Feb. 5, 1963 B. F. SCHMIDT 3,076,416

MULTIPLE PRODUCTION PUMP

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FIG. 1.

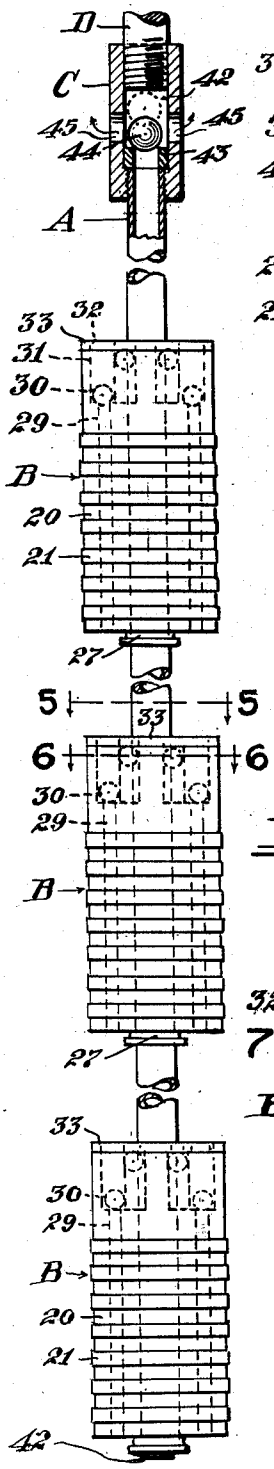


FIG. 2.

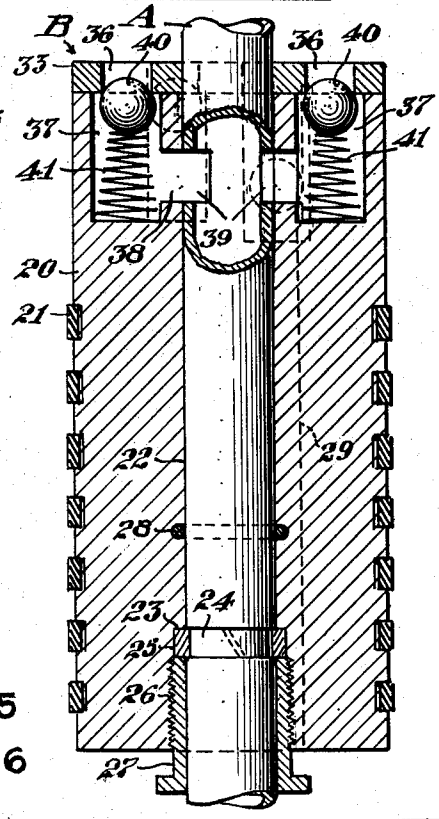


FIG. 3.

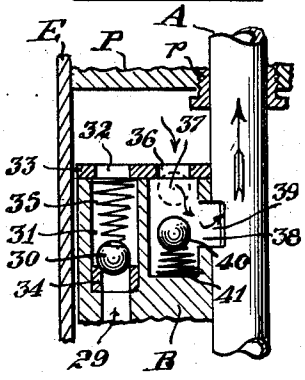


FIG. 4.

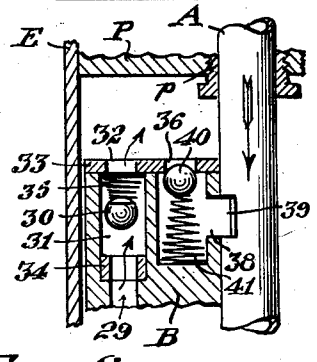


FIG. 5.

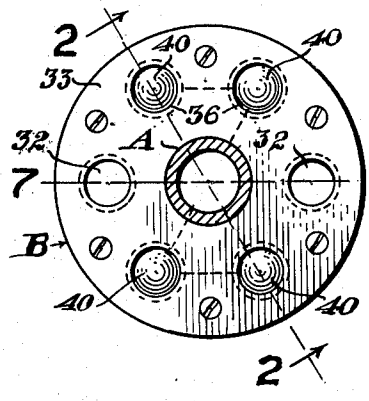
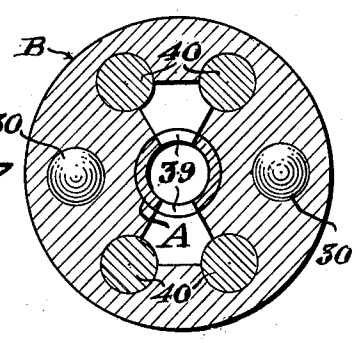


FIG. 6.



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FIG. 7.

