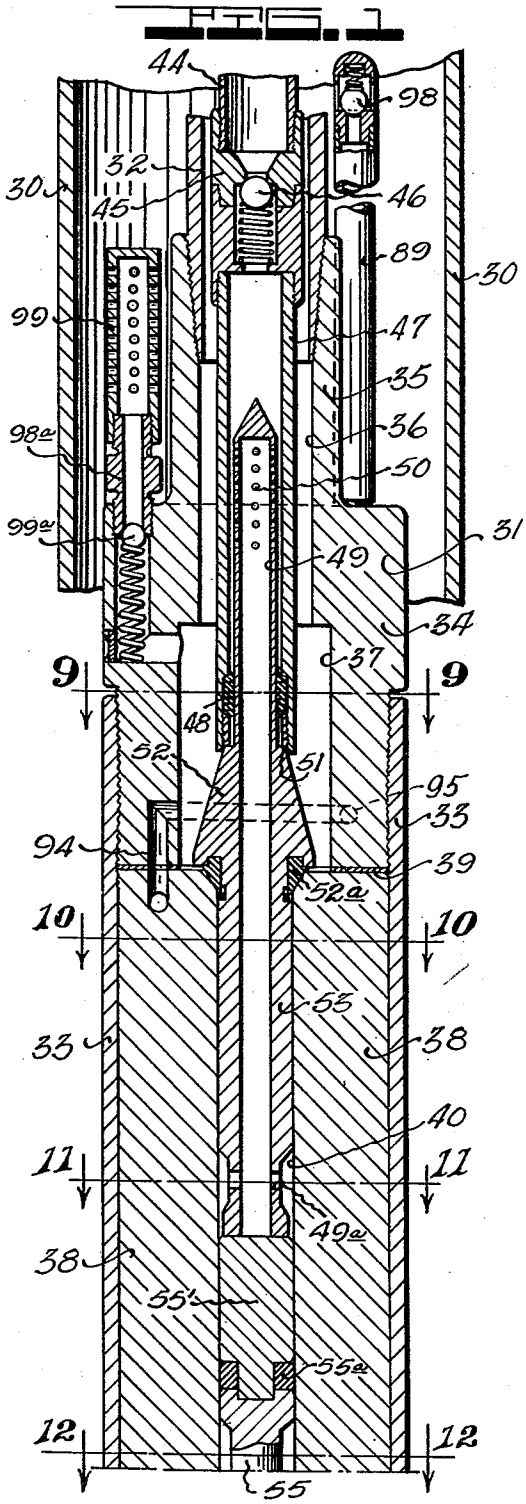
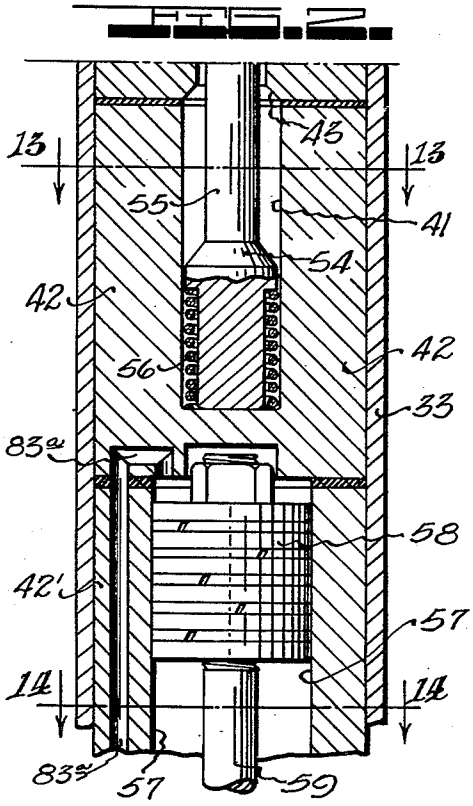
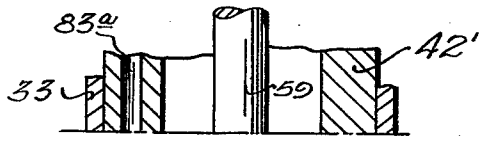
Nov. 9, 1943. R. P. GRAYSON 2,333,857

