

Aug. 12, 1952

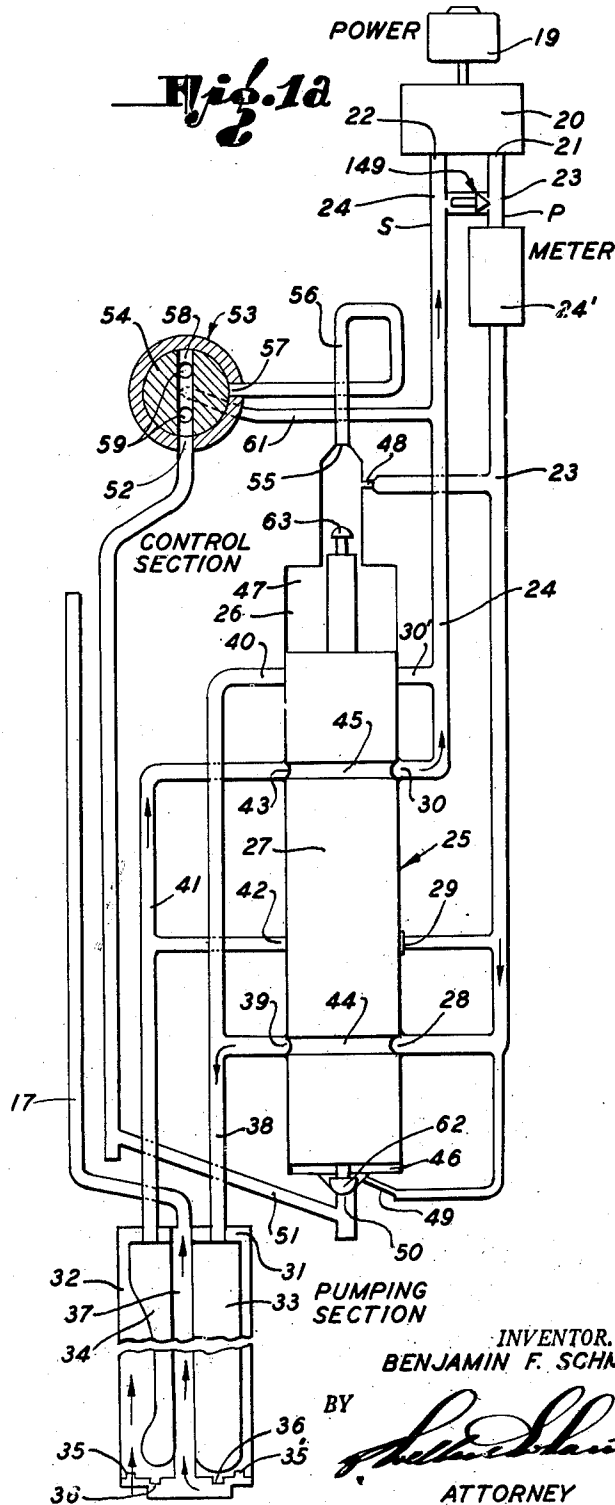
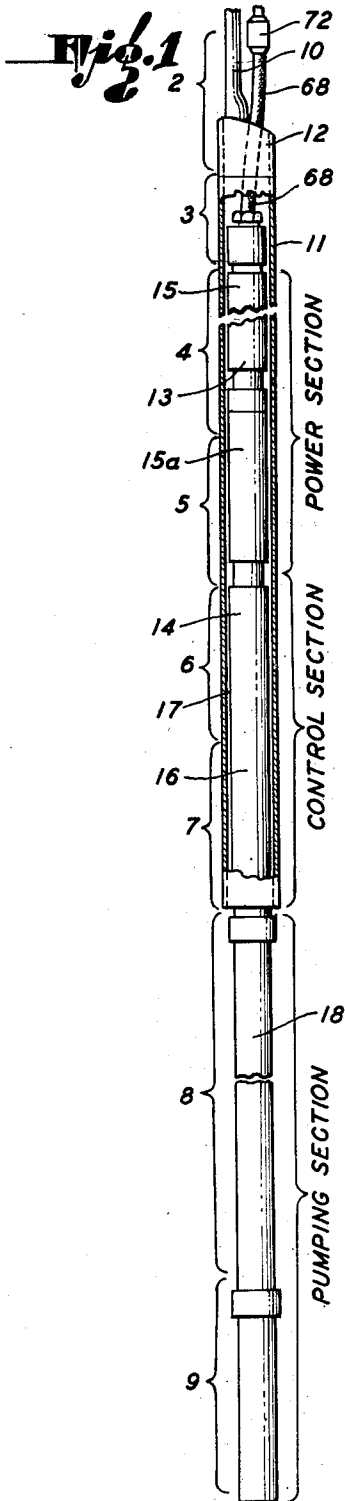
B. F. SCHMIDT

2,606,500

FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

Filed June 24, 1946

13 Sheets-Sheet 1



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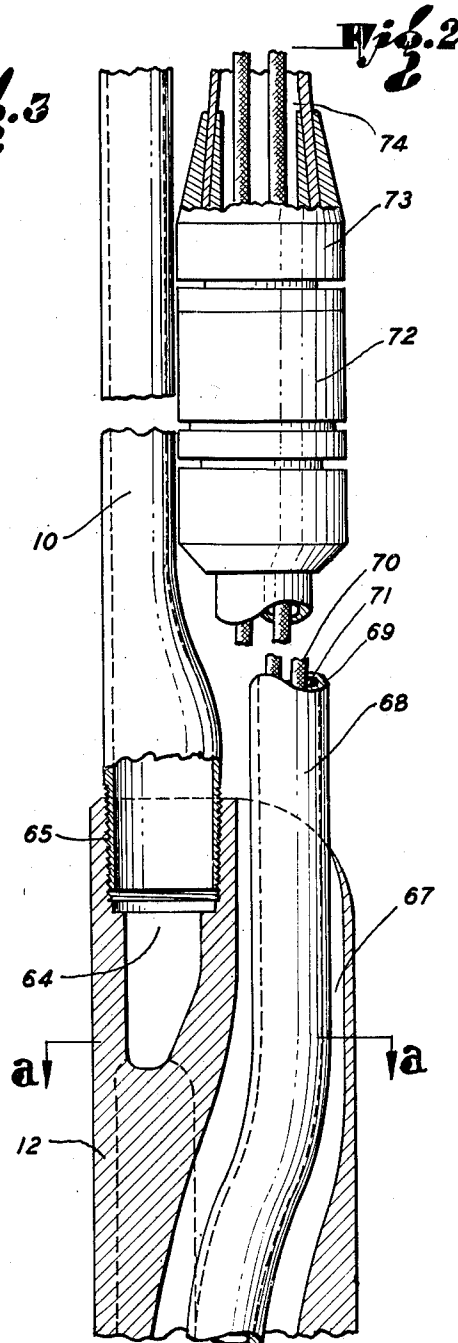
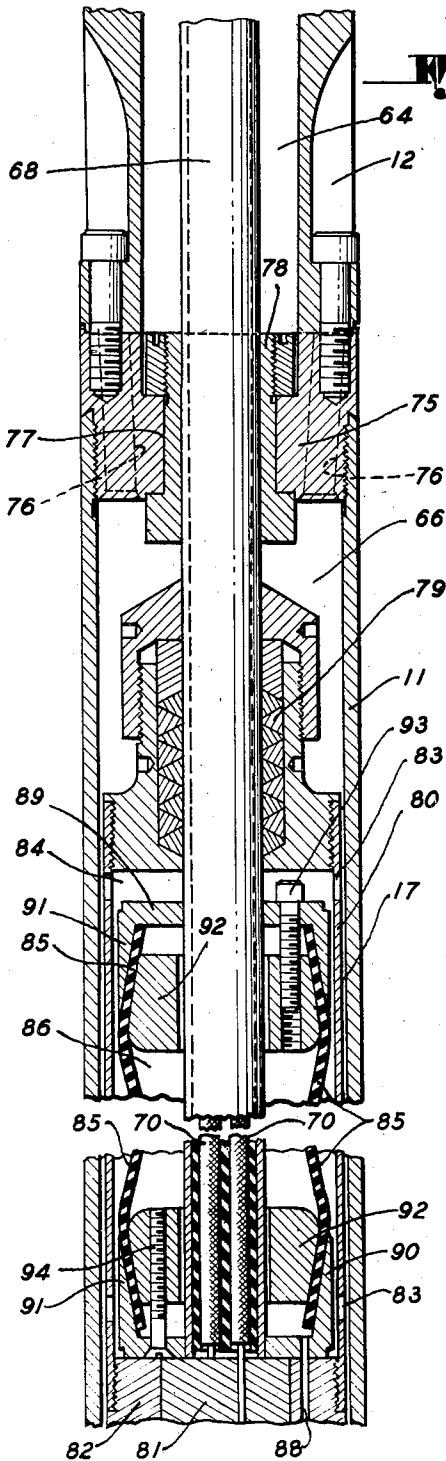
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13 Sheets-Sheet 2



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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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Fig. 2a

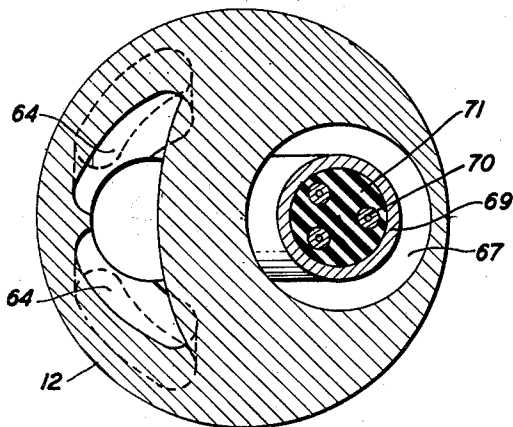


Fig. 10

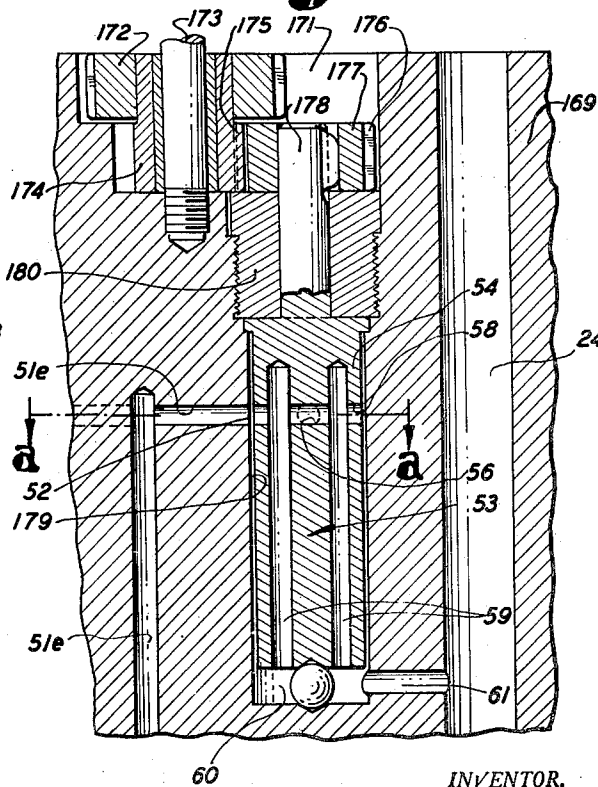
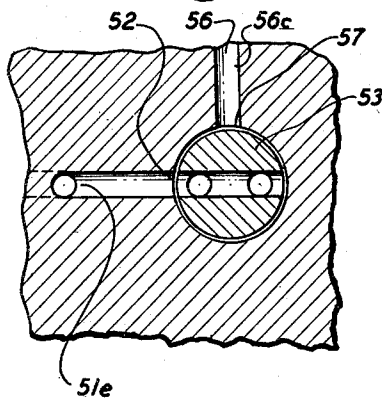


Fig. 10a



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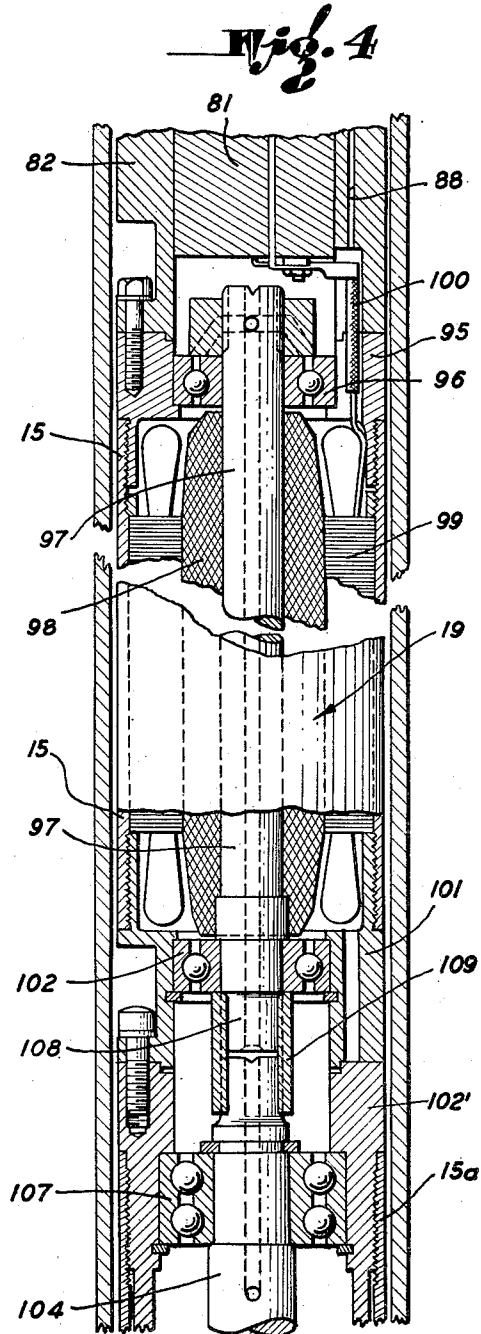
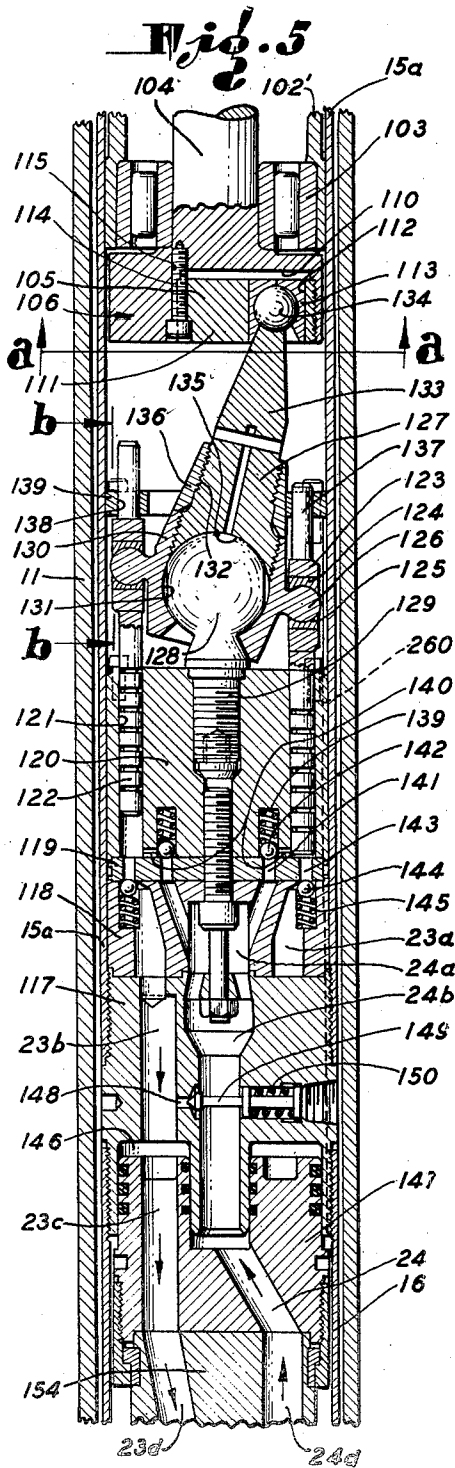
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13 Sheets-Sheet 4