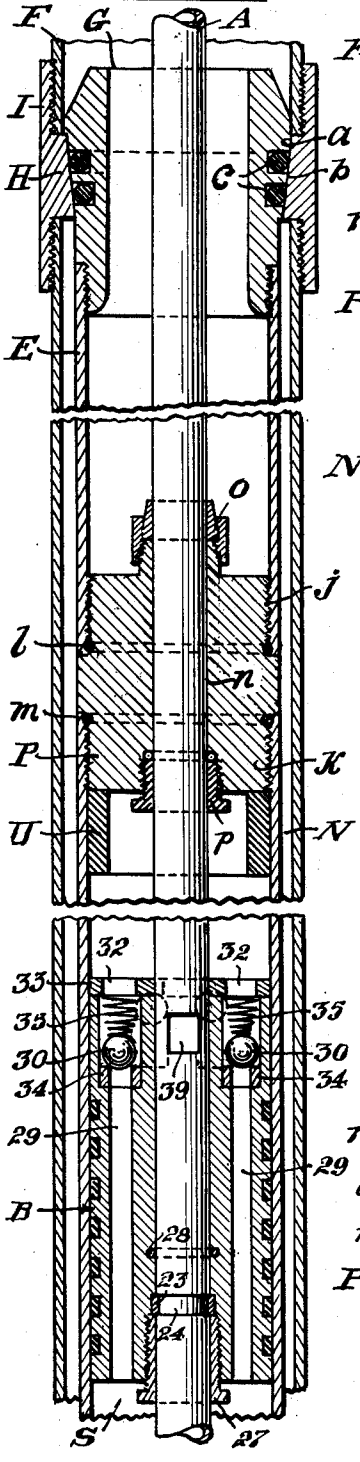


FIG. 8.

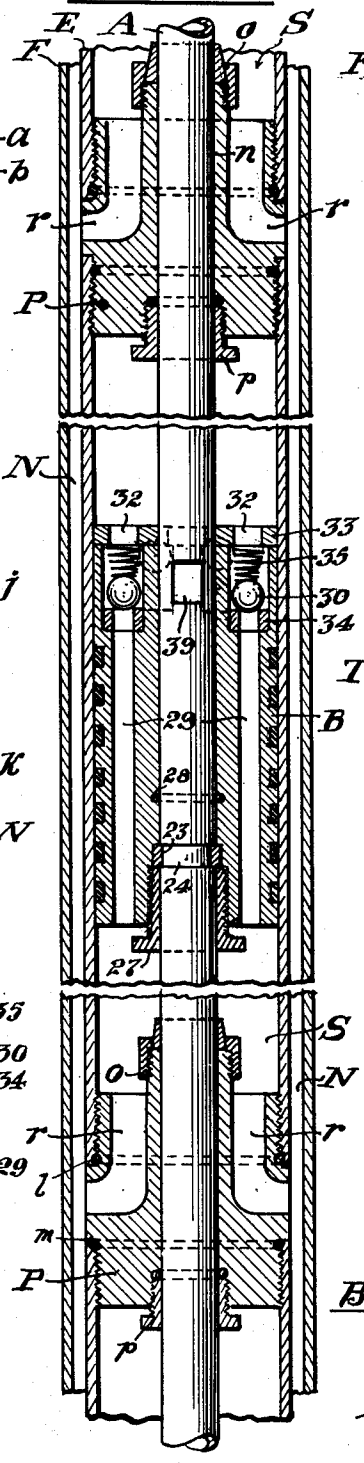
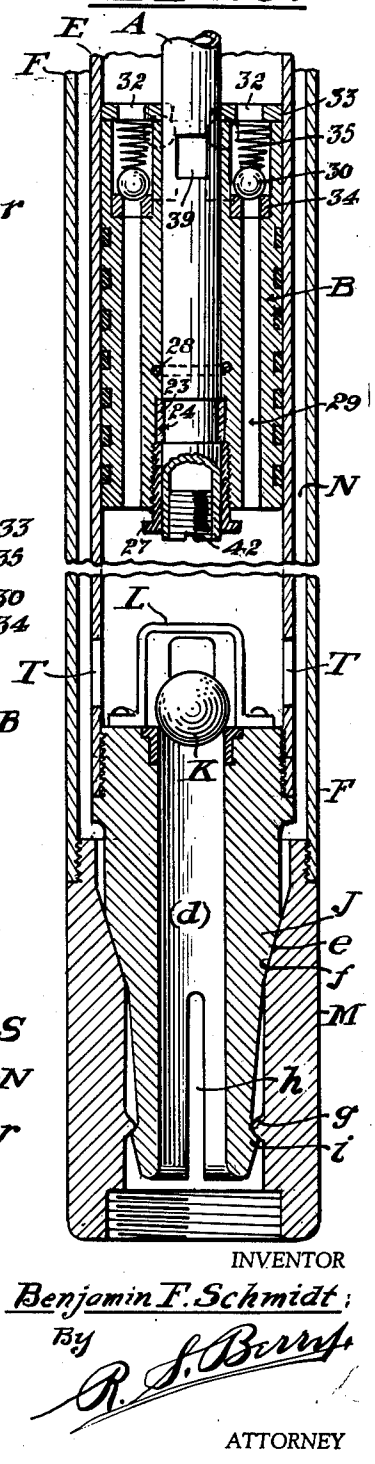


FIG. 9.



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FIG. 10.