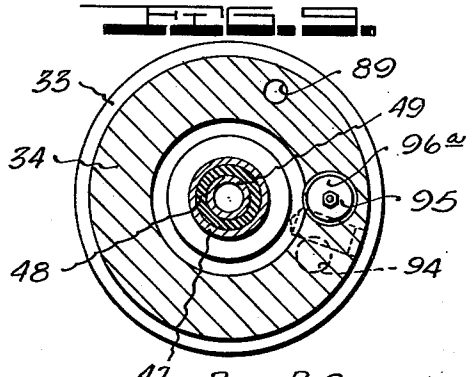
POWER WELL PUMPING UNIT

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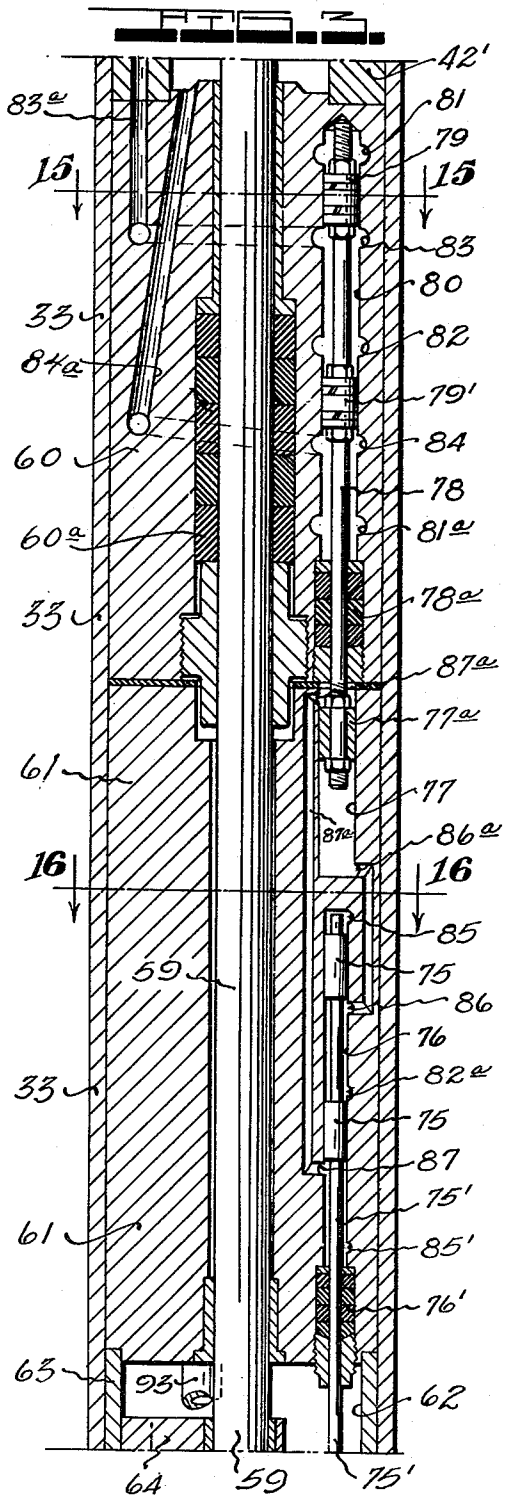