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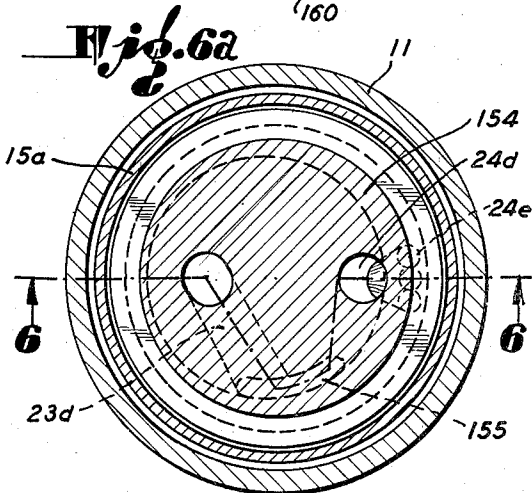
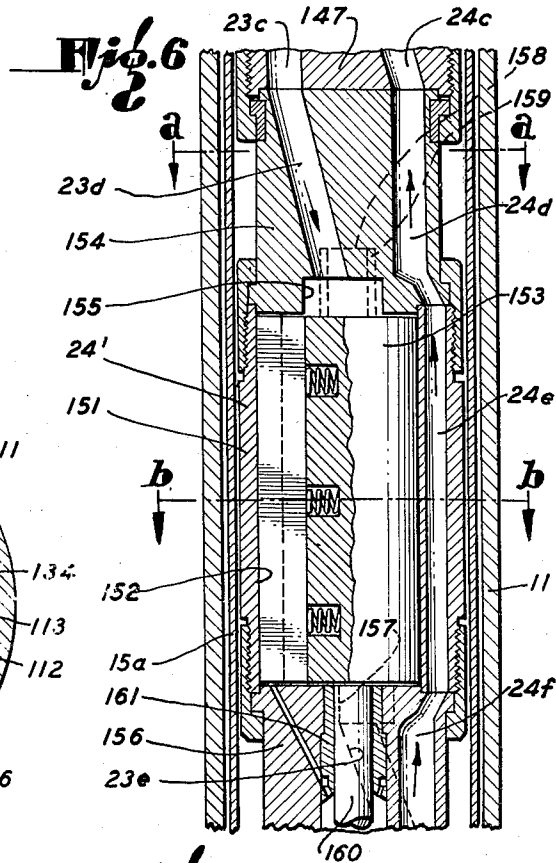
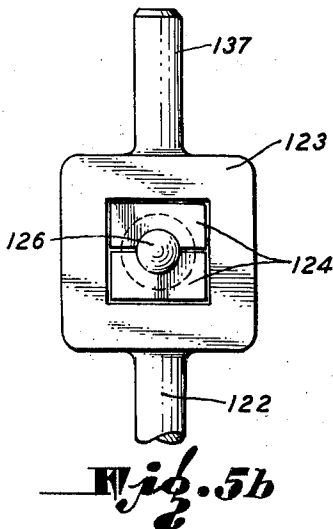
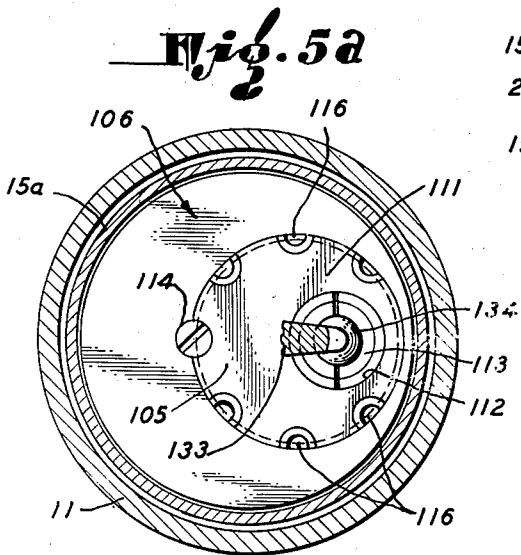
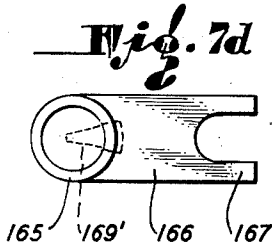
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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13 Sheets-Sheet 5



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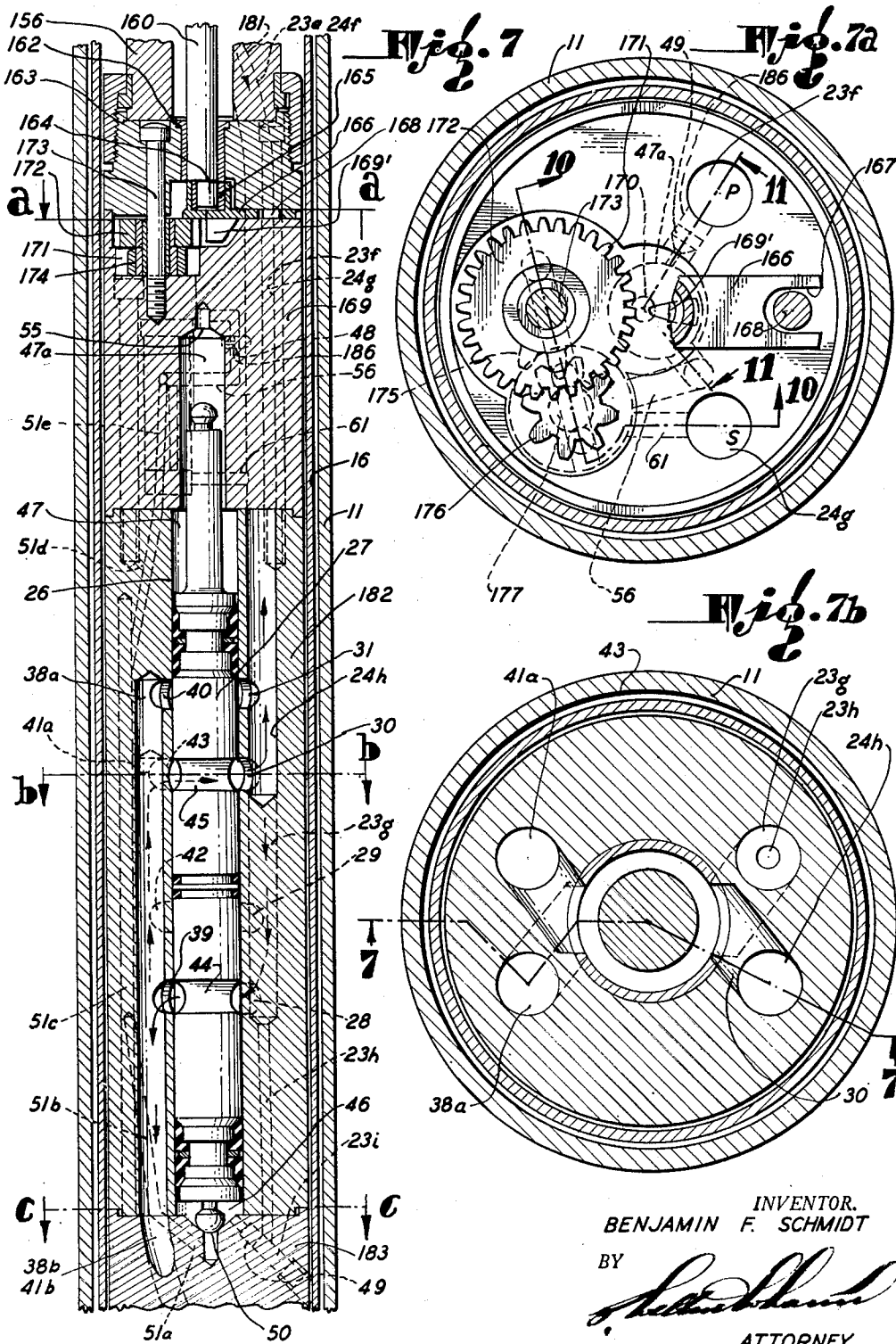
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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13 Sheets-Sheet 6



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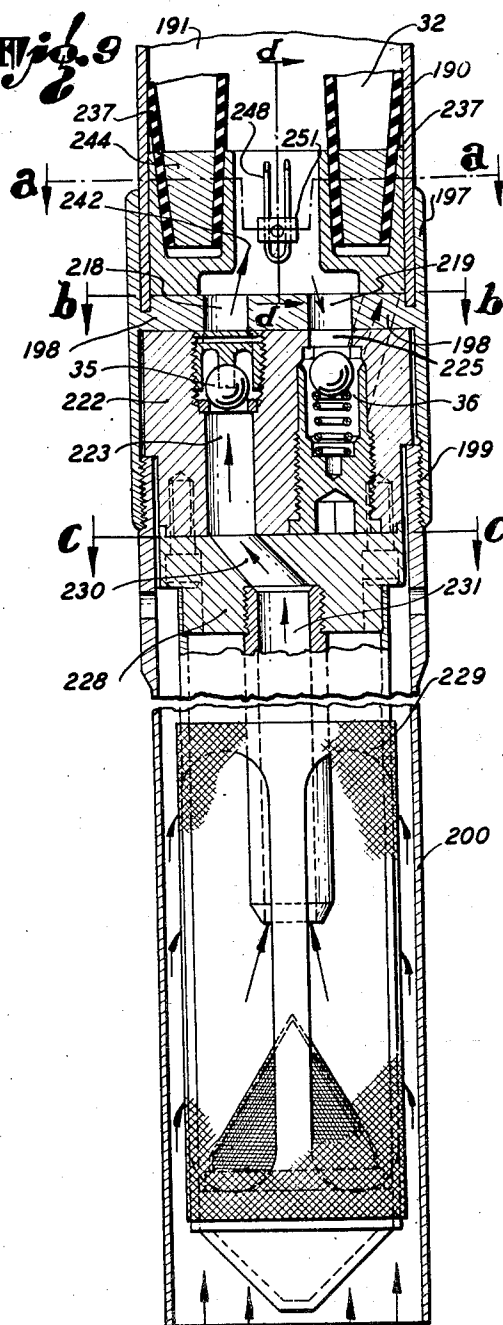
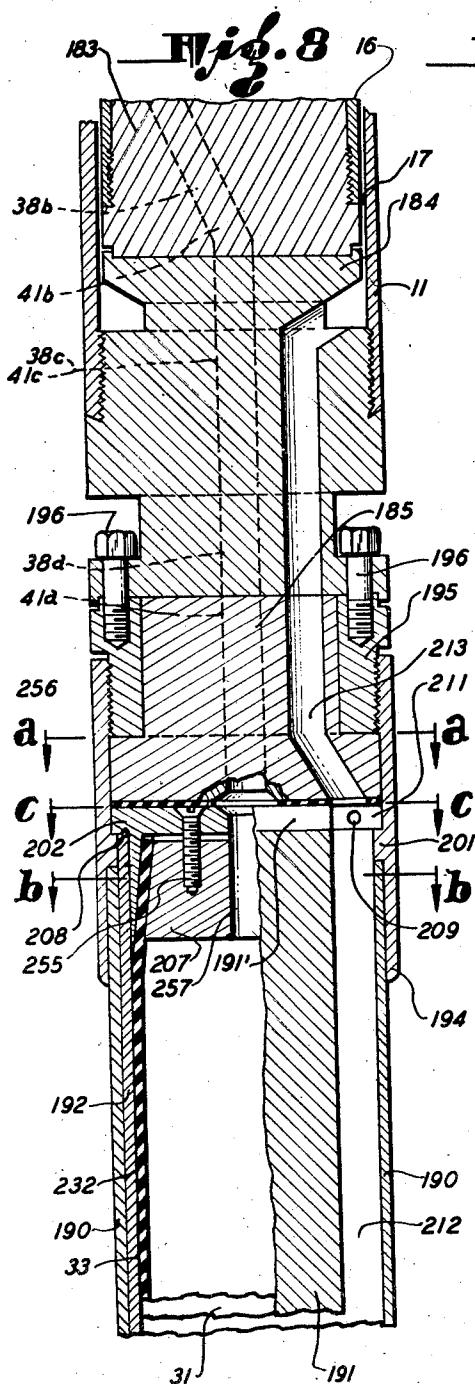
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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13 Sheets-Sheet 7



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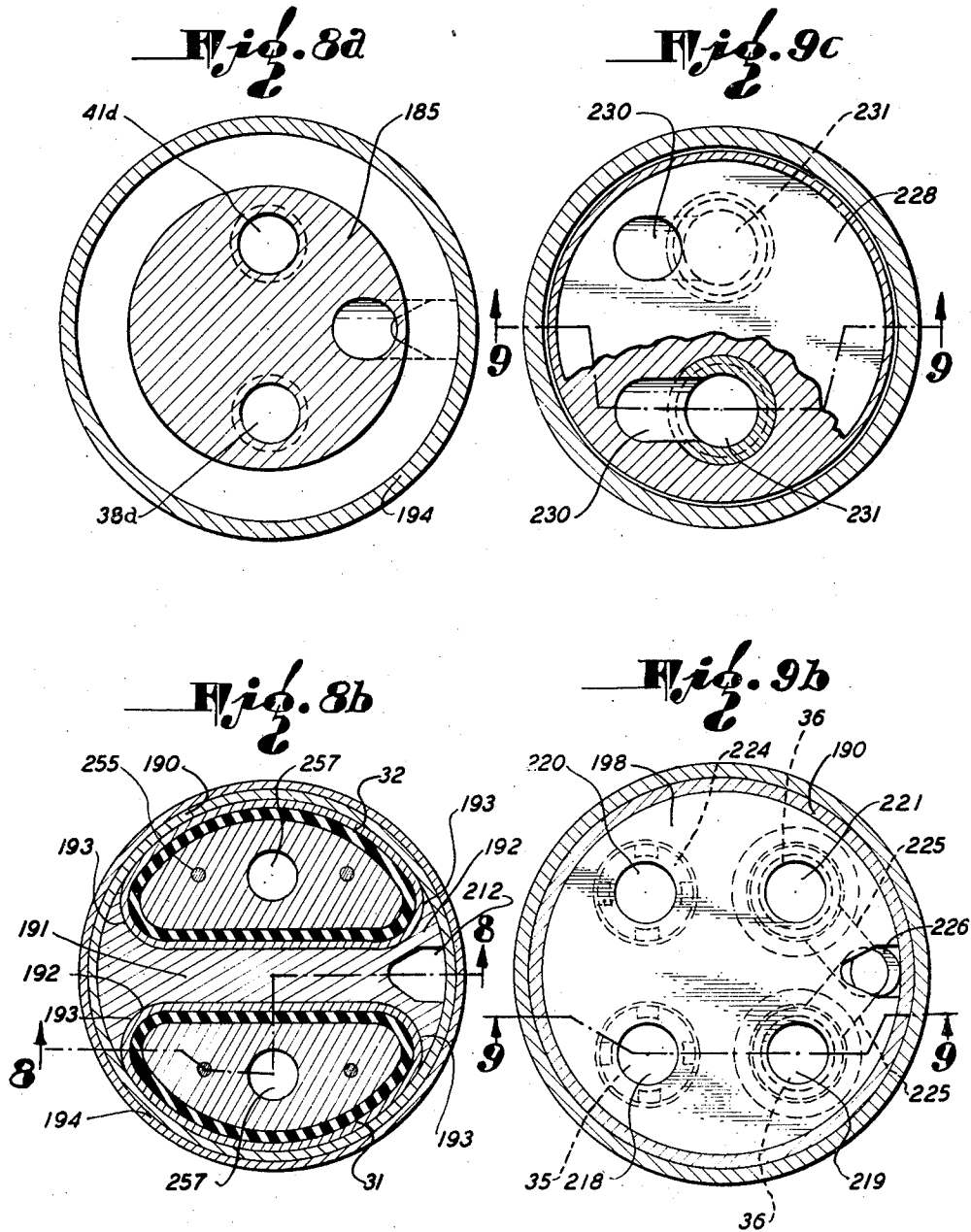
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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13 Sheets-Sheet 8