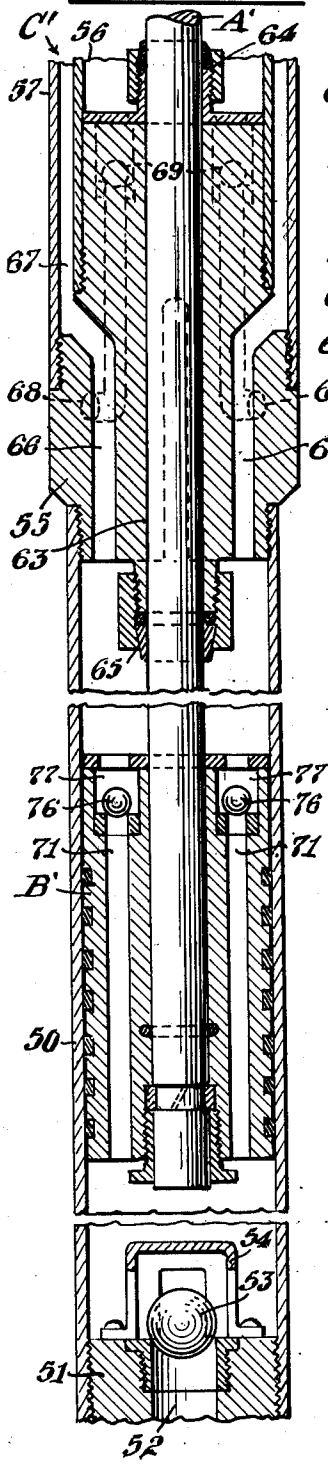


FIG. 11.

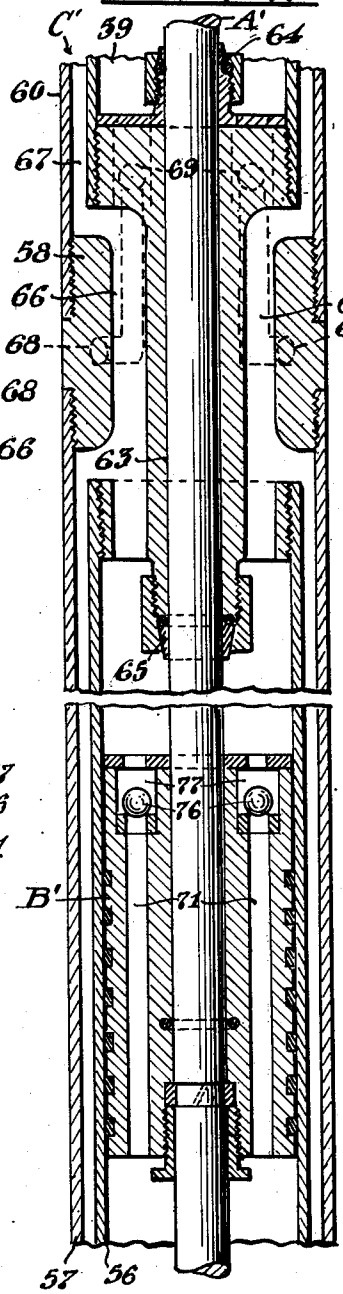
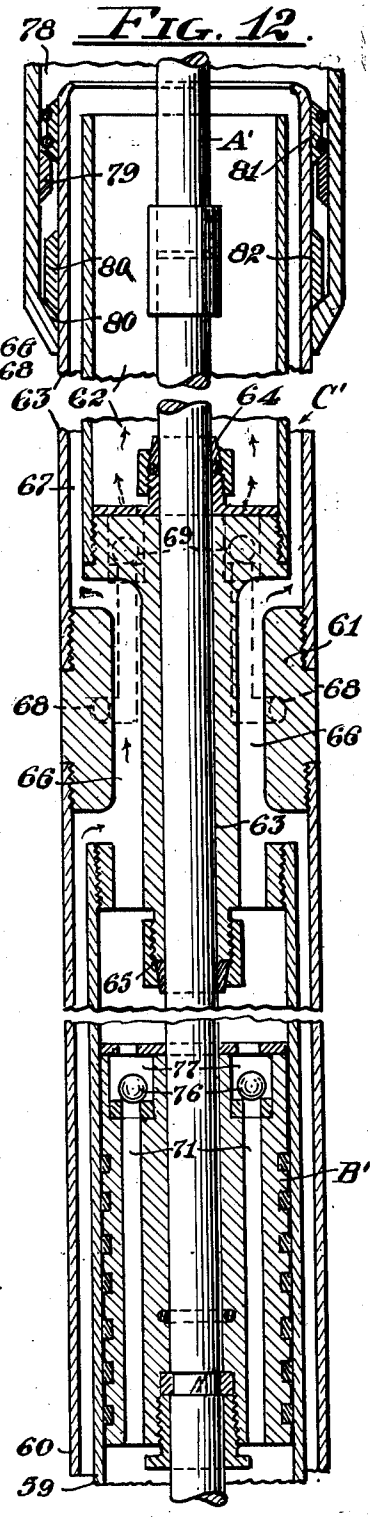


FIG. 12.