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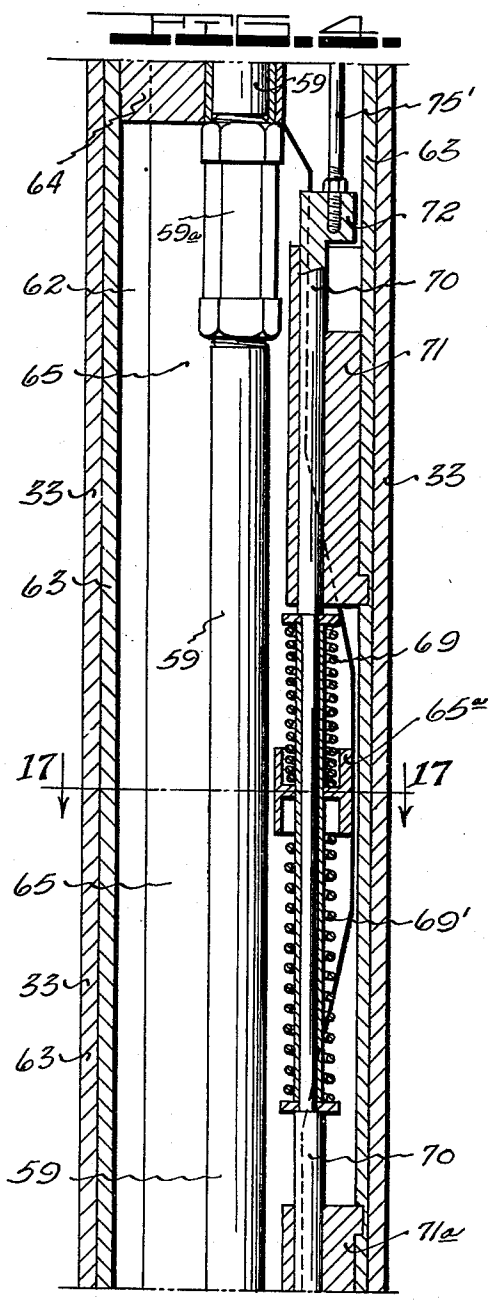
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POWER WELL PUMPING UNIT