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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

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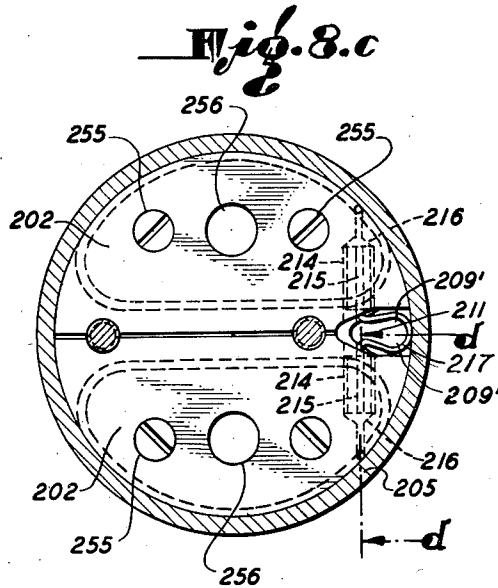
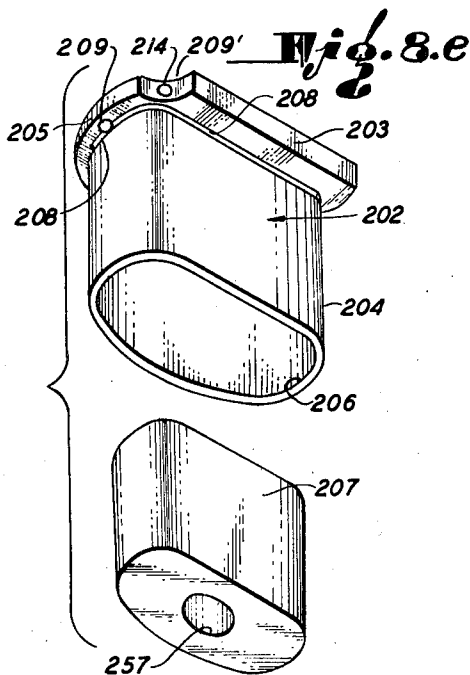


Fig. 8.d

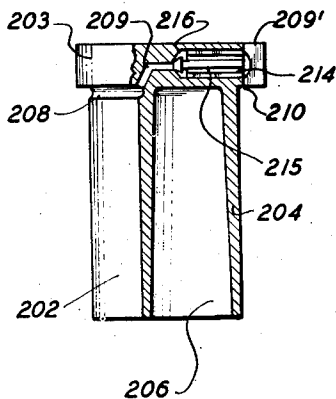
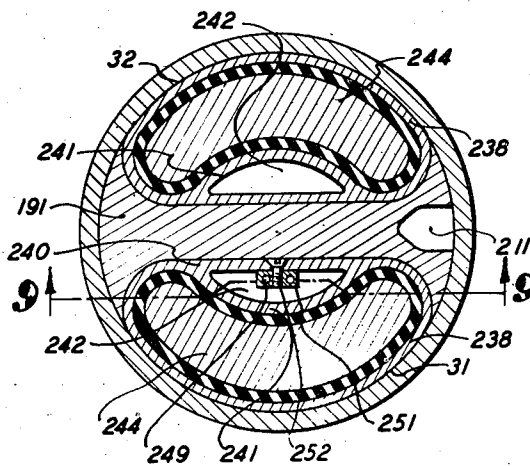


Fig. 9.a



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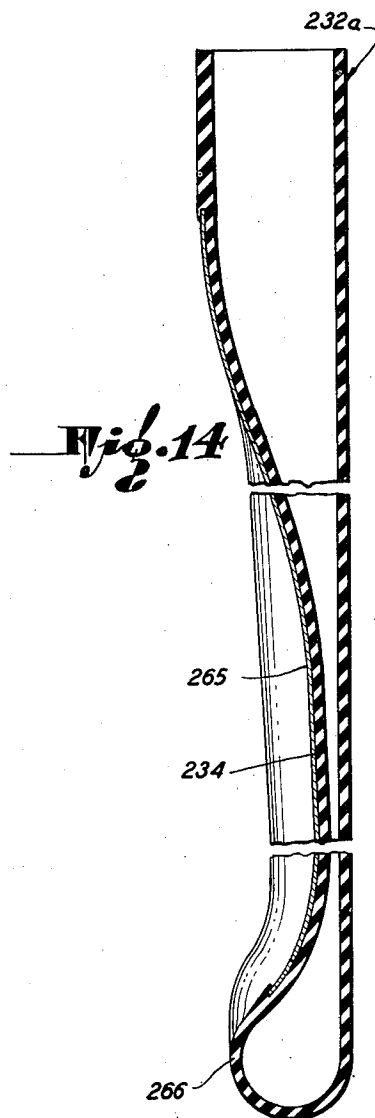
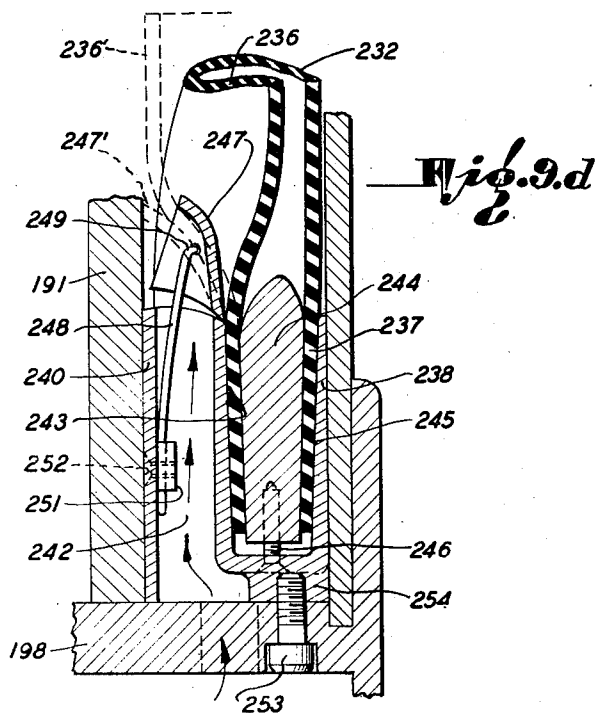
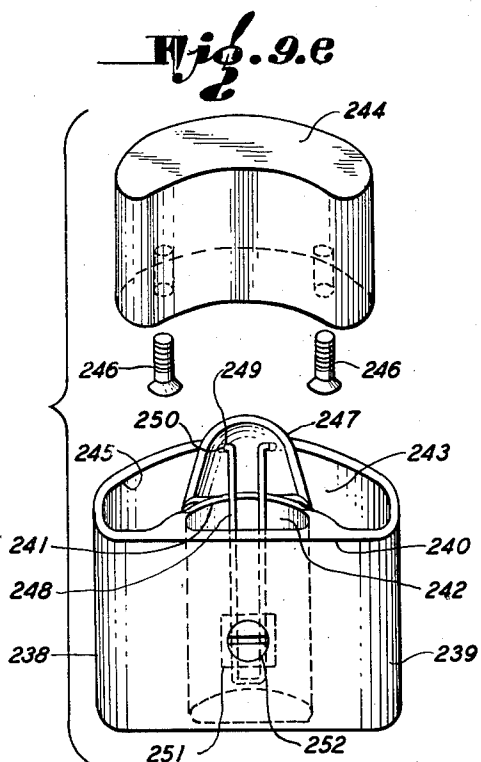
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

Filed June 24, 1946

13 Sheets-Sheet 10



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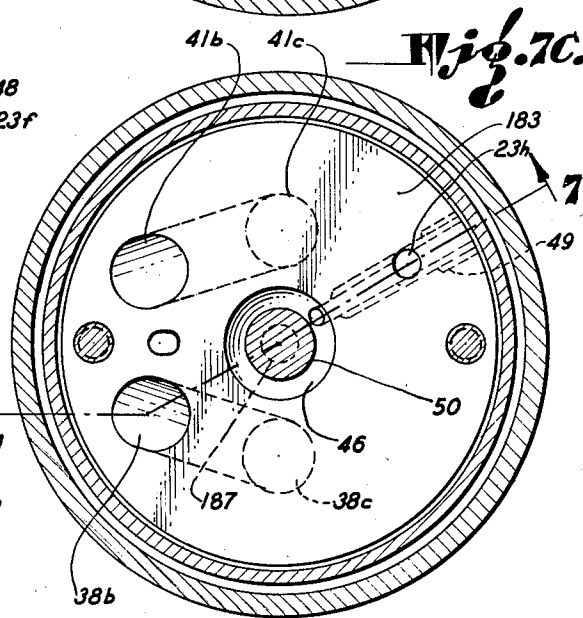
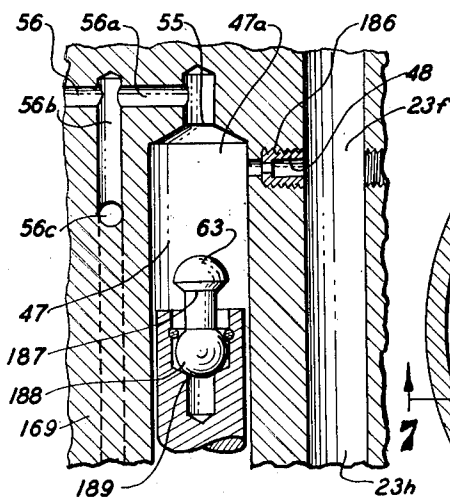
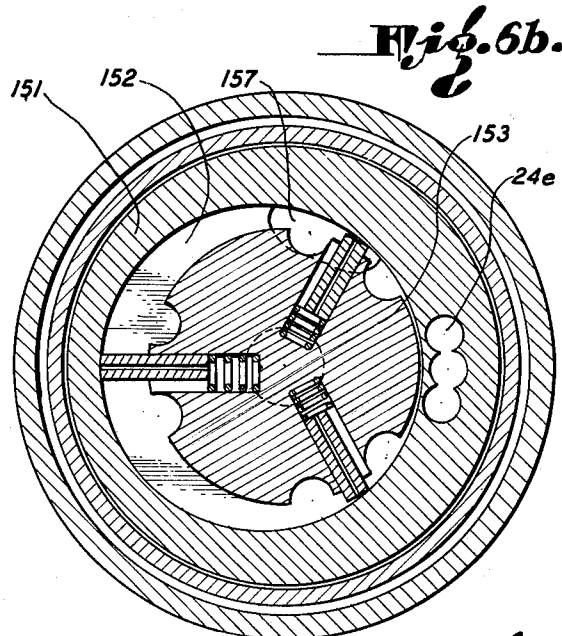
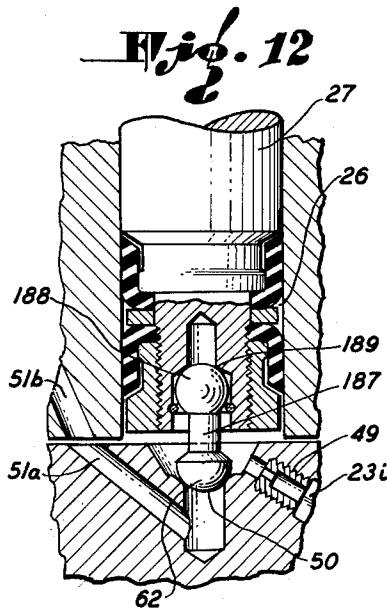
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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

Filed June 24, 1946

13 Sheets-Sheet 11



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FLUID ACTUATED DOUBLE-ACTING SUBMERSIBLE PUMP

Filed June 24, 1946

13 Sheets-Sheet 12

Fig. 13

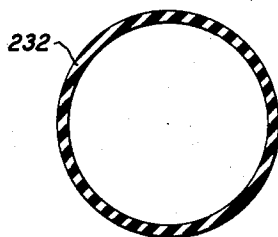
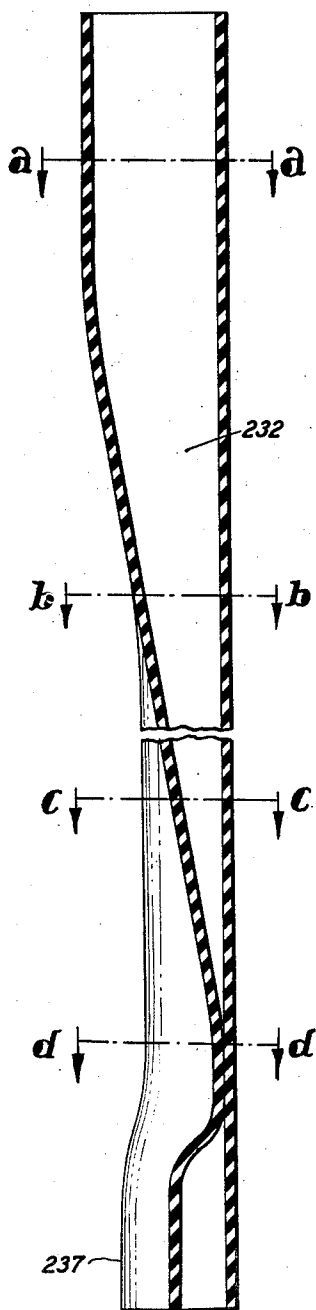


Fig. 13a

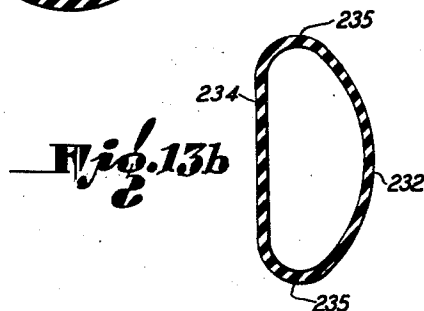


Fig. 13b

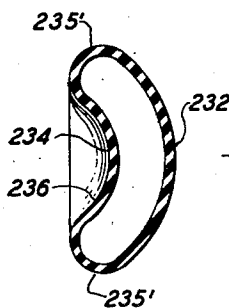


Fig. 13c

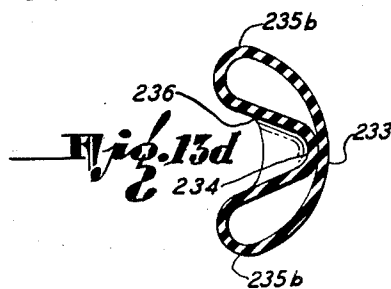


Fig. 13d

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UNITED STATES PATENT OFFICE

2,606,500

FLUID ACTUATED DOUBLE-ACTING
SUBMERSIBLE PUMP

Benjamin F. Schmidt, Los Angeles, Calif.