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FIG. 13.

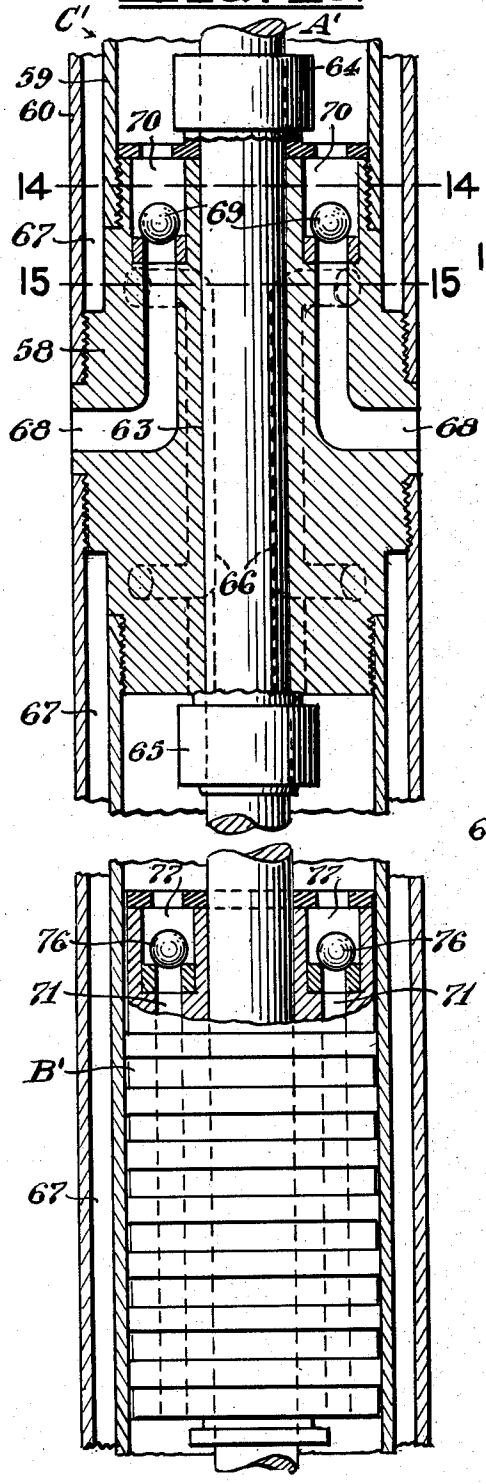


FIG. 14.

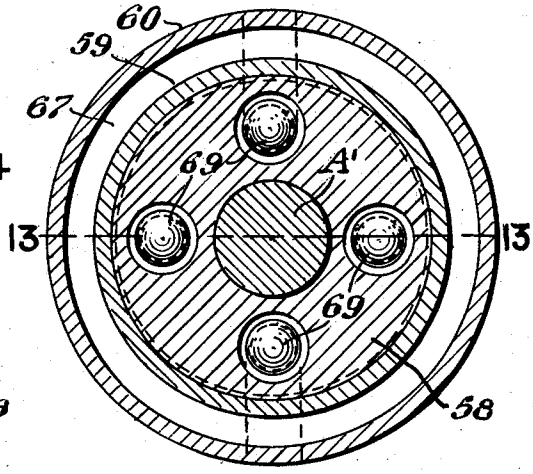
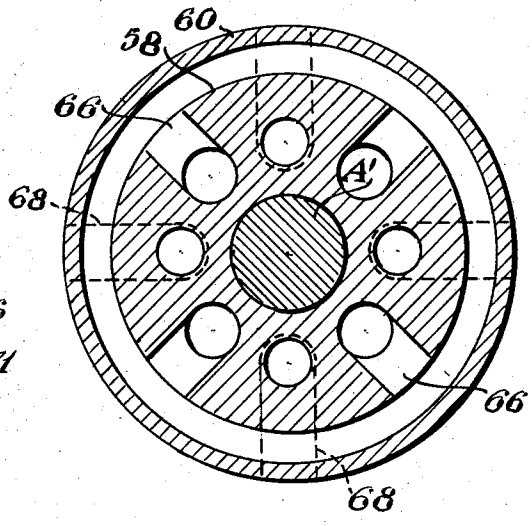


FIG. 15.



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3,076,416

MULTIPLE PRODUCTION PUMP

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Filed Sept. 22, 1960, Ser. No. 57,648
7 Claims. (Cl. 103—191)

This invention relates to an oil well pump and has as its primary object the provision of a reciprocal piston type pump which is so constructed as to produce a considerable increase in pumped liquid over that effected by a conventional piston type pump of corresponding bore and stroke.

The invention is carried into effect by the employment of a plurality of pistons arranged in tandem on a single sucker rod, with each piston having an independent intake, and each piston discharging into a common flow arrangement whereby pumped fluid is directed into a production tube which conducts the fluid from the well to discharge.

The accompanying drawings depict by way of example pump constructions embodying the invention which constructions are described in the following specification and which invention is defined in the appended claims.