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RALPH P. GRAYSON
INVENTOR.

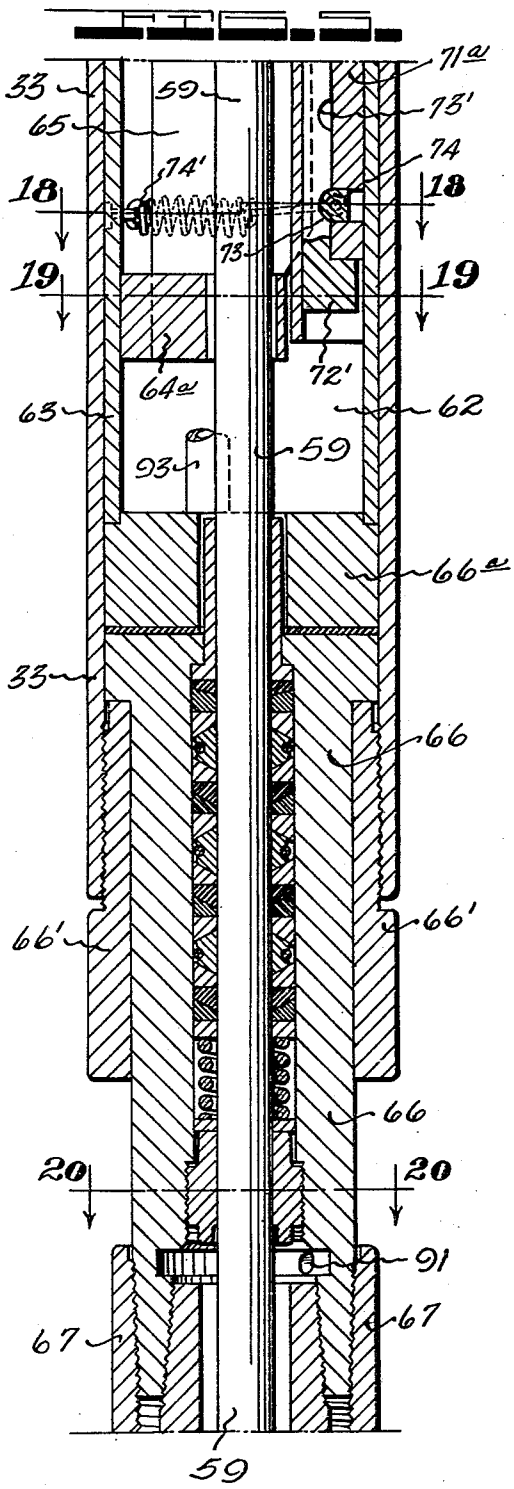
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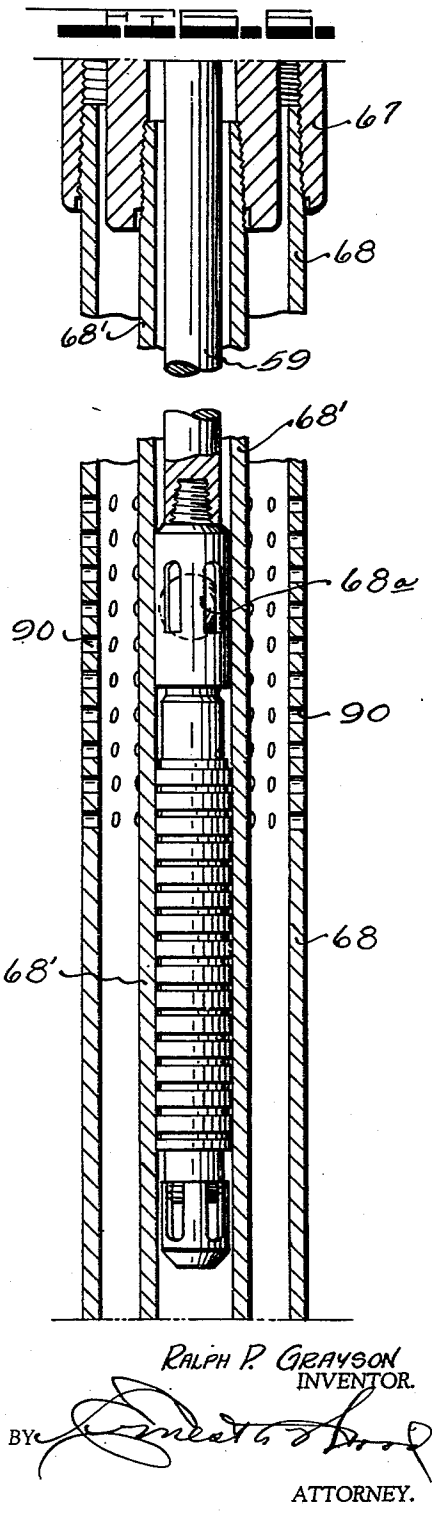
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POWER WELL PUMPING UNIT

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RALPH P. GRAYSON
INVENTOR.