Application June 24, 1946, Serial No. 678,741

37 Claims. (Cl. 103-45)

1

My invention relates in general to power operated pumps, and relates in particular to a pump for pumping fluids from deep wells, this pump having a novel pumping mechanism and motor therefor combined in a single unit which is submerged in the liquid in the well.

It is an object of the invention to provide a positively acting displacement pump which avoids the use of sucker rods such as commonly extended from plunger pumps to the top of the well and avoids the use of pistons and cylinders in contact with the liquid which is being pumped from the well. In this respect the invention, in avoiding the exposure of frictionally engageable parts to the pumped liquid which generally carries sand or other abrasives, achieves a greatly extended useful life of the operating parts of the pumping mechanism, thereby making it possible to use the pump for long periods of time before necessity of pulling the pump from the well for adjustment or part replacement is required.

It is an object of the invention to provide a deep well pump wherein the pumping force or power is transmitted from the power source of the pumping device to the movable walls of the device which contact the ordinarily contaminated liquid being pumped by means of a clean liquid, such as thin highly refined oil, this oil lubricating the moving parts of the device and thereby protecting the same against rapid wear. Accordingly, the internal operating parts of the device which move in frictional engagement, one with the other, are maintained in a bath of oil, protected from wear producing substances.

A further object of the invention is to provide a deep well pump having one or more pumping chambers which receive the liquid to be pumped through inlet valves, these pumping chambers having therein bellows or bladder elements which, upon expansion by the application of internal fluid pressure thereto, force the liquid through discharge valves into passages which lead to the top of the well.

An object of the invention is to provide in a pump having pumping chambers inlet and discharge valves so arranged that the presence of sand in the pumped liquid will have a minimum wearing effect on the valve parts. In this pumping device both the inlet and outlet valves of the pumping chamber are arranged at the lower end of the pumping chamber so that sand or other abrasive substances which are carried into the pumping chambers will be immediately removed therefrom and therefore will not be per-

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mitted to accumulate by sedimentation in the bottom of the pumping chambers.

An important object of the invention is to provide a pumping mechanism of the character described having a motor driven pump for pumping the operating fluid and means for directing this operating fluid into the expansile contractile members which are disposed in the crude oil pumping chambers of the device, whereby these expansile-contractile members will be expanded in timed relation so as to pump a substantially continuous flow of oil through the outlet passage of the device.

A further object of the invention is to provide a pump of the character described in the preceding paragraph, wherein the motor driven pump operates continuously to pump the operating liquid, for example, oil, there being means for progressively or alternately connecting the outlet of the motor driven pump with the expansile-contractile members, and it is a further object to provide a valve means which will connect the outlet of the motor driven pump with one of the expansile-contractile members and at the same time connect the inlet of the pump with the other of the expansile-contractile members, so that the first of the expansile-contractile members will be subjected to fluid pressure from the pump and the other of the expansile-contractile members will be connected to suction, the aforesaid valve means being reversed in timed relation so that the expansile-contractile members will be alternately expanded and contracted and the pumped liquid will be alternately drawn into the pumping chambers while at the same time, pumped liquid is being discharged alternately from the pumping chambers.

A further object is to provide a pump of the character set forth in the preceding paragraphs having for operation of the valve which controls the flow of the operating fluid, a timing means which is operated by the movement of the operating fluid, and a further object is to provide a means having the characteristics of a meter through which the operating fluid passes, this meter measuring the flow of operating fluid and reversing the position of the control valve when required quantities of the operating flow have passed through the metering device.

Further objects of the invention include a novel and effective means for connecting the upper end of the pumping device to a string of tubing through which the pumped liquid is carried to the top of the well and for connecting electrical cables to the upper end of the pump-

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ing device, whereby the motor or motors of the device may be energized; means for maintaining the motors and other internal operating parts of the device in a bath of clean oil; a compact and effective pump for pumping the operating fluid; a novel four-way valve for controlling the delivery of the operating fluid into the expansile-contractile members and for connecting these members with the inlet of the operating fluid pump; a simple and effective means whereby the movement of the operating parts of the metering device are translated into controlling movements and effects whereby the operating liquid control valve is actuated; a cooperation of simple and compact parts whereby the power and pumping mechanisms are embodied in an elongated slender structure which may be lowered into a well of relatively small diameter; a simple arrangement of pumping chambers at the lower end of this structure; and simple and durable expansile-contractile bellows or bladder elements operative in the pumping chambers.

A further object of the invention is to provide in a pump of this character a control for the pumping action which responds to pressures in the expansile-contractile bellows. In this alternative control for the pump, pilot valves are provided which respond to excess pressures built up in the bellows or bladder elements.

Further objects and advantages of the invention will be brought out in the following part of the specification.

Referring to the drawings, which are for illustrative purposes only:

Fig. 1 is a partly sectioned elevational view showing a preferred embodiment of my pump;

Fig. 1a is a diagrammatic drawing of the pumping device shown in Fig. 1;

Fig. 2 is a fragmentary sectional view of the portion 2 of Fig. 1;

Fig. 2a is a cross section, to enlarged scale, taken as indicated by the line *a—*a** of Fig. 2;

Fig. 3 is a fragmentary elevational sectional view of the portion 3 of Fig. 1;

Fig. 4 is a fragmentary elevational sectional view of the portion 4 of Fig. 1;

Fig. 5 is a fragmentary elevational sectional view of the portion 5 of Fig. 1;

Fig. 5a is a view looking upward from the plane *a—*a** of Fig. 5;

Fig. 5b is a fragmentary side view of a frame at the upper end of the piston and associated parts.

Fig. 6 is an enlarged sectional view of the portion 6 of Fig. 1, the upper half of Fig. 6 being sectioned substantially as indicated by the line 6—6 of Fig. 6a and the lower portion thereof being sectioned substantially on the transverse center line of Fig. 6b;

Fig. 6a is a sectional view taken as indicated by the line *a—*a** of Fig. 6;

Fig. 6b is an enlarged sectional view taken as indicated by the line *b—*b** of Fig. 6;

Fig. 7 is an enlarged sectional view of the portion 7 of Fig. 1, the middle and lower parts of this figure being sectioned as indicated by the lines 7—7 of Figs. 7b and 7c;

Fig. 7a is an enlarged cross section taken as indicated by the line *a—*a** of Fig. 7;

Fig. 7b is a cross section, to enlarged scale, as indicated by the line *b—*b** of Fig. 7;

Fig. 7c is an enlarged cross section taken as indicated by the line *c—*c** of Fig. 7;

Fig. 7d is a plan view of the oscillating plate, a partial plan of which is shown in Figure 7a,

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Fig. 8 is an enlarged fragmentary section of the portion 8 of Fig. 8, the lower part of Fig. 8 being sectioned as indicated by the line 8—8 of Fig. 8b;

Fig. 8a is an enlarged sectional view taken as indicated by the line *a—*a** of Fig. 8;

Fig. 8b is an enlarged cross sectional view taken as indicated by the line *b—*b** of Fig. 8;

Fig. 8c is an enlarged fragmentary sectional view taken as indicated by the line *c—*c** of Fig. 8, to show the upper ends of the connector members;

Fig. 8d is an enlarged fragmentary sectional view taken as indicated by the line *d—*d** of Fig. 8c;

Fig. 8e is a perspective view of a connector with its tube clamping body or plug;

Fig. 9 is an enlarged fragmentary sectional view of the portion 9 of Fig. 1, the upper portion in the region of the line *a—*a** of this figure being sectioned as indicated by the line 9—9 of Fig. 9a, the portion of this figure below the line *b—*b** being sectioned as indicated by the line 9—9 of Fig. 9b, and the portion of this figure below the line *c—*c** being sectioned as indicated by the line 9—9 of Fig. 9c;

Fig. 9a is a cross sectional view taken as indicated by the line *a—*a** of Fig. 9;

Fig. 9b is an enlarged cross section taken as indicated by the line *b—*b** of Fig. 9;

Fig. 9c is an enlarged cross section taken as indicated by the line *c—*c** of Fig. 9;

Fig. 9d is an enlarged fragmentary sectional view taken as indicated by the line *d—*d** of Fig. 9;

Fig. 9e is a perspective view of a lower connector or closure for a tube, and the tube clamping plug therefor;

Fig. 10 is an enlarged fragmentary schematic sectional view taken as indicated by the line 10—10 of Fig. 7a;

Fig. 10a is a fragmentary sectional view taken as indicated by the line *a—*a** of Fig. 10;

Fig. 11 is an enlarged fragmentary schematic sectional view showing the duct arrangement at the upper end of the valve chamber of the device;

Fig. 12 is an enlarged fragmentary schematic sectional view showing the duct arrangement at the lower end of the valve chamber;

Fig. 13 is a longitudinal section through a preferred form of flexible pumping member, intermediately shortened so that both of the pumping member can be shown in the single view;

Fig. 13a is a cross section taken as indicated by the line *a—*a** of Fig. 13;

Fig. 13b is a cross section taken as indicated by the line *b—*b** of Fig. 13;

Fig. 13c is a cross section taken as indicated by the line *c—*c** of Fig. 13;

Fig. 13d is a cross section taken as indicated by the line *d—*d** of Fig. 13;

Fig. 14 is a longitudinal section through an alternative form of a flexible member;

Fig. 15 is a schematic view showing my pump with the alternative pressure-responsive control which may be employed in substitution for the metering device previously shown.

The pumping device shown in Fig. 1 is of vertically elongated form so that it may be lowered into a well by means of tubing 10 which has also the purpose of conveying the pumped fluid—for example, oil—to the top of the well. The pumping device includes an outer shell 11 which is connected to the tubing 10 by a fitting 12. The vertically elongated tubular shell 11 contains therein the power section 13 and the control section 14 of the pumping device, these sections 13

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and 14 being contained in connected inner tubular shells 15, 15a and 16 of such diameter as to leave an annular space or passage 17, through which the pumped fluid may pass from the upper end of the pumping section 18 of the device to the fitting 12 and then into the lower end of the tubing 10.

The power section 13 has in the upper end thereof electrically driven motor means represented by a motor 19 which may be employed singly or in multiplicate, depending upon the power required. The power section also includes a pump 20 for operating fluid, this pump 20 having a pressure outlet 21 and a suction inlet 22. From the outlet 21 a pressure passage 23 leads downwardly into the control section of the pumping device and a suction or return passage 24 leads downward from the suction inlet 22.

In the control section 14 of the pumping device there is a meter 24' which is connected in series with the pressure passage 23, and a control valve 25 comprises a cylinder 26 in which a piston 27 is vertically slidable. The lower end of the pressure passage 23 connects with the cylinder 26 through spaced ports 28 and 29, and above the ports 28 and 29 ports 30 and 30' connect the lower end of the suction passage 24 with the cylinder 26.

The vertically elongated pumping section of the device has pumping chambers 31 and 32 in side by side relation, in which expansile-contractile members 33 and 34 are operative. Each of the chambers 31 and 32 has an inlet valve 35 and a discharge valve 36. The discharge valves 36 communicate with a rising passage 37 which connects with the lower end of the passage 17 of the control and power sections of the pumping device. An operating fluid passage 38 extends upward from the expansile-contractile member 33 and is connected to the space within the cylinder 26 by ports 39 and 40, which are respectively in the horizontal planes of the ports 28 and 31. An operating fluid passage 41 extends upwardly from the expansile-contractile member 34 and is connected to the space within the cylinder 26 by ports 42 and 43 respectively in the horizontal planes of the ports 29 and 30. The valve piston 27 has therein annular channels or ducts 44 and 45 spaced so that when the piston 27 is in the lowered position in which it is shown in Fig. 1a, the channel 44 will connect the pressure passage 23 with the operating fluid passage 38 through the ducts 28 and 39, and the channel 45 will connect the operating fluid duct 41 with the suction passage 24 through the ports 43 and 30. At this time, operating fluid under pressure will pass into the expansile-contractile member 33 through the passage 38 and operating fluid will pass out of the member 34 through the passages 41 and 24 to the inlet of the pump 20 which will deliver such fluid into the upper end of the pressure passage 23 until this cycle of operation is completed under control of the meter 24' which is capable, when a measured quantity of operating fluid has passed into the expansile-contractile member 33, of actuating the control valve 25 so as to reverse the flows of operating fluid through the passages 38 and 41. For operation of the valve 25, I provide means for hydraulically shifting the valve piston 27 from one of its positions to the other positively and rapidly.

The valve cylinder 26 provides at the ends of the piston 27 chambers 46 and 47 which are connected to the pressure passage 23 through orifices 48 and 49 so that when these chambers 46 and 47 are closed against escape of fluid there-

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from, the pressures against the opposite ends of the piston 27 will be balanced. At the lower end of the chamber 46 there is a pressure release port 50 which is connected through a pressure release passage 51 with a port 52 of a pilot valve 53 having a valve body 54 which is rotated by the meter 24' as will be hereinafter explained. At the upper end of the chamber 47 there is a pressure release port 55 which is connected through a pressure release passage 56 with a port 57 of the pilot valve 53. The body 54 of the valve 53 has a transverse passage or port 58 which communicates through vertical passages 59 with a chamber 60, Fig. 10, at the lower end of the valve body 54, this chamber 60 being connected through a passage 61 with the pressure return passage 24. At the ends of the valve piston 27 there are closures 62 and 63 adapted to respectively close the pressure release ports 50 and 55 when the valve piston 27 reaches the end of its intended travel. In Fig. 1a the closure 62 is in a position to close the pressure release port 50 so that even though the pressure release passage 51 is connected through the pilot valve 53 and the passage 61 with the return passage 24, flow of fluid from the chamber 46 into the passage 51 cannot occur.