In the drawings:

FIG. 1 is a view in elevation partly in section of the tandem piston assembly showing a preferred embodiment of the invention wherein a tubular sucker-rod is employed, and depicting the assembly apart from the pump barrel:

FIG. 2 is a view in vertical section of one of the pump pistons as seen on the line 2—2 of FIG. 5;

FIG. 3 is a diagrammatic sectional view of a part of the upper portion of the pump piston shown in FIG. 2, depicting a pair of valves in the piston head as positioned on the "up" or discharge stroke of the piston and showing the piston as disposed in a pump barrel:

FIG. 4 is a view similar to FIG. 3 depicting the parts as positioned on the "down" or intake stroke of the piston:

FIG. 5 is a view in cross section and plan as seen on the line 5—5 of FIG. 1:

FIG. 6 is a view in cross section taken on the line 6—6 of FIG. 1:

FIGS. 7, 8 and 9 collectively depict the multiple piston and sucker-rod assembly as arranged in a pump barrel disposed within the production tube of an oil well as seen in section on the line 7—7 of FIG. 5 with parts in elevation, FIG. 7 showing the upper portion of the assembly, FIG. 8 depicting the intermediate portion thereof, and FIG. 9 showing the lower end portion of the assembly:

FIGS. 10, 11 and 12 collectively depict in vertical section partly in elevation, a modified form of the invention wherein the pump barrel and production tube are adapted to co-act with the piston assembly in conveying the liquid being pumped the figures showing in their order the lower, intermediate and upper portions of the assembly:

FIG. 13 is an enlarged view in section and elevation of the intermediate portion of the assembly shown in FIG. 11 perpendicular to the plane of the latter as seen on the line 13—13 of FIG. 14:

FIG. 14 is a view in cross section as seen on the line 14—14 of FIG. 13: and

FIG. 15 is a view in cross section taken on the line 15—15 of FIG. 13.

Considering the drawings more specifically, reference now being had to FIGS. 1 to 9 inclusive, A indicates a length of tubular sucker rod on which is fixedly mounted a plurality of complementary pump pistons B here shown as three in number.

Each of the pistons B embodies a cylinder 20 fitted with a plurality of circumferentially arranged sealing rings 21

in a usual manner. The cylinder 20 has an axial bore 22 through which the sucker-rod A extends. A divided snap-ring 23 is arranged in a circumferential channel 24 in the sucker-rod and has its outer periphery engaged in a channel 25 in the wall of the bore 22 extending opposite the channel 24 and arranged at the upper end of an internally threaded counter-bore 26 in the lower end of the cylinder 20 in which is screwed an externally threaded sleeve 27 having its inner end abutting the ring 25. The counter-bore 26 initially affords a clearance space to permit assemblage of the piston on the sucker-rod which is effected by advancing the assembled rod and cylinder relative to each other so that the split-ring 23 will pass through the counterbore 26 from the lower end of the cylinder 20 to its seated position in the channel 25 thus seating the piston on the ring 23 and thereby holding the piston against downward movement relative to the sucker-rod.

The sleeve 27 is then screwed in place in the counterbore 26 and when seated against the ring 23 will form an abutment whereby the piston will be held against upward movement relative to the sucker-rod. A sealing O-ring 28 is interposed between the sucker-rod and piston at a suitable point above the snap-ring 23 to close the clearance gap between the sucker-rod and piston against leakage of fluid therethrough.

In carrying out the invention the piston cylinder 20 has one or more fluid intake passages 29 extending longitudinally therethrough, a pair of such passages being here shown in diametrically opposed relation to each other. A spring pressed upwardly opening check valve 30 is arranged within a cage 31 at the upper end of the passage 29, which cage opens to space above the piston through an aperture 32 in a cap-plate 33 fixed on the upper end of the piston cylinder.

The upper end of the passage 29 is fitted with a seat 34 against which the valve 30 normally abuts under the urge of a spring 35 as shown in FIG. 3. The piston B also embodies one or more discharge passages in its upper end, four of such passages being here shown each of such passages embodying an aperture 36 in the cap-plate 33 opening to a cage 37 in the piston head from which leads a passage 38 registering with a port 39 in the wall of the sucker-rod A. The inner margin of the aperture 36 constitutes a seat for a ball valve 40 within the cage 37 which valve normally abuts such seat under the urge of a spring 41 as shown in FIG. 4.

The tubular sucker-rod A is closed at its lower end immediately below the lowermost piston B by a plug 42 and has its upper end fitted with a coupling C for connection to a length of solid sucker rod D leading to suitable pumping mechanism. The coupling C encompasses a valve chamber 42 fitted with a valve seat 43 registering with the upper end of the sucker-rod A. A ball valve 44 in the chamber 42 normally rests on the seat 43. Discharge ports 45 lead from the chamber 42 to the exterior of the coupling C.