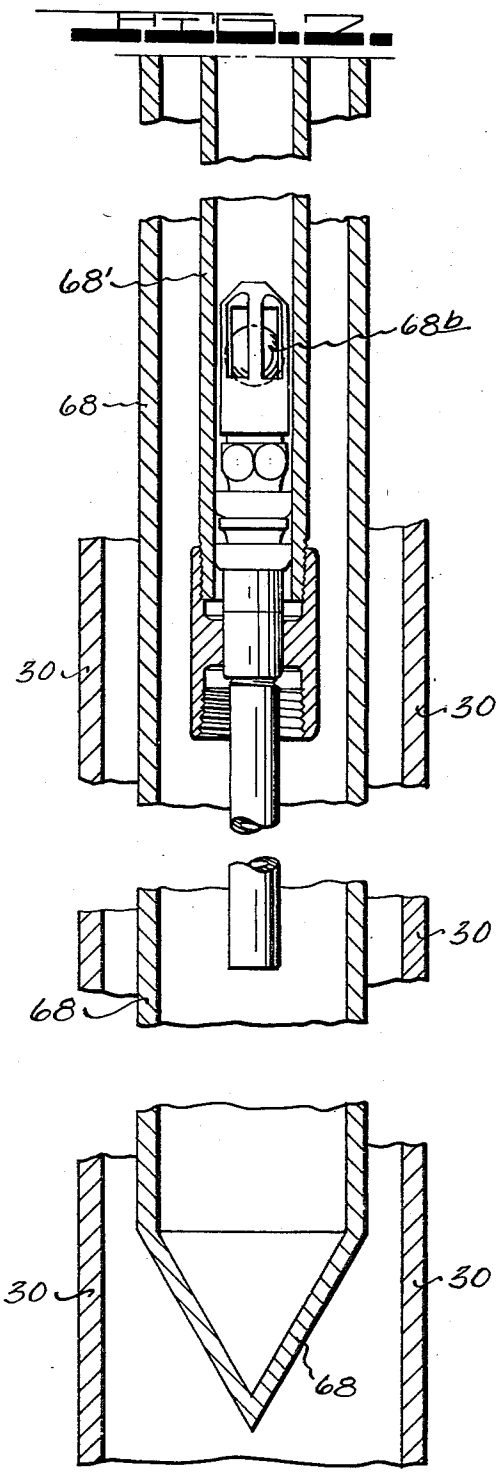
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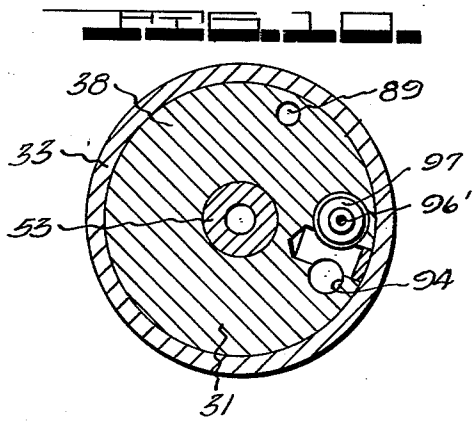
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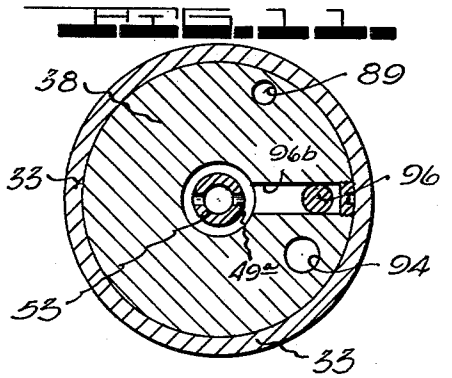
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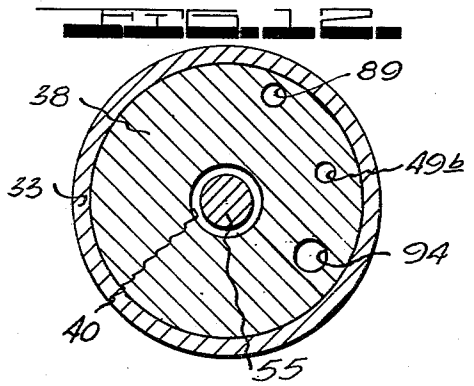
POWER WELL PUMPING UNIT

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RALPH P. GRAYSON
INVENTOR.

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Nov. 9, 1943. R. P. GRAYSON 2,333,857