When the action of the meter 24' rotates the plug 54 of the valve 53 so as to bring the port 58 into conjunction with the port 57, the pressure release passage 56 of the upper chamber 47 of the valve device 25 will be connected to the suction passage 24, and at the same time the valve plug 54 will close off the pressure release passage 51 of the lower chamber 46 of the valve device 25. The capacity of the pressure release passages 51 and 56 is made purposely greater than that of the orifice 49, so that when the operation of the valve device 53 opens the passages 51 and 56 in their proper order, the valve piston 27 will be shifted as a result of hydraulic differential pressure against the ends thereof. For example, with the valve piston 27 in the lowered position in which it is shown in Fig. 1a, the opening of the pressure release passage 56 will result in an outflow of fluid from the chamber 47 at a rate greater than the inflow of fluid through the orifice 48, there being then a reduction in pressure in the chamber 47 so that fluid which enters the lower chamber 46 under pressure from the orifice 49 acts against the lower end of the valve piston 27 to shift it upwardly, this upward shifting movement of the piston 27 continuing until the closure 63 closes the pressure release port 55, thereby stopping the escape of fluid from the chamber 47. When the valve piston 27 reaches its raised position, the flow of operating fluid in the passages 38 and 41 will reverse. The channel 44 of the piston 27 will then connect the pressure passage 23 with the passage 41 through the ports 29 and 42 so that fluid under pressure will be fed into the expansile-contractile member 34, and the channel 45 of the piston 27 will connect the passage 38 with the return or suction passage 24 through the ports 40 and 31 so that the expansile-contractile member 33 may collapse. The reversal of the cycle described in the foregoing will occur intermittently under control of the meter, so that the members 33 and 34 will be consecutively and alternately expanded and collapsed, thereby performing alternate pumping actions in the pumping chambers 31 and 32, resulting in a substantially constant flow of pumped fluid upward through the passage 17 into

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the delivery tubing 10 which extends to the surface of the ground.

As shown in Fig. 2, the fitting 12, which is connected to the upper end of the outer shell 11, has therein a pumped fluid passage 64 having internal threads 65 to receive the threaded lower end of the tubing 10. This passage 64 communicates with the space 66, Fig. 3, in the upper end of the shell 11, which space 66 constitutes a continuation of the pumped oil passage 17. The fitting 12 has also therein a passage 67 through which a cable conduit 68 passes into the upper end of the outer shell 11, as shown in Fig. 3. This cable conduit comprises a metal tube 69 through which electrical conductors 70 extend, these conductors 70 being embedded in a body of rubber 71 which is secured in place so as to fill the interior of the tube 69 and thereby provide a seal to prevent entry of fluid into operative parts of the device through the cable conduit 68. At the upper end of the cable conduit 68 there is a cable connector body 72 adapted to be connected to a cable connector member 73 which is disposed at the lower end of a cable 74 which extends from a source of power at the top of the well for the purpose of supplying electrical energy to the motor 19 of the pumping device. To provide space for the connectors 72 and 73, the tubing 10 is locally flattened as shown in Fig. 2.

As shown in Fig. 3, a plug 75 is provided at the upper end of the outer shell 11 for connection of the fitting 12, this plug being threaded into the upper end of the shell 11 and having therein openings 76 which connect the bifurcated lower end of the passage 64 with the space 66. The plug 75 has also an opening 77 through which the cable conduit 68 passes, there being packing means 78 in the opening 77 for sealing around the cable conduit 68. As further shown in Fig. 3, the cable conduit 68 is carried through a clamping and packing device 79, disposed at the upper end of a cylindrical cage 80, to a multiple electrical connector 81 which is carried in the connector fitting 82, Fig. 4, by which the cage 80 is connected to the upper end of the shell 15 having therein the motor 19 which is of slender vertically elongated form and may be employed in multiplicate. The cage 80 consists of a section of metal tubing having openings 83 therein, through which the pressure of fluid in the space or passage 17 may be transmitted to the space 84 surrounding the pressure balancer which is disposed within the cage 80. This pressure balancer 85 consists of a tubular wall of flexible material supported so that the intermediate portion thereof may flex and thereby act as a barrier between a body of protective oil occupying the interior of the pressure balancer and the pressure of fluid in the annular passage 17 surrounding the power and control sections 13 and 14 of the device, the internal space 86 of the pressure balancer 85 communicating through a passage 88 in the fitting 82 with the interior of the motor shell 15 which in turn communicates with the interior of the shell 16 of the control section as will be hereinafter described.

The ends of the tubular pressure balancer 85 are closed by upper and lower cups 89 and 90 which surround the cable conduit 68 at spaced points within the cage 80, these cups 89 and 90 having internally tapered side walls 91 to receive the ends of the tubular pressure balancer 85 so that these ends of the member 85 may be clamped against the walls 91 by clamping bodies 92 which

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are externally tapered to correspond to the taper of the walls 91 of the cups 89 and 90 and are pulled into the cups 89 and 90 by use of screws 93 and 94. The clamping bodies 92 are of annular form so that they may surround the conduit 68. Also the lower cup 90 is secured to the upper face of the fitting 82 and has therein a portion of the intercommunicating passage 88, through which fluid pressure may be transmitted between the space 86 within the pressure balancer 85 and the interior of the motor shell 15.

As shown in Fig. 4, the motor shell 15 has at its upper end a ring fitting 95 which serves as a means for the attachment 96 to support the upper end of the shaft 97 which carries the rotor 98 of the motor 19 which is of slender form so that it will operate within the motor field 99. Electrical connections between the conductors 70 of the conduit 68 and the motor 19 are schematically shown at 100.

At the lower end of the motor shell 15 there is a fitting 101, as shown in Fig. 4, having therein a bearing 102 to support the lower end of the motor shaft 97. This fitting 101 is secured to the upper face of a concentric bearing support 102' which is of tubular form and extends downwardly within the pump shell 15a to the upper end of which it is connected. As shown in Fig. 5, a rugged radial bearing 103 is supported in the lower end of the bearing support 102', to carry the lower end of a shaft 104 which projects upwardly from the annular body 105 of an eccentric or crank member 106. As shown in Fig. 4, the upper end of the shaft 104 is supported by a bearing 107 and is connected to the downwardly projecting end 108 of the motor shaft 97 by a sleeve coupling 109 so that the eccentric 106 will be driven by the motor.

In the lower face of the body 105 there is a circular recess 110 to receive an adjustable eccentric disc 111 having an eccentric opening 112 which receives a bearing block 113. The disc 111 may be rotated in the recess 110 and may be held in its various positions of adjustment by a screw 114 which is threaded into an opening 115 in the body 105.

As shown in Fig. 5a, the disc 111 has a plurality of peripheral channels 116, any of which channels 116 may be brought into conjunction with the body of the screw 114 by rotation of the disc 111 in the recess 110, thereby changing the distance of the bearing block 113 from the axis of rotation of the body 105.

A body 117 is secured in the lower end of the shell member 15a. On the upper face of the body 117 there is a valve body 118 superseded by a valve plate 119 against which a pump body 120 is positioned. This pump body 120 has near the periphery thereof a plurality of cylinder bores 121 which are parallel to the vertical axis of the body 120. Each of the cylinder bores 121 receives a piston 122 which projects above the upper face of the body 120. Each piston 122 has thereon a rectangular frame 123 to receive a divided cross head block 124 having a spherical opening 125 between its component parts to receive a spherical actuating lever 126 which projects laterally from the lower end of an operating arm 127. The operating arm 127 is supported on a ball 128 formed on a pin 129 which is secured in the pump body 120.

The operating arm 127 consists of a body 130 of generally cylindrical form, which body has the lever 126 projecting therefrom. This body 130 has a spheroidal cavity 131 to receive the lower

half of the ball 128 and an upwardly extending threaded opening 132 to receive the lower threaded end of a stem portion 133 which converges upwardly and has thereon a ball 134 which is received by the bearing block 113, so that when the eccentric member 106 is rotated, the upper end of the operating arm 127 will describe a circle and circumduction of the arm 127 around the center of the ball 128 will be accomplished. This circumduction or rocking movement of the arm 127 results in a vertical reciprocation of the levers 126 which vertical reciprocation is transmitted through the cross head blocks 124 to the pistons 122. The stem 133 has a spheroidal seat 135 to engage the upper face of the ball 128, and a lock nut 136 is provided on the stem 133 for locking the stem 133 in the body 130 when these parts have been adjusted into proper relation to the ball 128. Stems 137 project upwardly from the rectangular frames 123 of the pistons 122 and are guided in openings 138 in a guide ring 139.

Adjacent the lower end of each cylinder bore 121 there is a valve cavity 139 drilled upwardly into the pump body 120, the lower end of this valve cavity 139 communicating with the lower end of the adjacent cylinder bore 121 through an opening 140. The plate 119 has a port 141 communicating with the lower end of the valve cavity 139 and an inlet valve closure in the form of a spring-pressed ball 142 and is seated in the upper end of the port 141. Also, the plate 119 has in communication with the lower end of each cylinder bore 121 a discharge valve port 143, the lower end of which is adapted to be closed by a discharge check valve closure consisting of a spring-pressed ball 144 disposed in a valve cavity 145 in the upper space of the valve body 118. Each of the cavities 145 communicates with a discharge passage 23a in the valve body 118 which comprises the upper extremity of the pressure passage 23 described with relation to Fig. 1a. It will be understood that in the following description the openings or passages in the various parts which form a part of the pressure passage 23 will be identified by the numeral 23 and a conjoined letter. The body 117 at the lower end of the shell 15a has passages 23b therethrough which connect the passages 23a with a recess 146 in the lower face of the body 117, this recess 146 communicating with a pressure passage section 23c in a connector body 147 which extends upwardly into the recess 146. As shown in Fig. 5, portions or sections 24a, 24b, and 24c are formed respectively in the valve body 118, the body 117 and the connector body 147. The passage 24a in the body 118 communicates with the lower end of the inlet or suction valve port 141 in the plate 119. In the body 117 a port 148 connects the section 23b of the pressure passage 23 with the section 23b of the suction passage 24, and a pressure release valve 149 is extended across the passage 24b and is urged into closing relation to the port 148 by a spring 150, the strength of which will determine the pressure differential between the passages 23b and 24b at which the pressure release valve 149 will open and permit release of pressure from the passage 23b through the port 148. The inner tubular shell 16, as shown in the lower part of Fig. 5, threads onto the body 117 and projects downwardly around the connector body 147, around the meter shown in Fig. 6, around the valve mechanism shown in Fig. 7, and ends in the lower part of the control section of the device as shown in Fig. 8.

The meter 24' comprises a body 151 of cylindrical form having a cylindrical bore from end to end thereof to provide a chamber 152 in which a vane rotor 153 operates in eccentric position characteristic of vane type pumps or motors. The upper end of the chamber 152 is closed by a head 154 which is connected to the lower face of the connector body 147 and has therein continuations of the pressure and suction passages 23 and 24 specifically identified by the numerals 23d and 24d.

As shown in Figs. 6 and 6a, the passage 23d slopes downwardly and forwardly to a port 155 constituting the fluid inlet of the meter 24'. The passage 24d connects with the upper end of a return passage portion 24e which extends vertically through the side wall of the meter body 151. The lower end of the meter chamber 152 is closed by a head 156 having in its upper face an outlet port for the meter chamber 152, this outlet port 157 being disposed at the upper end of a pressure passage section 23e which slopes downwardly and rightwardly within the head 156. The head 156 has also therein a suction passage section 24f, the upper end of which connects with the lower end of the passage section 24e.

The rotor 153 has an upwardly projecting stub shaft 158 which is received by a sleeve bearing 159 carried in the upper head 154. A shaft 160 projects downwardly from the meter rotor 153 through a bearing 161 carried by the lower head 156.

As shown in Fig. 7, the shaft 160 projects down through the head 156 and through a bearing 162 carried by a body member 163 which is connected to the lower face of the head 156. The shaft 160 has an eccentric pin 164 on its lower end which engages a bearing 165 mounted on the leftward end of an oscillating plate 166, a plan of which is shown in Fig. 7d and a partial plan of which is shown in Fig. 7a. At the rightward end of the plate 166 there is a fork 167 which straddles the portion of a screw 168 by which the body member 163 is secured to the upper face of a body member 169. As the crank pin 164 crosses the leftward end of the plate 166 to describe a small circle, the rightward end of the plate 166 is kept from rotation and is permitted to slide back and forth in a lateral direction, as a result of the engagement of the fork 167 with the screw 168. On the lower face of the plate 166 there is a tooth 169' which, as a result of the motion transmitted to the plate 166 by the crank pin 164, is caused to travel through a circle 170, Fig. 7a.

The upper face of the body member 169 has therein a cavity 171 to receive a gear 172 which revolves on a portion of the screw 173 in a position to be engaged by the tooth 169' as it oscillates. Each movement of the tooth 169' through the circle 170 will advance one tooth of the gear 172, thereby producing a slow rotation of the gear 172 as a result of the rotation of the rotor 153 of the meter 24'. Secured to the under face of the gear 172 there is a gear segment 174, likewise in the cavity 171, this gear segment 174 having two teeth 175 adapted to engage the teeth 176 of a gear 177, each time the gear 172 makes a complete revolution.

As shown in Fig. 10, the gear 177 is fixed on the upper end of a shaft 178 which projects upwardly from the valve body or plug previously described with relation to Fig. 1a. This valve body 54 is rotatable in a recess 179 formed in the body 169 below the recess 171. The valve body 54 is held in the recess 179 by a threaded plug

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180 which surrounds the shaft 178 below the gear 176. The body member 169 has therein pressure and suction passage sections 23f and 24g which communicate respectively with the passage sections 23e and 24f of the head 156, through passages formed in the body member 163 as indicated by dotted lines 181 in the upper part of Fig. 7. The body member 169 has also therein the upper reduced portion of the chamber 47 formed above the valve piston 27 in the valve cylinder 26 which is formed in the body 162 which abuts the lower face of the body 169. In alignment with the passage sections 23f and 24g, the body 162 has extending downwardly from the upper face thereof the lower extremity of the pressure passage, embodied in the passage section 23g, and the suction passage section 24h which constitutes the lower end of the suction passage 24.

The body 162 has also the upper ends 38a and 41a of the operating fluid passages 38 and 41 first described with relation to Fig. 1a. The body 162 has likewise therein the ports 28, 29, 30, 31, 39, 40, 42 and 43 adapted to cooperate with the channels 44 and 45 of the valve piston 27. The passages 38 and 41 are carried downward by passage sections 38b and 41b in the body member 163 which closes the lower end of the inner shell 16 and which rests against the lower end of the body member 162, passage sections 38c and 41c in the head 184 which closes the lower end of the outer shell 11, and terminates with passage sections 38d and 41d of the fitting 185.

As shown in Figs. 7 and 7b, a connection is made with the chamber 46 at the lower end of the piston 27 through a small passage 23h drilled downwardly from the lower end of the passage section 23g, this passage 23h being continued downward into the upper portion of the body 163, Fig. 7, to meet a diagonal passage 23i in which a flow control orifice 49 is situated as shown in Fig. 12. Fluid pressure from the pressure passage 23 is conducted into the upper chamber 47 as shown in Figs. 7, 7a and 11 by drilling and threading an opening 186 connecting the passage section 23f and the upper portion 47a of the chamber 47 and placing therein an orifice member 49.

The pressure release passage 51, shown schematically in Fig. 1a, is formed by drilling in the bodies 163, 162 and 169 interconnected passages as indicated at 51a, 51b, 51c, 51d, and 51e, from the release port 50 of the chamber 46 to the port 52 of the pilot valve 53. The pressure release passage 56 is formed from the pressure release port 55 of the upper chamber 47a to the port 57 of the valve 53, Fig. 10a, by interconnected drilled passages, 56a, 56b and 56c in the body 169, as shown in Fig. 11. As shown in Figs. 11 and 12, the pressure release valve closures 62 and 63 are formed on stems 187 having spheroidal inner ends 188 seated in openings 189 in the ends of the valve piston 27, thereby supporting the closures 62 and 63 so that they are self-aligning with respect to the ports 50 and 55.