The lower portion of the above described piston and sucker-rod assembly is reciprocally mounted in a cylindrical pump barrel E as shown in FIGS. 7, 8 and 9, which barrel is adapted to be mounted in the lower end portion of the cylindrical production tube F of a well. The upper end of the barrel E is fitted with a sealing ring G as shown in FIG. 7 which ring encircles the sucker-rod A in spaced relation thereto. The ring G is designed to seat on an inwardly projecting collar H on a coupling I uniting the ends of adjacent sections of the tube F; the collar H having a downwardly and inwardly inclined annular face *a* on which a correspondingly inclined outer face *b* of the ring G rests.

Sealing rings *c*—*c* carried in circumferential channels in the ring G seal the joint between the inclined faces

a—b. The lower end of the pump barrel E has affixed thereon an elongated downwardly and inwardly tapered extension J having a cylindrical open-ended axial bore *d* constituting an intake passage the lower end of which opens to the intake end of the well tube F leading into the body of liquid to be pumped and the upper end of which bore leads to the interior of the lower portion of the pump barrel E. A foot valve K normally closes the upper end of the bore *d*, which valve is housed in a cage L on the upper end of the extension J.

An inclined face *e* on the extension J is designed to abut a correspondingly inclined face *f* on the interior of a tubular coupling M fixed on the lower end of the tube F, whereby the extension J on the lower end of the pump barrel E co-operates with the sealing ring G on the upper end of the pump barrel to support the latter in the tube F in spaced concentric relation thereto so as to provide a fluid conducting enclosed space N between the tube F and pump barrel E extending substantially throughout the length of the latter.

As a means of stabilizing the pump barrel E in the tube F the interior of the coupling M has a circumferentially extending rib *g* and the lower portion of the extension J has open ended slots *h* (one only of which is shown) to render it contractible, and has a peripheral bead *i* adapted to be sprung into anchoring engagement with the underside of the rib *g* and thereby effect detachable interlocking connection between the extension J and coupling M when in their assembled position as shown in FIG. 9.

The pump barrel E consists of a series of tubular cylindrical sections and uniting the ends of adjacent sections is a partition coupling P arranged a short distance above each of the pistons B. Each of said couplings has externally threaded end portions *j—k* with which adjacent internally threaded ends of the sections of the pump barrel are engaged and abutted against spaced sealing rings *l—m* encompassing the coupling P.

Each of the couplings P has an axial bore *n* through which the sucker-rod A slidably extends. Packing glands *o—p* are mounted on the couplings P and encompass a sucker-rod A at the ends of the bore *n*.

The uppermost partition P serves solely as a separable closure for the upper end portion of the pump barrel above the upper piston B while the other partitions each have a plurality of passages *r* leading inwardly from sides thereof and opening upwardly to the space S in the pump barrel beneath the adjacent superposed piston B; the passages *r* providing open communication between the space S and the fluid conducting space N between the pump barrel E and the production tube F as shown in FIG. 8. The partitions P having the passages *r* thus constitute delivery units whereby liquid displaced by the upwardly moving pistons above the lowermost piston will be delivered from the space N to the spaces S.

The pump barrel E has openings T therein immediately above the lower end extension J through which liquid is inducted into the space N on upstroke of the pistons B located above the lowermost piston.

In putting the invention, as above described to practice any desired number of the pistons B and their associated pump partitions P may be employed as occasion may require.

The pump barrel E with its partitions P and the sucker-rod A with its pistons B are assembled above ground progressively from the lower end of the pump-barrel, the end extension J with the foot valve K thereon being first attached to the lower end section of the pump barrel in threaded engagement therewith. The sucker-rod A with the lower piston B mounted thereon as indicated in FIG. 9 is then inserted in the lower end section of the pump-barrel whereupon the lower partition coupling P is strung on the sucker rod A and screwed into engagement with the upper end of the lower section of the pump barrel. The intermediate piston B is then strung on the sucker rod and affixed thereto as before described and as shown in FIG. 8. The intermediate section of the pump barrel is then slipped over the intermediate piston and screwed into engagement with the previously assembled partition coupling P, whereupon the intermediate partition coupling P is applied to the sucker-rod and screwed into engagement with the upper end of the intermediate section of the pump barrel as shown in FIG. 8. The upper piston B is then applied to the sucker-rod A and its companion length of the pump-barrel is slipped over the then assembled piston and screwed into engagement with the upper end of the intermediate coupling P as shown in FIG. 8. The upper or capping coupling P is then applied to the sucker-rod and screwed into engagement with the previously applied pump barrel section. The final upper end section of the pump barrel together with the sealing ring F is then screwed into engagement with the capping partition coupling P as shown in FIG. 7.

By regulating the length of the upper end section of the pump barrel E in accordance with the distance between the inclined seating faces *a* and *f* on the end couplings H and M of the production tube F, the inclined faces *b* and *e* of the sealing ring G and end extension J respectively may be made to conform to the sealing faces *a—f*.

On the pump structure being thus assembled the upper end of the tubular sucker rod A is connected by the coupling C to the lower end of a solid sucker rod D, as shown in FIG. 1 whereupon the pump assembly is lowered into its seated position in the tube F. During this operation the pump barrel is supported on the upper piston B through a cushioned abutment ring U assembled in the pump barrel adjacent the inner end of the capping coupling P previous to applying the latter, the ring U then seating against the upper end of the piston.