POWER WELL PUMPING UNIT

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FIG. 5

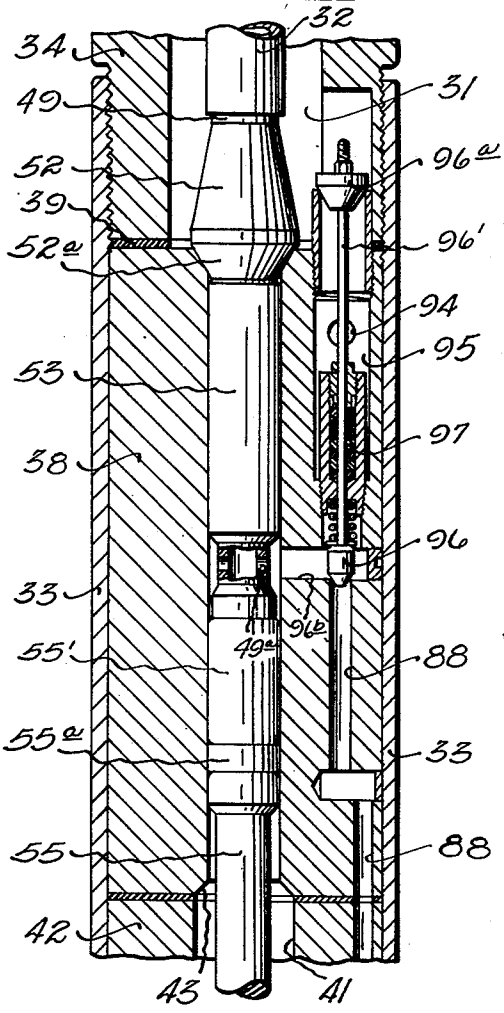


FIG. 14

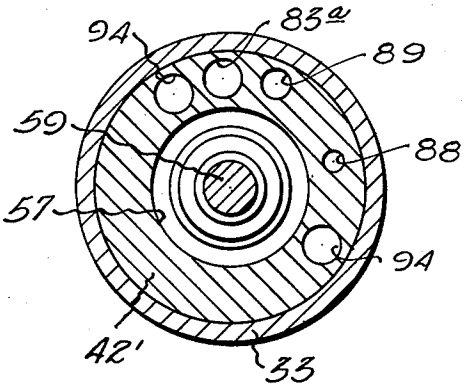


FIG. 15

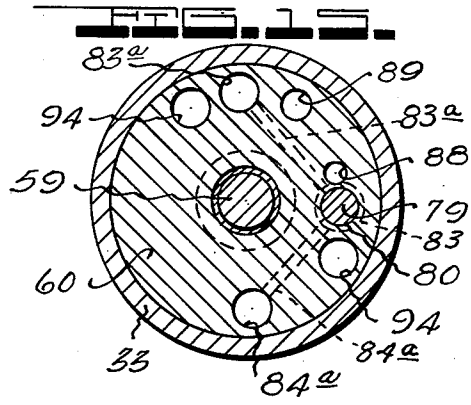


FIG. 16

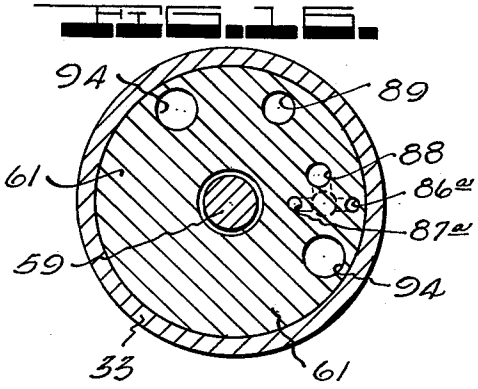
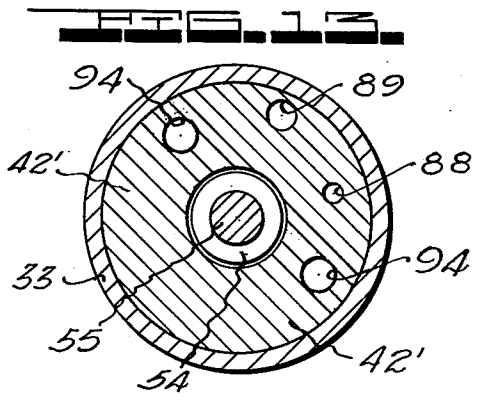


FIG. 13



RALPH P. GRAYSON
INVENTOR.

