwardly on the operating rod to a substantially tandem position with respect to the other piston section as described in connection with the previous embodiments.

However, the upper thimbles 104 of the piston sections are somewhat smaller in radius than the thimbles of the previous embodiments in order that a perforated piston expanding sleeve 106 secured to the top member 100 and extending downwardly below the relief ports 66 may contact the beveled faces of the piston section packers 108 in order to expand said packers by

squeezing them against the inner wall of the barrel.

When the piston is elevated in the barrel to draw in a charge, the lower end of the sleeve 106 will contact the upper beveled face of the packer rubbers 102 as at 110 slightly before the head 98 contacts the inner face of the top member 100, thus expanding the packers. However, the parts are so arranged that immediately after sufficient expansion of the packers is provided, the head 98 will engage the inner face of the top member 100, thus supporting the weight of the tool at this point, rather than having the entire weight of the tool supported on the packer rubbers.

It will be apparent that I have provided a sand pump of pronounced efficiency, and one which is unlikely to become disabled due to the fouling of valves and the like.

Furthermore, the apparatus disclosed herein includes a novel arrangement wherein a charge may be taken from the well into a sand pump, and retained therein at bottom-hole pressure when the tool is withdrawn from the well, so that the charge may be expelled from the tool under its own pressure.

I claim:

1. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom and to remove the charge from the well, said barrel having a charge-taking port in the side wall of the barrel adjacent the lower end thereof, a charge-retaining valve above said inlet, a piston operating downwardly and upwardly in said barrel to draw by suction a charge into the barrel through said inlet, operating means for moving said piston in said barrel including a member on which said piston is mounted, said piston comprising a pair of sections, and means for mounting said piston on said member whereby said sections assume a substantially tandem relation with respect to one another when the piston is moving downwardly in the barrel to permit well fluid to flow past the same, and a substantially side-by-side relation with respect to one another when the piston is moving upwardly in the barrel to form a seal with the wall of the barrel to draw a charge through said inlet past said charge retaining valve.

2. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom and to remove the charge from the well, said barrel having a charge-taking port in the side wall of the barrel adjacent the lower end thereof, said port providing a side inlet passage in the said barrel, means for varying the area of said side inlet passage, a charge-retaining valve above said inlet, a piston operating downwardly and upwardly in said valve to draw by suction a charge into the barrel through said inlet, operating means for moving said piston in said barrel including a member on which said piston is mounted, said piston comprising a pair of sections, and means for mounting said piston on said member whereby said sections assume a substantially tandem relation with respect to one another when the piston is moving downwardly in the barrel to permit well fluid to flow past the same, and a substantially side-by-side relation with respect to one another when the piston is moving upwardly in the barrel to form a seal with the wall of the barrel to draw a charge through said inlet past said charge-retaining valve.

3. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom, and to remove the charge from the well, said barrel having a top at its upper end and a charge-taking inlet adjacent its lower end, a piston operating downwardly and upwardly in said barrel to draw by suction a charge into the barrel through said inlet, operating means for moving said piston in said barrel including a member extending through said top on which said piston is mounted, said piston comprising a pair of sections and means for mounting said piston on said member whereby said sections assume a substantially tandem relation with respect to one another when the piston is moving downwardly in the barrel to permit well fluid to flow past the same, and a substantially side-by-side relation with respect to one another when the piston is moving upwardly in the barrel to form a seal with the wall of the barrel to draw a charge through said inlet, a head carried by said operatnig means within said barrel and above said piston, and a lost motion connection in said operating means above said piston, whereby said head may be moved downwardly and rapidly upwardly to impact said top without moving said piston in said barrel.

4. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom, and to remove the charge from the well, said barrel having a charge-taking inlet adjacent the lower end thereof, a charge-retaining valve above said inlet, an expansible piston operating downwardly and upwardly in said barrel and forming a seal with the inner wall thereof during its upward movement to draw by suction a charge into the barrel through said inlet past said charge-retaining valve, and means for expanding said piston against the inner wall of the barrel at the termination of its upward stroke, to retain the charge in the barrel at high well pressure.

5. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom, and to remove the charge from the well, said barrel having a charge-taking inlet adjacent the lower end thereof, a charge-retaining valve above said inlet, a piston including an expansible packer operating downwardly and upwardly in said barrel and forming a seal with the inner wall thereof during its upward movement to draw by suction a charge into the barrel through said inlet past said charge-retaining valve, and means on said barrel for expanding the packer of said piston at the termination of its upward stroke to retain the charge in said barrel at high well pressure.

6. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom, and to remove the charge from the well, said barrel having a top at its upper end and a charge-taking inlet adjacent its lower end, a charge-retaining valve above said inlet, an expansible piston operating downwardly and upwardly in said barrel and forming a seal with the inner wall thereof during its upward movement to draw by suction a charge into the barrel through said inlet past said charge-retaining valve, and suspension means for the pump comprising a lowering line and an operating rod connected with said piston and extending through said top, said piston engaging said top at the termination of its upward stroke to support said barrel on said suspension means while the barrel is being withdrawn from the well, said piston being expanded by the weight of the pump to retain the charge in the barrel at high well pressure.

7. A sand pump comprising a barrel adapted to be lowered into a well to take a charge therefrom, and to remove the charge from the well, said barrel having a charge-taking inlet adjacent the lower end thereof, a charge-retaining valve above said inlet, and an expansible piston operating downwardly and upwardly in said barrel to draw by suction a charge into the barrel through said inlet, operating means for moving said piston in said barrel including a member on which said piston is mounted, said piston comprising a pair of sections, means for mounting said piston on said member whereby said sections assume a substantially tandem relation with respect to one another when the piston is moving downwardly in the barrel to permit well fluid to flow past the same, and a substantially side-by-side relation with respect to one another when the piston is moving upwardly in the barrel to form a seal with the wall of the barrel to draw a charge through said inlet, past said charge-retaining valve, and means for expanding said piston against the inner wall of the barrel at the termination of its upward stroke, to retain the charge in the barrel at high well pressure.

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