As shown in Figs. 8, 8b, 9, and 9a, the pumping chambers 31 and 32, schematically shown in Fig. 1a, are formed in a tubular member 190 which forms part of the pumping section 18 by a median partitioned wall 191 which extends substantially from end to end of the tubular member 190. As shown in Fig. 8b, the edges 192 of the partition wall 191 are flared, and these flared edges of the partition wall 191 are provided with curved surfaces 193 which merge with the inner surface of the tubular member 190, cooperating there-

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with to form chambers 31 and 32 of approximately semi-circular cross section with rounded edges, following the curved surfaces 193. The upper end of the tubular member 190 is brazed in a sleeve coupling 194 which has a bushing 195 threaded into its upper end for connection by screws 196 to the lower end of the head 184 which closes the lower end of the outer shell 11. As shown in Fig. 9, the lower end of the tubular member 190 is brazed in a sleeve connector 197 having a transverse wall 198 and an internally threaded lower extension 199 to receive an oil inlet tube 200. Referring to Fig. 8, the upper end 191' of the partition wall 191 and an internal flange 201 in the coupling 194, form a shoulder around the upper ends of the pumping chambers 31 and 32. Upper connectors 202 for the expansile-contractile members 33 and 34 are disposed at the upper ends of the chambers 31 and 32, each of these members being of the form shown in Figs. 8c and 8e. They are each of cup-like form and have a top plate 203 and a downwardly extending side wall 204 externally shaped so as to correspond to the cross sectional shape of the chambers 31 and 32 and being externally of such size as to slip down into the upper end of a chamber 31 or 32. Each top wall 203 of the connectors 202 is of larger area than the side wall cross section so as to provide a flange 205 projecting from the upper edge of the side wall 204 for overlying the shoulder 201 formed by the upper end 191' of the wall 191 and the internal flange 201 of the connector 194. The side wall 204 of each connector 202 is internally tapered so as to provide a cavity 206 which gradually decreases in area upwardly. As shown in Fig. 8e, a clamping plug 207 is provided for each cavity 206. Also, side wall 204 has around its upper edge adjacent the flange 205 a channel 208 to form a passage for the flow of gas or liquid to the inlet 209 of a gas bleed valve 210 for the upper end of the pumping chamber 31 or 32 associated therewith. As shown in Figs. 8c and 8e, the flanges 205 have therein cooperating notches or recesses 209' defining an opening 211 aligned with the upper end of an oil discharge passage 212 formed along the rightward side of the partition wall 191, and forming a connecting aperture between the passage 212 and the oil discharge passage 213 through the bodies 185 and 184, the upper end of this passage 213 communicating with the annular discharge space or passage 17 within the outer shell 11.

As shown in Figs. 8c and 8d, the gas escape valves 210 are formed by drilling openings 214 horizontally into the top walls 203 of the connectors 202, from the notches 209', and slidably disposing in these openings 214 are longitudinally channeled closures 215 adapted to engage seats 216 at the inner ends of the openings 214, and thereby prevent reverse flow of fluid through the valve inlet passages 209. As shown in Fig. 8c, a bow spring 217 is disposed in the opening 211 formed by the notches 209' in such position that its ends will engage the rear ends of the closures 215 and yieldably force them outwardly into closing relation to the seats 216.

As shown in Figs. 9 and 9b, the transverse wall 198 has therein inlet and discharge ports 218 and 219 communicating with the lower end of the pumping chamber 31, inlet and discharge ports 220 and 221 communicating with the lower end of the pumping chamber 32. A valve body 222, which is clamped against the lower face of the wall 198 by the upper end of the oil inlet

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tube 200, has therein two oil inlet passages 223, communicating respectively with the ports 218 and 220 and each having therein an inlet check valve 35. The body 222 also has therein a pair of discharge valve passages 225 for connecting the ports 219 and 221 with an opening 226 in the transverse wall 198, which opening 226 communicates with the lower end of the pumped oil discharge passage 212. In each of the discharge passages 225 there is a discharge check valve 36. As shown in Figs. 9 and 9c, a plate 228 is secured to the lower face of the body 222 for supporting an inlet screen 229 which projects downwardly within the oil inlet tube 200. Diagonal openings 230, in the plate 228, connect the lower end of the inlet passages 223 of the body 222 with the upper ends of oil inlet tubes 231 which project downwardly from the head 228 within the screen 229. When the expansile-contractile members 33 and 34 are alternately collapsed and expanded in the chambers 31 and 32, oil will be drawn in through the passages 223, into the chambers 31 and 32, and will be discharged therefrom through the discharge passages 225.

Each of the expansile-contractile members 31 and 32 consists of a preformed tube 232, Fig. 13, of flexible material, such as a synthetic rubber compound of oil-resisting qualities either reinforced or non-reinforced as may be desired. This tube 232 is molded to the shape shown in Figs. 13, 13a, 13b, 13c, and 13d. At the plane indicated by the line *b-b* of Fig. 13, the tube 232 has the cross-sectional form shown in Fig. 13b. Its external form and size at this plane *b-b* are the same as the interior of the pumping chambers 31 and 32 in which it is to be used. At this plane it has a convex wall portion 233 and a flat wall portion 234 connected to the curved wall portion 233 by the edge wall portions 235 of sharper curvature. Upwardly from the plane *b-b* the tube 232 gradually changes from the approximately semi-circular form shown in Fig. 13b to circular form as shown in Fig. 13a. However, the change of the tube from flattened form, as shown in Fig. 13b, to circular form, as shown in Fig. 13a, is accomplished without change in the circumference of the tube. Therefore, it is possible to deform the upper end of the tube 232 from the circular form in which it is shown in Fig. 13a to the form disclosed in Fig. 13b, in which form the upper end of the tube 232 will fit into the pumping chamber. However, there will be a constant tendency for the upper part of the tube 232 to resume circular form and therefore the upper portion of the tube 232 will press tightly against the flat surface of the adjacent partition wall 191 when the tube is in a pumping chamber 31 or 32.

Downwardly from the plane *b-b*, Fig. 13, the tube 232 gradually changes toward the form shown in Fig. 13c, and then to the form shown in Fig. 13d. The inner or flat wall 234 of Fig. 13b is bent inwardly so that regarded in cross section, it will have a reentrant curve 236. This curving of the rubber wall 234 at 236 will result in the edge curves 235 being drawn toward each other as indicated at 235' in Fig. 13c, and as the reentrant curve of the wall is increased so that it substantially touches the wall 233 as shown in Fig. 13d, the edge curves 235 of the tube 232 will be further drawn toward each other as indicated at 235b. It will be understood that the change in the form of the tube wall from the plane *b-b* to the plane *d-d* will be accomplished without substantial change in the circumference of the

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tube; therefore, it is possible to inflate the device, as shown in Figs. 13, 13c and 13d, into engagement with the adjacent walls of the pumping chamber in which it is employed without stretching the tube wall. Below the plane *d-d* the tube 232 relatively rapidly changes from the form shown in Fig. 13d to the form shown in Fig. 13c so that its lower end 237 will fit into a lower connector or closure 238, as shown in Figs. 9, 9a, and 9d. As shown in Fig. 9e, the closure 238 comprises a cup having a side wall 239 of external form and size corresponding to the cross sectional size and shape of a pumping chamber 31 or 32, so that the member 232 will fit into the lower end of a pumping chamber as shown in the preceding figures. On the inner face of the flat portion 240 of the wall 239 there is an arcuate wall 241 defining a vertical oil passage 242. The arcuate wall 241 cooperates with the wall 239 to form an upwardly faced cavity 243 having the same outline as the lower end 237 of the tube 232, so that the lower end 237 of the tube 232 may be received within the cavity 243 and therein clamped by a tapered clamping plug 244. The inner surface 245 of the walls 239 and 241 defining the cavity 243 are tapered downwardly to correspond to the external taper of the clamping plug 244. As shown in Fig. 9d, the clamping plug 244 is placed in the lower end 237 of the tube 232 and the lower end of the tube and the plug are inserted in the cavity 243. Screws 246 are then employed to pull the plug 244 down into the tapered cavity 243, thereby clamping the lower end 237 of the tube 232 in the recess 243.

At the upper end of the oil passage 242 a rounded cover or closure 247 is supported by means of a hairpin spring 248 having outwardly bent portions 249 which enter laterally directed openings 250 in the concave surface of the cover 247. The lower portion of the spring 248 is clamped against the flat wall portion 240 of the lower tube closure 238 by a channeled nut 251 held by a screw 252. This spring 248 is of such form that it tends to hold the cover 247 in the open position in which it is shown in Figs. 9d and 9e, in which position the cover 247 permits a free flow of oil through the passage 242. When the tube 232 is expanded or inflated from the shape thereof shown in full lines in Fig. 9d, so that the reentrant wall portion 236 of the tube will be moved into the position shown by dotted lines 236', the cover 247 will be swung into its dotted line position 247' to close the upper end of the passage 242 and prevent fluid pressure acting within the tube 232 from forcing a portion of the wall of the tube down into the upper end of the opening 242. The connector or closure 238, as shown in Fig. 9d, is held down against the upper face of the transverse wall 198 by means of a screw 253, which passes upwardly through the wall 198 and threads into the lower end wall 254 of the member 238. The lower end of the passage 242 is expanded so that it will communicate with one inlet and one outlet port in the transverse wall 198. For example, the expanded lower end of the passage 242 is shown in connection with the inlet and outlet ports 218 and 219 of the transverse wall 198. The upper end of each tube 232 is inserted in the cavity 206 of an upper connector 202 and is clamped therein by a clamping body 207, the body 207 being drawn tightly up into the cavity 206 by screws 255, as shown in Fig. 8. Each top plate 203 of a connector 202 has an opening 256 therein, Fig. 8c, and each clamping body 207 has an opening 257 extended vertically therethrough, connecting

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the upper interior ends of the tubes 232 respectively with the passage sections 38d and 41d, constituting the lower ends of the operating fluid passages 38 and 41. All of the spaces within the inner tubular shells 15, 15a, and 16 are filled with liquid. The chambers and passages of the pump 20, the pressure and return passages 23, and 24, the chamber of the meter 24', the valve passages, the operating fluid passages 38 and 41 and the expansile-contractile members 33 and 34 have operating fluid therein. All of the other spaces within the shells 15, 15a and 16 are occupied by a body of liquid which may be of the same character as the operating fluid, this body of liquid extending up into and filling the space 86 within the pressure balancer 85, Fig. 3. Since the wall of the pressure balancer 85 is flexible, the pressure of oil in the passage 17 will be transmitted through the openings 83 and will be transmitted through the wall of the pressure balancer 85 to the body of filling fluid which extends up into the space 86. To provide for the small flow of the filling or pressure balancing oil required by temperature expansion and contraction, small openings are provided through the walls which divide the interiors of the casings 15, 15a and 16. For example, as shown in Figs. 3 and 4, a small opening 88 provides a passage connecting the upper end of the chamber of the motor 19 with the space 86 of the pressure balancer 85. Another small intercommunicating passage extends along the course of the dotted line 260 of Fig. 5, through the edge portions of the members 117, 118, and 120.

The preforming of the tubes 232 contributes to the characteristic pumping action of the device. When a tube 232 is expanded by the pressure of internally applied operating fluid, the inflation or expansion of the tube starts at the top and proceeds downwardly, so that, except for the small amount of gas or oil discharged through the associated gas release valve 210, the oil in the pumping chamber is forced downwardly progressively with the result that any sand which may have been taken into the lower end of a pumping chamber is discharged and the discharge valves are then washed by the cleaner oil. In the operation of the applicant's pump, the oil is drawn into the lower end of the pumping chamber and discharged from the lower end thereof, thereby substantially avoiding opportunity for accumulation of sand in the pumping chambers.

In Fig. 14, I show an alternative form of expansile-contractile tube 232a which is in all respects the same as the tube 232 shown in Figs. 13, 13a, 13b, 13c, and 13d, with the exception that the reentrant wall 234 thereof carries a leaf spring 265, and the lower end of the tube 232a is closed by an integrally formed bulbular wall 266 of flexible material. The spring 265 controls the inflation and deflation of the tube 232a so that the characteristic expansion and contraction hereinbefore mentioned is not dependent alone upon the preformed shape of the tube 232a.

In Fig. 15, which shows my pump in the form having an alternative control for the expansion and contraction of the bellows, many of the parts shown and described with relation to Fig. 1a are represented, with the exception of the meter 24', the pilot valve 53, and a few passages cooperating therewith, for the reason that in the form of the invention shown in Fig. 15, the meter 24' and the pilot valve 53 are replaced by pressure actu-

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ated valve mechanisms 270 and 270a which are duplicates. Accordingly, those parts which have been previously shown and described have, in Fig. 15, been identified by the same numerals as previously employed. The pressure responsive valve mechanisms each include a valve cylinder bore 271, the lower ends of these bores 271 respectively communicating with passages 272 and 273 with the operating fluid passages 38 and 41 which lead from the valve device 25 to the bellows 33 and 34 situated in pumping chambers 31 and 32. The upper ends of the bores 271 are connected by passages 274 with the internal fluid filled space 275 within the inner shell sections 15, 15a, and 16. This internal space 275 communicates at its upper end with the space 86 within the pressure balancing wall or diaphragm 85, the result being that the pressure of fluid in the passage 17 which extends upward from the discharge valves 36 of the pumping chambers 31 and 32 within the outer shell 11 of the pumping device, is transmitted to the oil in the space 275. The upper end of this space 17 communicates with the oil delivery tubing 10 which carries the pumped oil to the surface of the ground. Accordingly, the pressure in the space 17 constitutes the pressure head against which the pump must operate. In view of the use of the pressure balancing wall 85 as a means for separating the passage 17 from the space 86, the pressure in the space or passage 275 will be the same as the pressure in the passage 17.

In the upper part of each bore 271 there is a shuttle valve 276 having a longitudinal passage 277 therethrough and engageable by a spring-pressed detent 278. Above each shuttle valve 276 there is a compression spring 279 to serve principally as a return means for the valve 276, and below each shuttle valve 276 there is a compression spring 280 which is stronger than the spring 279 and which engages the upper face of a vertically slidable piston 281. Opposite the detent 278, each shuttle valve 276 has a depression forming a valve port 282. A suction passage 61 connects the suction passage 24 with the side wall of each bore 271 as shown. A pressure release passage 56 connects the valve port 55 at the upper end of the valve bore 26 with the wall of the left-hand bore 271 adjacent the point of connection of the suction passage 61 with the wall of the left-hand bore 271. Accordingly, when the shuttle valve 276 of the control valve 270 is raised from the position in which it is shown, the valve port 282 of this shuttle valve will connect the passage 56 with the suction passage 61 so that fluid may flow from the space 47 at the upper end of the valve piston 27. In a like manner, a pressure release passage 51 connects the valve port 50 with the side wall of the right-hand valve bore 271 adjacent a point of communication therewith of the suction passage 61 so that when the shuttle valve 276 of the right-hand control valve 270a is raised from the position in which it is shown, the port 282 thereof will connect the passages 51 and 61.