Manifestly the pump barrel may be withdrawn from the tube F in like manner.

In the operation of the above described pump structure the sucker rod A with the series of pistons B thereon is reciprocated relative to the pump barrel in the usual manner. Assuming the sucker rod A and pistons B are in their lowermost position and that the spaces interior of the pump barrel are filled with pumped crude oil the action will be as follows: On upstroke of the pistons oil from the well will be inducted into the lower end of the pump barrel through the passage *d* past the then opened foot valve K and at the same time oil entrapped in the pump barrel above each of the pistons B will be directed through the discharge passages in the upper ends of the pistons B past the valves **40** and into the tubular sucker rod A through the ports **39** in the latter, the oil in the pump barrel above each piston being thus delivered to the production tube F through the coupling C past the valve **44** in the latter and thence to discharge from the well. During the upstroke of the several pistons, each piston will act to induct oil from the space N through the passages *r* into the spaces in the pump barrel beneath the pistons, the oil body thus taken from the space N being replenished by oil then being inducted from the well and delivered to the space N through the openings T in the lower portion of the pump barrel. In this fashion the several pistons B act on their upstroke to discharge oil from above the pump and at the same time induct oil into the lower portion of the production tube and also into the pump barrel beneath the pistons where the oil is trapped on closing of the foot valve K. On down stroke of the pistons the oil trapped therebeneath in the pump barrel is directed in part through the passages **29** past the valves **30** to charge the spaces in the pump barrel above the pistons for subsequent delivery to discharge on upstroke of the pistons as before described.

Referring to FIGS. 10–15 depicting another application of the invention, A' indicates a solid sucker rod, B'

designates each of a plurality of pistons fixed on the rod as before described, and C' indicates a pump barrel of particular construction in which the sucker rod and piston assembly is mounted. The pump barrel C' embodies a lower end section comprising a cylindrical tube **50** in which the lower piston B' is reciprocably mounted. The lower end of the tube **50** connects with a coupling **51** having an axial intake bore **52** fitted with an upwardly opening foot valve **53** arranged in a cage **54** within the tube **50**.

The upper end of the tube **50** connects with a coupling **55** which in turn connects with the lower ends of a pair of spaced concentric inner and outer cylindrical tube sections **56—57** as shown in FIG. 10 the upper ends of which tube sections connect with a similar intermediate coupling **58** from which lead spaced inner and outer tube sections **59—60** as shown in FIG. 11 the upper ends of which connect with an upper coupling **61** as shown in FIG. 12. The upper ends of the coupling **61** connect with a pair of upper spaced open ended tube sections **62—63**. The intermediate inner tube section **56** forms a pump chamber in which the intermediate piston B' operates as shown in FIG. 11 and the inner tube section **59** forms a pump chamber in which the upper piston B' operates as shown in FIG. 12.

The couplings **55, 58** and **61** each have axial bores **63** through which the sucker rod A' slidably extends which bores are fitted at their upper and lower ends with packing glands **64—65**. The couplings **55, 58** and **61** each have passages **66** leading longitudinally thereof from their lower ends and opening laterally to the space **67** thereabove extending between the inner and outer tube sections **56—57, 59—60** and **62—63**, the passages **66** of the couplings **58** and **61** having side branches opening to the adjacent spaces **67** beneath the couplings **58** and **61** whereby continuous open liquid conducting passageways lead from above the lowermost piston B' to the open upper end of the pump barrel.

Each of the couplings **55, 58** and **61** have intake passages **68** leading inwardly from the sides thereof and opening to the upper ends thereof. The upper ends of the passages **68** are normally closed by ball valves **69** arranged in cages **70** in the upper end of the couplings. The valves **69** constitute foot valves for the pump chambers extending above the several couplings.

Each of the pistons B' has intake passages **71** extending longitudinally therethrough which passages are fitted at their upper ends with normally closed ball valves **76** housed in cages **77** in the upper ends of the pistons.

The above described pump assembly is designed to be lowered into the production tube **78** of an oil well and to be suspended therefrom as shown in FIG. 12 with the sucker rod A' leading upwardly through the production tube **78** to any suitable operating mechanism, not shown.

As a means for supporting the pump assembly on the production tube **78** the latter has a pair of interior flanges **79** and **80** having beveled upper margins on which are seated flanges **81** and **82** on the exterior of the upper outer tube section **63**, the flanges **81—82** having beveled lower margins conforming to the upper margins of the flanges **79—80**.

Assuming the pump to be positioned in a body of oil such as to submerge the foot inlet **52** and the side inlets **68**, upstroke of the sucker-rod and pistons will act to induct oil into the pump chambers beneath the several pistons, the lowermost piston inducting oil past the foot valve **53** and the superimposed pistons inducting oil through the side inlets **68** past the valves **69**. Downstroke of the several pistons through the bodies of oil therebeneath displaces a portion of such oil through the passages **71** and past the valves **76** of the pistons into the pump chambers immediately above the pistons from whence the oil will be discharged from the pump on the succeeding upstroke of the pistons.