The operation of the form of the invention disclosed in Fig. 15 is as follows: With the slide valve 47 in the position shown in Fig. 15, pressure fluid from the pump 20 is flowing through the pressure passage 23 and the operating fluid passage 38 into the bellows 33. The pressure in the passage 38 is transmitted through the passage 272 to the lower face of the left-hand piston 281. At the same time, pressure from the space 275 is transmitted through the left-hand passage 274

and through the passage 277 of the left-hand shuttle valve 276 to the upper face of the left-hand piston 281 to substantially offset the pressure acting upwardly against the lower face of said piston. At the same time, the pump 20 is drawing fluid through the suction passage 24 and the passage 41 from the right-hand bellows 34 so that there is an inflow of oil from the well into the right-hand pumping chamber 32. When the left-hand bellows 33 is fully expanded to the limit permitted by the walls of the chamber 31, the pressure in the bellows 33 and in the passage 38 will increase above the pressure existing in the space 275 and the left-hand piston 281 will be forced upwardly, compressing the spring 280 thereabove and transmitting upward force to the left-hand shuttle valve 276, which will move upward from the position in which it is shown when this upward pressure exceeds the restraining force of the left-hand detent 278 associated therewith. The upward shifting of the left-hand shuttle 276 brings the valve port 282 thereof into a position connecting the pressure release passage 56 with the suction passage 61, thereby releasing the fluid pressure from the space 47 at the upper end of the piston 27.

It will be remembered that prior to this time, the flow of pressure fluid through the orifices 49 from the pressure passage 23 has maintained balanced pressures in the spaces 47 and 46 adjacent the opposite ends of the valve piston 27. When the passage 56 is connected to the suction passage 61 by the left-hand valve port 282, fluid pressure is released from the upper space 47 and the fluid pressure against the space 46 then shifts the valve piston 27 upward from its lowered position to its raised position, bringing the closure 63 into a position to close the release port 55 so that there will be no further outflow of fluid from the space 47 through the passage 56. The raising of the valve piston 27 as described in the foregoing reverses the connections of the bellows 33 and 34 with the pressure and suction passages 23 and 24 of the pump 20. The channel 44 of the piston 27 will now connect the pressure passage 23 with the passage 41 leading to the right-hand bellows 34, and the channel 45 of the valve piston 27 will connect the suction passage 24 with the passage 38 leading to the bellows 33 so that fluid under pressure will be fed into the bellows 34 and fluid will be withdrawn from the bellows 33, and from the passage 272. The left-hand spring 279 will now act to return the left-hand shuttle valve 276 to its lowered position and the left-hand spring 280 will return the left-hand piston 281 to its lowered position. When the right-hand bellows 34 is fully expanded, the pressure increase in the passage 41 will act upon the right-hand control valve structure 270a and operate the same in the same manner as described with relation to the operation of the valve structure 270. The consequent lifting of the right-hand shuttle valve 276 will connect the pressure release passage 51 with the suction passage 61 and pressure will then be released from the space 46 so that the valve piston 27 will be returned to its lowered position, in which it is shown in Fig. 15.

The pressure excess in the passages 38 and 41, over the static pressures existing in the space 275 and in the passage 17, is determined by the strength of the springs 279 and the restraining characteristics of the detent 278. This pressure excess may be readily adjusted by changing the

strength of the springs 290 which urge the detent 278 toward the shuttle valve 276.

I claim as my invention:

1. In a deep well oil pump of the character described, the combination of: a supporting structure adapted to be placed in the well having walls forming a pumping chamber with inlet and outlet ports at the lower end thereof and means for bleeding gas from the upper part of said chamber; inlet and outlet valves for said ports; walls forming a discharge passage extending upward from said outlet valve; means for connecting the upper portion of said passage to a pipe for delivery of pumped fluid; a pumping member in said pumping chamber; and motor driven means operable in the well for intermittently delivering an operating liquid under pressure into and releasing said liquid from said member to expand the same, whereby liquid from the well will enter said pumping chamber through said inlet valve and will be forced from said chamber through said outlet valve.

2. In a deep well oil pump of the character described, the combination of: a supporting structure adapted to be placed in the well having walls forming a pumping chamber with inlet and outlet ports associated therewith, at least said outlet port being disposed at the bottom of said pumping chamber and means for bleeding gas from the upper part of said chamber; inlet and outlet valves for said ports; walls forming a discharge passage extending upward from said outlet port along said pumping chamber to the upper part of said structure; means for connecting the upper portion of said passage to a pipe for delivery of pumped fluid; a pumping member in said pumping chamber; and motor driven means carried by said supporting structure for intermittently delivering an operating liquid under pressure into, and releasing said liquid from said member to expand the same, whereby liquid from the well will enter said pumping chamber through said inlet valve and will be forced out from the lower end of said chamber and through said outlet valve.

3. In a deep well oil pump of the character described, the combination of: a supporting structure adapted to be placed in the well having walls attached to the lower end thereof, said walls forming a vertical elongated pumping chamber with inlet and outlet ports associated therewith, at least said outlet port being disposed at the bottom of said pumping chamber and means for bleeding gas from the upper part of said chamber; inlet and outlet valves for said ports; walls forming a discharge passage extending upward from said outlet port along said pumping chamber to the upper part of said structure; means for connecting the upper portion of said passage to a pipe for delivery of pumped fluid; an expansile-contractile member in said pumping chamber, comprising a tube of flexible material having its lower portion normally collapsed and its upper portion normally expanded, said member being arranged to collapse and expand laterally; and motor driven means carried by said supporting structure for intermittently delivering an operating liquid under pressure into said member to expand the same, whereby fluid which has entered said pumping chamber through said inlet valve will be forced from the lower end of said chamber and through said outlet valve.

4. In a deep well oil pump of the character described, the combination of: a supporting

structure adapted to be placed in the well having walls forming a vertical elongated pumping chamber with inlet and outlet valve ports associated therewith; inlet and outlet valves for said ports; walls forming a discharge passage extending upward from said outlet valve; means for connecting the upper portion of said passage to a pipe for delivery of pumped fluid; an expansile-contractile member in said pumping chamber, comprising a tube of flexible material arranged to collapse and expand laterally and being of such size that when it is expanded its side wall without substantial stretching thereof will engage the side wall of said chamber, said member being so formed that when collapsed it will have a reentrant wall portion along one side thereof and a non-reentrant portion along the opposite side thereof; and motor driven means operable in the well for intermittently delivering an operating fluid under pressure into said member to expand the same, whereby fluid which has entered said pumping chamber through said inlet valve will be forced from said chamber through said outlet valve.

5. In a deep well oil pump of the character described, the combination of: a supporting structure adapted to be placed in the well having walls attached to the lower part of said supporting structure and forming a pumping chamber with inlet and outlet ports at the lower end thereof; inlet and outlet valves for said ports; walls forming a discharge passage extending upward from said outlet; a pumping member in said pumping chamber, said member comprising a tubular wall having a peripheral dimension when deflated substantially equal to the internal peripheral dimension of the pumping chamber and said tubular wall being preformed with the lower portion thereof substantially collapsed and with a convex wall portion along one side thereof and a reentrant wall portion along the opposite side thereof; and motor driven means carried by said supporting structure for intermittently delivering an operating fluid under pressure into said member to expand the same, whereby fluid which has entered said pumping chamber through said inlet valve will be forced from said chamber through said outlet valve.

6. An expansile-contractile member for use in an elongated pumping chamber, comprising: a tubular wall adapted to expand and contract laterally by inflation and deflation, said tubular wall being preformed with a convex portion curved around an axis which extends longitudinally of said tubular wall, and with a reentrant portion lying within said convex portion, said reentrant portion defining a flow channel extending longitudinally of said tubular wall and being adapted to move laterally outwardly in response to fluid pressure applied to the interior of said expansile-contractile member.

7. In a pumping device of the character described, the combination of: a supporting structure having an elongated pumping chamber and valved inlet and outlet ports communicating therewith; an elongated expansile-contractile member in said chamber, said member comprising an elongated tubular member open at its ends and preformed so that when it is collapsed, it will have a reentrant wall portion along one side thereof, said reentrant wall portion extending at least to the far end thereof; means for delivering fluid under pressure into the near end of said tubular member; and means to close the far end of said tubular member comprising a hol-

low member to receive therein the far end portion of said tubular member and an internal filler piece, said end portion of said tubular member being clamped between said filler piece and the wall of said hollow member.

8. In a pumping device of the character described, the combination of: a supporting structure having an elongated pumping chamber and valved inlet and outlet ports communicating with the far end thereof; an elongated expansile-contractile member in said chamber, said member comprising an elongated tubular member open at its ends and preformed so that when it is collapsed, it will have a reentrant wall portion along one side thereof, said reentrant wall portion extending at least to the far end thereof; means for delivering fluid under pressure into the near end of said tubular member; and means to close the far end of said tubular member comprising a hollow member to receive therein the far end portion of said tubular member and an internal filler piece, said end portion of said tubular member being clamped between said filler piece and the wall of said hollow member, said hollow member being so formed with relation to the far end of said pumping chamber as to provide passage for the flow of fluid between the interior of said pumping chamber and said inlet and outlet valve ports.

9. In a pumping device of the character described, the combination of: a supporting structure having an elongated pumping chamber and valved inlet and outlet ports communicating therewith, at least said outlet port being disposed at the far end of said pumping chamber; an elongated expansile-contractile member in said chamber, said member comprising an elongated tubular member open at its ends and preformed so that when it is collapsed, it will have a reentrant wall portion along one side thereof, said reentrant wall portion extending at least to the far end thereof; means for delivering fluid under pressure into the near end of said tubular member; means to close the far end of said tubular member comprising a hollow member to receive therein the far end portion of said tubular member and an internal filler piece, said end portion of said tubular member being clamped between said filler piece and the wall of said hollow member, said hollow member being so formed with relation to the far end of said pumping chamber as to provide a passage for the flow of fluid between the interior of said pumping chamber and at least said outlet port; and guard means for said passage for preventing entry of said tubular member into said passage under pressure built up in said tubular member.

10. In a pumping device of the character described, the combination of: a supporting structure having an elongated pumping chamber and passage means extending from the far end of said pumping chamber; an elongated expansile-contractile member in said chamber, said member comprising an elongated tubular member preformed so that when it is collapsed, it will have a reentrant wall portion along one side thereof, said reentrant wall portion extending at least to the far end thereof; means for delivering fluid under pressure into the near end of said tubular member; means to close the far end of said tubular member; and guard means for preventing said tubular member from being forced into said passage by fluid pressure built up in said tubular member.

11. In a deep well oil pumping device of the character described, the combination of: a supporting structure adapted to be placed in the well having an elongated pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; an elongated tubular member in said chamber comprising flexible material and being adapted to be collapsed and expanded in said chamber to perform a pumping action, said member filling said chamber when it is expanded; means for intermittently delivering operating fluid into said tubular member; a movable guard member at the mouth of said passage controlled by said tubular member to prevent the wall of said tubular member from being forced therinto by fluid pressure in said tubular member.

12. In a pumping device of the character described, the combination of: a supporting structure having an elongated pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; an elongated tubular member in said chamber comprising flexible material and being adapted to be collapsed and expanded in said chamber to perform a pumping action; means for intermittently delivering operating fluid into said tubular member; and guard means for said passage to prevent the wall of said tubular member from being forced therinto by fluid pressure in said tubular member, said guard means comprising a wall to cover the inner end of said passage, said wall being arranged so that it is urged toward open position with relation to the inner end of said passage and is moved into covering relation to the inner end of said passage by expansive movement of tubular member.

13. In a pumping device of the character described, the combination of: a supporting structure having a pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; a pumping member disposed at least in part in said chamber, comprising a wall movable by pressure of an operating fluid to cause said pumping member to perform a pumping action; pump means having a suction duct and an outlet duct; fluid pressure operated valve means for alternately connecting the suction and the outlet of said pump means with said pumping member; means for applying fluid pressure to said valve means to operate the same, comprising means continuously connecting said outlet duct to both ends of said valve means; and spring loaded valve means actuated by said fluid pressure to connect said suction duct alternately to the opposite ends of said valve means, to move said valve means back and forth.

14. In a pumping device of the character described, the combination of: a supporting structure having a pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; a pumping member disposed at least in part in said chamber, comprising a wall movable by pressure of an operating fluid to cause said pumping member to perform a pumping action; an operating fluid pump; valve means for alternately connecting the inlet and the outlet of said operating pump with said pumping member, said valve means being operable by fluid pressure differential applied to opposite pressure receiving walls thereof; means for supplying substantially equal fluid forces simultaneously to both of said pressure receiving walls of said valve

means; and means for alternately releasing the fluid pressure, first from one of said pressure receiving walls and then the other to produce said fluid pressure differential whereby said valve means will be operated comprising a shuttle valve, spring means adjacent the rear face of said shuttle valve, a fluid actuated piston for comprising said spring means to store energy for moving said shuttle valve, and a pressure releasable detent arranged to prevent movement of said shuttle valve until a predetermined force has been applied thereto by said spring means.

15. In a pumping device of the character described, the combination of: a supporting structure having a pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; a pumping member disposed at least in part in said chamber, comprising a wall movable by pressure of an operating fluid to cause said pumping member to perform a pumping action; an operating fluid pump; valve means for alternately connecting the inlet and the outlet of said operating pump with said pumping member, said valve means being operable by fluid pressure applied to a movable wall thereof; walls cooperating with said movable wall to form a chamber to receive fluid under pressure to move said movable wall, said chamber having a pressure port and a release port; means for continuously supplying fluid pressure to said pressure port so that pressure may be built up in said chamber to move said wall in one direction; means operating to move said wall in the other direction; a pressure release valve for said release port; means for intermittently operating said pressure release valve; and a valve operable by said movable wall to control flow of fluid through said release port.

16. In a pumping device of the character described, the combination of: a supporting structure having a pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; a pumping member disposed at least in part in said chamber, comprising a wall movable by pressure of an operating fluid to cause said pumping member to perform a pumping action; an operating fluid pump having an outlet duct and a suction duct; valve means for alternately connecting the inlet and the outlet of said operating pump with said pumping member, said valve means being operable by fluid pressure applied to a movable wall thereof; walls cooperating with said movable wall to form a chamber to receive fluid under pressure to move said movable wall, said chamber having a pressure port and a release port; means for continuously supplying fluid pressure from said outlet duct through said pressure port so that pressure may be built up in said chamber to move said wall in one direction; means operating to move said wall in the other direction; a pressure release valve for connecting said release port with said suction duct; means for intermittently operating said pressure release valve; and means operated by movement of said movable wall to prevent flow of fluid through said release port.

17. In a pumping device of the character described, the combination of: a fluid operated reciprocating pump; a power driven operating fluid pump; a slide valve for controlling the delivery of operating fluid from said operating fluid pump to said reciprocating pump, said valve having a piston member; walls forming

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chambers receiving the ends of said piston member; means for supplying restricted flows of fluid under substantially identical pressures simultaneously to said chambers; and valve means operative to alternately release fluid pressure by suction from said chambers to reciprocate said piston member.

18. In a pumping device of the character described, the combination of: a fluid operated reciprocating pump; a power driven operating fluid pump; a slide valve for controlling the delivery of operating fluid from said operating fluid pump to said reciprocating pump, said valve having a piston member; walls forming pressure chambers receiving the ends of said piston member, said pressure chambers having pressure release passages connected to suction of operating fluid pump; means for supplying restricted flows of fluid under substantially identical pressures simultaneously to said chambers; means for alternately releasing fluid pressure by suction from said chambers to reciprocate said piston member; and valve means operatively connected to said piston for closing said pressure release passages at the ends of the piston strokes.

19. In a pumping device of the character described, the combination of: an elongated structure having at the lower end thereof a cylindric casing divided by a partition wall into a pair of elongated approximately semi-cylindric pumping chambers disposed in side by side relation; valved inlet and outlet ports connected to the lower ends of said pumping chambers; wall means defining a common discharge passage between said chambers and connected to said outlet ports; elongated expansile-contractile members disposed in said pumping chambers; and power operated means carried by said structure for alternately delivering fluid under pressure into the upper ends of said expansile-contractile members to expand the same and force from said chambers through said outlet ports the fluid which has entered through said inlet ports.

20. In a pumping device of the character described, the combination of: an elongated hollow structure having at the upper end thereof an outlet for pumped fluid and at the lower end thereof a cylindric casing divided by a partition wall into a pair of elongated approximately semi-cylindric pumping chambers; wall means defining a common discharge passage between said chambers and connected to said outlet ports; valved inlet and outlet ports connected to the lower ends of said pumping chambers; wall means forming a common discharge duct connecting said valved outlet port and the interior of said hollow structure; elongated expansile-contractile members disposed in said pumping chambers; a sealed operating pump carried within said supporting structure; wall means forming a common discharge duct connecting said valved outlet port and the interior of said hollow structure valve means operative to alternately connect the outlet of said operating pump with the upper end of each of said expansile-contractile members and the inlet of said operating pump with the near end of the other of said expansile-contractile members to alternately expand and contract the same.

21. In a deep well pumping device of the character described, having a pump section at its lower end, and an operating section above said pump section, the combination of: walls forming a pumping chamber in said pump sec-

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tion, valved inlet and outlet ports communicating with the lower end of said pumping chamber, and a discharge passage leading from said outlet port to the upper end of said pumping device; an operating fluid pump in said operating section; an electric motor in said operating section for driving said operating fluid pump; an expansile-contractile member in said pumping chamber; valve means in said operating section for intermittently delivering operating fluid from said pump to the upper end of said expansile-contractile member to expand the same and force from said chamber through said outlet port the fluid which has entered the chamber through said inlet port; and walls forming a protective chamber including said operating section and the parts contained therein for holding a body of fluid surrounding said parts, one of the walls of said chamber being movable where-
by the pressure of fluid externally of said operating section will be transmitted to the fluid in said last named chamber.

22. In a deep well pumping device of the character described, having a pump section at its lower end, and an operating section above said pump section, the combination of: walls forming a pumping chamber in said pump section, valved inlet and outlet ports communicating with the lower end of said pumping chamber, and a discharge passage leading from said outlet port to the upper end of said pumping device; an operating fluid pump in said operating section; an electric motor in said operating section for driving said operating fluid pump; an expansile-contractile member in said pumping chamber; valve means in said operating section for intermittently delivering operating fluid from said pump to the upper end of said expansile-contractile member to expand the same and force from said chamber through said outlet port the fluid which has entered the chamber through said inlet port; and walls forming a protective chamber including said operating section and the parts contained therein for holding a body of protective fluid surrounding said parts, said protective chamber being formed in part by a tubular wall of flexible material, the outer surface of which is exposed to external fluid pressure.

23. In a deep well pumping device of the character described, having a pump section at its lower end, a control section above said pump section and a power section above said control section, the combination of: walls forming a pair of horizontally disposed pumping chambers in said pump section, valved inlet and outlet ports communicating with the lower end of said pumping chambers, and a discharge passage leading from said outlet ports to the upper end of said pumping device; an electric motor in said power section; eccentric means in said power section rotated by said motor; an operating fluid pump in said power section having piston means reciprocated by said eccentric means; pressure relief means connecting the outlet of said fluid pump with said inlet; an expansile-contractile member in each of said pumping chambers; and valve means in said control section for intermittently delivering operating fluid from said pump to the upper end of each one of said expansile-contractile members one at a time to expand the same and force from said chamber through said outlet port the fluid which has entered the chamber through said inlet port.

24. In a deep well pumping device of the character described, having a pump section at its lower end, a control section above said pump section and a power section above said control section, the combination of: walls forming a pumping chamber in said pump section, valved inlet and outlet ports communicating with the lower end of said pumping chamber, and a discharge passage leading from said outlet port to the upper end of said pumping device; a motor driven pump in said power section; pressure and return passages leading downward from said pump into said control section; a fluid meter in said control section having an inlet duct and an outlet duct, one of said ducts being connected to one of said passages of said pump; a valve in said control section operated by said meter; and a contractile-expansile means in said pumping chamber connected alternately to said pressure and return passages by said valve under control of said meter, whereby said contractile-expansile means will perform a pumping action in said pumping chamber.

25. In a pumping device of the character described, the combination of: a supporting structure having walls forming a pumping chamber at the lower end thereof and valved inlet and outlet ports communicating with the pumping chamber; a power means having a rotating output shaft; an eccentric member rotated by said shaft; an arm mounted for circumduction, the outer end of said arm being connected to said eccentric member so as to be circumducted thereby; a lever projecting laterally from said arm; an operating fluid pump having a moving wall arranged to be reciprocated by said lever as said arm is circumducted; an expansile-contractile means in said pumping chamber; and means for intermittently delivering operating fluid under pressure from said pump to said expansile-contractile means to cause the same to perform a pumping action.

26. In a pumping device of the character described, the combination of: a supporting structure having walls forming a pumping chamber at the lower end thereof and valved inlet and outlet ports communicating with the pumping chamber; a power means having a rotating output shaft; an eccentric member rotated by said shaft; an arm mounted for circumduction, the outer end of said arm being connected to said eccentric member so as to be circumducted thereby; levers projecting laterally from said arm; an operating fluid pump having a plurality of chambers each having a moving wall arranged to be reciprocated by one of said levers as said arm is circumducted; an expansile-contractile means in said pumping chamber; and means for intermittently delivering operating fluid under pressure from said pump to said expansile-contractile means to cause the same to perform a pumping action.

27. In an oil well pumping mechanism: a tubular housing arranged to be lowered in an oil well; an electric cable and crude oil discharge pipe connected at one end of said housing; an enclosed electric motor supported in spaced relation to the walls internally of said tubular housing and connected to said cable; an operating fluid circulating pump connected to said motor; fluid passages connected to the inlet and outlet of said fluid pump; a longitudinally divided tube forming two sections having closed ends and connected to said housing, each section provided with intake and discharge ports and a common passageway

for discharge of fluid to be pumped to the interior of said tubular housing; a flexing expansile-contractile crude oil pumping element in each of said sections adapted to be contacted on one side by the fluid to be pumped and on the other side by the operating fluid circulated by said fluid circulating pump; ports and flow passages connecting each of said flexing elements to the fluid passages of said fluid circulating pump; a translatable flow directing mechanism interposed in said fluid passages between the flexing crude oil pumping elements and the fluid circulating pump; and a mechanism to alter the pressure on alternate ends of said translatable elements at alternate times to cause same to move across said fluid flow lines and alter the direction of fluid flow to and from said flexing crude oil pumping elements, to effect a pumping action within said longitudinally divided tube.

28. In an oil well pumping mechanism: a tubular housing arranged to be lowered in an oil well, there being an outlet from said housing for pumped fluid; an electric motor in said housing; an electric cable connected to said housing to supply operating power for said electric motor; an operating fluid circulating pump in said housing operatively connected to said motor; pressure and suction fluid passageways extending from said fluid pump within said housing; a divided oil pumping chamber supported by said tubular housing; a closure in one end of each division; ports through said end for liquid to be pumped; intake and discharge valves controlling said ports; a passageway directing the flow of pumped fluid from said discharge valve to the interior of said tubular housing; a hollow flexible element in each of said pumping chambers progressively expandable from the top downward and progressively contractible from the bottom upward; removable closure means for the other ends of said pumping chamber having ports therein communicating with the interiors of said hollow flexible elements, said flow passageways being connected to said ports; and means for reversing the direction of flow through said passageways to cause said flexible contractible or expandable element to progressively contract or expand by in and or out flow of operating fluid upon operation of said fluid circulating pump.

29. In a well pumping mechanism: a tubular housing arranged to be lowered in a well and adapted to receive and to discharge well fluid; a tube for fluid outlet and an electric power cable for supplying power attached to one end of said housing; a motor in said housing connected to said power cable; an operating fluid circulating pump connected to said motor; a valved pumping chamber suspended from the lower end of said tubular housing having valved inlet and discharge ports at the lower end thereof, passage means connecting said discharge port with the interior of said tubular housing, and containing a flexing contractible and expandable element arranged in said housing to receive the fluid to be pumped on one side and the operating fluid from said operating fluid pump on the other; walls forming a fluid passageway connecting said fluid pump to said element; a fluid passageway in said tubular housing to said fluid outlet tube of same; and a fluid direction valve mechanism operated by the operating fluid and aided by suction for directing the flow to and from one side of the

flexing element in said pumping chamber to effect a pumping action in said chamber.

30. In a double acting oil well pump: a tubular housing arranged to be lowered in a well; a tube for fluid outlet and an electric power cable attached to one end of said housing; valve controlled crude oil pumping chambers supported by said housing, said pumping chambers having crude oil outlets communicating with their lower ends and providing flow passage for fluid to be pumped from said crude oil pumping chambers to the interior of said tubular housing; auxiliary outlet valve means connecting the upper ends of said pumping chambers with the interior of said housing; a pair of flexing elements housed respectively in said pumping chambers and defining therein operating fluid chambers; walls forming fluid flow passageways connecting the operating fluid chambers with an operating means consisting of a body of operating fluid; electrically driven fluid flow means for moving said operating fluid; and a flow directing valve mechanism for said operating fluid supported by said tubular housing having movable parts arranged for directing the flow of operating fluid into and out of said operating fluid chambers to produce a pumping action in said pumping chambers.

31. In a submersible oil well pump mechanism supported in a housing: a tubular member connected to said housing having a valved intake and discharge ports for oil to be pumped; a laterally contractible and expansible element housed in said tubular member; and instrumentalities in said submersible pump housing for flowing operating fluid under controlled pressure in and out of said flexible element to produce a pumping action, said element being so constructed that when subjected to operating fluid flow pressure it will progressively expand beginning at top and advancing downwardly, and when relieved of fluid flow pressure it will collapse progressively upward from its lower part toward the top.

32. In a submersible oil well pump mechanism supported in a housing: a tubular member connected to said housing having at the lower end thereof valved intake and discharge ports for oil to be pumped; a passage for pumped oil leading upward from said discharge port and a second valved discharge port connecting the upper part of said tubular member to said passage; a contractible and expansible element housed in said tubular member; and instrumentalities in said submersible pump housing for flowing operating fluid under controlled pressure in and out of said flexible element to produce a pumping action, said elements being so constructed that when subjected to operating fluid flow pressure it will progressively expand beginning at the top and advancing downwardly, and when relieved of fluid flow pressure it will collapse progressively upward from its lower part toward the top.

33. In a submersible oil well pump mechanism supported in a housing: a tubular member connected to said housing having at the lower end thereof a valved inlet port, a valved discharge port for oil and sand, a passage for pumped oil leading upward from said discharge port and a second valved discharge port for gas connected with the upper part of said tubular member; a contractible and expansible element housed in said tubular member; and instrumentalities in said submersible pump housing for flowing operating fluid under controlled pressure in and out

of said flexible element to produce a pumping action, said elements being so constructed that when subjected to operating fluid flow pressure it will progressively expand beginning at the top and advancing downwardly, and when relieved of fluid flow pressure it will collapse progressively upward from its lower part toward the top.

34. In a submersible oil well pump mechanism supported in a housing: a tubular member connected to said housing having at the lower end thereof a valved inlet port, a valved discharge port for oil and sand, a passage for pumped oil leading upward from said discharge port and a second valved discharge port for gas connecting the upper part of said tubular member to said passage; a contractible and expansible element housed in said tubular member arranged so that its upper end will expand before its lower end; instrumentalities in said submersible pump housing for flowing operating fluid under controlled pressure in and out of said element to produce a pumping action; and means acting in consequence of the expansion of said element to inhibit flow through said second discharge port.

35. In a device for pumping oil from deep wells, a unit adapted to be lowered into a well, comprising: an oil pump; means for operating said oil pump, said means including a motor; power transmitting means for carrying power from said motor to said pump; and walls forming a protective chamber including said operating means and said power transmitting means for holding a body of fluid surrounding said operating and power transmitting means, at least one of the walls of said chamber being movable, whereby the pressure of fluid externally of said chamber will be transmitted to the fluid in said chamber.

36. In a submersible double acting oil well pump: a tubular housing arranged to be lowered into the well, said housing having a crude oil inlet at the bottom and a crude oil outlet at the top for conduction of the crude oil to the surface, and a sealed inlet for a power line; walls forming a pair of horizontally disposed crude oil pump chambers connected to the lower end of said housing; bladders in said chambers; intake and discharge crude oil valves communicating with the lower ends of said pump chambers; walls forming a passageway for crude oil extending upwardly from said discharge valves to the interior of said tubular housing a sealed pump and operating structure in said housing employing fluid seal for its working parts, means for maintaining the fluid at a pressure substantially equal to discharge head pressure, a motor and a high pressure fluid circulating pump driven by said motor means forming a closed circuit and control for the operating fluid circulated by said pump including intake and discharge fluid connections to and from said pump, a sliding piston flow director adapted to be released for operation by pump suction for directing in and out flows of circulating fluid in and out of said bladders, means normally simultaneously maintaining circulating pump pressure on each end of said piston flow director, ports at each end of said piston flow director arranged to be open or closed to the suction of the intake of said fluid circulating pump, spring loaded sliding valve means operative to release the pressure alternately on the opposite ends of said piston flow director to move the same in opposite directions to effect change in direction of fluid flow in and out of said

bladders to produce pumping action in said pump chambers; and means independent of said spring loaded sliding valve, means carried by said piston flow director for closing said ports at the ends of the movement of said piston flow director.

37. In a deep well oil pumping device of the character described adapted to be operated by an operating fluid, the combination of: a supporting structure adapted to be placed in a well having a pressure duct, a suction duct, a pumping chamber and a passage communicating with said chamber for flow of fluid; valve means for said passage; a pumping member disposed at least in part in said chamber, comprising a wall movable by pressure of the operating fluid to cause said pumping member to perform a pumping action; pumping means for moving an operating fluid; reciprocable valve means for alternately connecting said pressure and suction ducts with said pumping member to alternately retract and advance said wall thereof; and valve op-

erating means for operating said reciprocable valve means, comprising spring loaded valve means actuated by the pressure of the operating fluid to connect said suction duct alternately to the opposite ends of said reciprocable valve means to move it back and forth.

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