By the employment of a multiple of pump pistons on a single sucker-rod together with a pump-barrel having a series of aligned superimposed pump chambers therein through which the sucker-rod extends with a piston in each of the chambers and with independent valved inlets and outlets for each chamber, as herein set forth, a reciprocal single acting piston pump of given stroke and piston area may be produced having greatly increased production capacity over the ordinary single piston pump now generally in use, since each piston in the arrangement herein set forth will effect the intake and discharge of its quota of oil on each stroke of the piston. By varying the number of pistons and pump chambers the capacity of the pump may be varied accordingly.

While I have shown and described specific embodiments of my invention it is not limited to the exact construction shown, and the invention embraces such changes, modifications and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

I claim:

1. In a pump, well tubing; a pump barrel mounted in and spaced from said tubing to define therebetween an annular fluid chamber; a partition closing the upper end of said barrel; means providing in said barrel a fluid intake chamber having a normally closed inlet; separate pump chambers in said barrel above said intake chamber; partitions in said barrel defining the lower ends of said pump chambers; said last-named partitions having constantly open passages leading from said annular fluid chamber into the lower ends of said pump chambers; a reciprocable piston in each of said pump chambers and in said intake chamber; a reciprocable tubular sucker rod extending through said partitions and attached to each of said pistons; normally closed valve inlet passages leading through each piston; normally closed valved discharge outlets in the upper ends of said pistons opening to the interior of said tubular sucker rod; and port means establishing communication from said valved inlet passages to said valved discharge outlets.

2. A pump comprising: a pump barrel; means providing in said barrel a plurality of superimposed pump chambers and a fluid intake chamber below said pump chambers; normally closed valved inlet means for said fluid intake chamber; a piston in each of said chambers; a tubular sucker rod to which each of said pistons is attached; normally closed valve inlet passage means leading through each piston; said tubular sucker rods having intake ports; normally closed valved outlets in said pistons for establishing through said pump chamber fluid flow from said valved inlet passage means into said ports in said sucker rod; said barrel having constantly open ports leading into said chambers.

3. The structure set forth in claim 2 including a normally closed foot valve controlling fluid flow into said intake chamber; and said sucker rod ports and said outlets being disposed adjacent the upper ends of said pistons.

4. An oil well pump comprising: a production tube; a pump barrel supported at its ends in said tube in sealed and spaced relation thereto to provide therebetween an annular fluid chamber extending the length of said barrel; means in said barrel providing separate pump chambers one above the other; means in said barrel providing an intake chamber having a normally closed valved inlet; a piston in each of said chambers; said barrel having constantly open intake passages leading from said annular chamber into said pump chambers; said piston having normally closed valved passages extending therethrough for affording flow of fluid therefrom into said pump chambers; a tubular sucker rod extending into said chambers and attached to said pistons; said sucker rod having ports therein; said pistons having ports therein open to said pump chambers and said sucker rod ports; and normally closed valve means controlling said piston ports so as to open on the upstroke of said pistons.

5. In an oil well pump: a plurality of connected production tubes for positioning in an oil well; a pump barrel supported at its ends in said tubes in sealed relation thereto; said tubes and said pump barrel defining therebetween an annular fluid chamber extending the length of the latter and closed at its ends; means defining a plurality of separate pump chambers located one above the other in said barrel; means defining in said barrel an intake chamber having a normally closed valved inlet; means closing the uppermost of said chambers at its upper end; a piston operable in each of said chambers; a partition between adjacent pistons defining the lower ends of said chambers; each of said pistons having constantly open ports leading from said annular fluid chamber to its associated pump chamber; normally closed valved passage means leading through each of said pistons; a tubular sucker rod extending into each of said chambers and to which said pistons are connected; each of said pistons having normally closed valved discharge outlets; said sucker rod having openings therein; and means affording communication between said valved passages in said pistons and said openings in said sucker rod.

6. In an oil well pump; a cylindrical pump barrel; a tubular sucker rod extending axially in said barrel; spaced apart pistons fixed on and encompassing portions of said sucker rod; said sucker rod having ports in said portions encompassed by said pistons; each of said pistons having a normally closed valved outlet; means providing in each piston port means for conducting fluid from said outlet to the adjacent port in said sucker rod; partitions in said

barrel between adjacent pistons; said partitions having constantly open well fluid intake passages leading from the exterior of said barrel into the interior of said barrel beneath said pistons; said pistons having normally closed valved intake passages extending therethrough; means in each of said pistons for communicating valved intake passages with said valved outlet ports; means closing the upper portion of said pump barrel above the uppermost piston; and a normally closed valved inlet in the lower end of said barrel below the lowermost piston.

7. The structure defined in claim 6 wherein production tubing surrounds said pump barrel and defines an annular fluid chamber between the pump barrel and said tubing affording the flow of well fluid through said constantly open intake passages; and cooperable means on said tubing and the ends of said pump barrel supporting the latter on said tubing and sealing said annular fluid chamber.

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