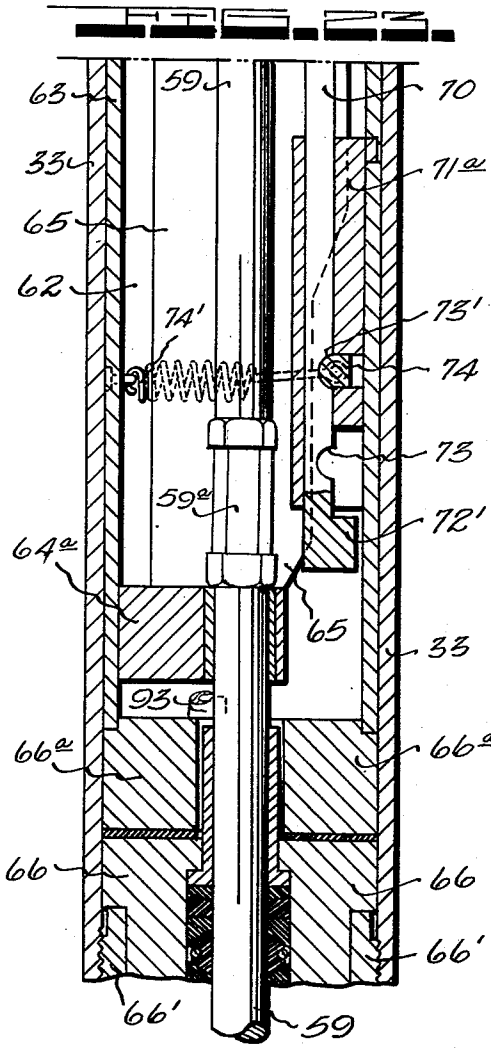
BY Ernest C. Todd

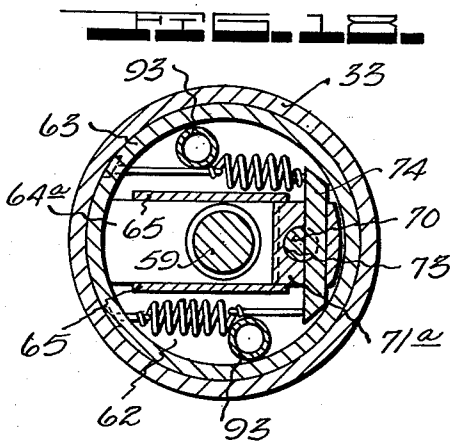
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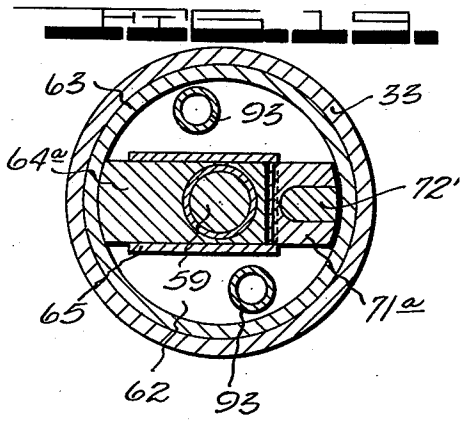
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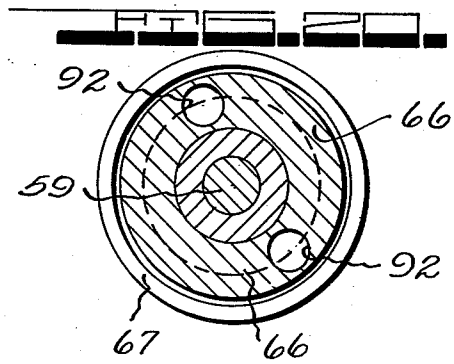
POWER WELL PUMPING UNIT

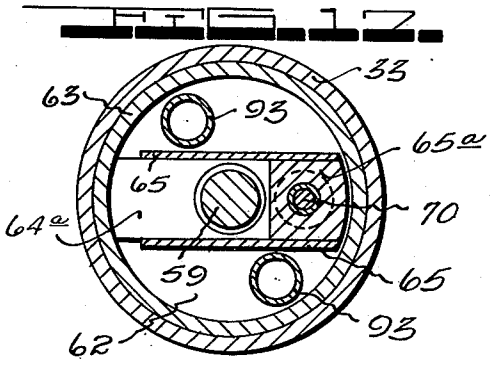
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RALPH P. GRAYSON
INVENTOR.

BY Ernest G. Hood

ATTORNEY.

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POWER WELL PUMPING UNIT

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FIG. 21

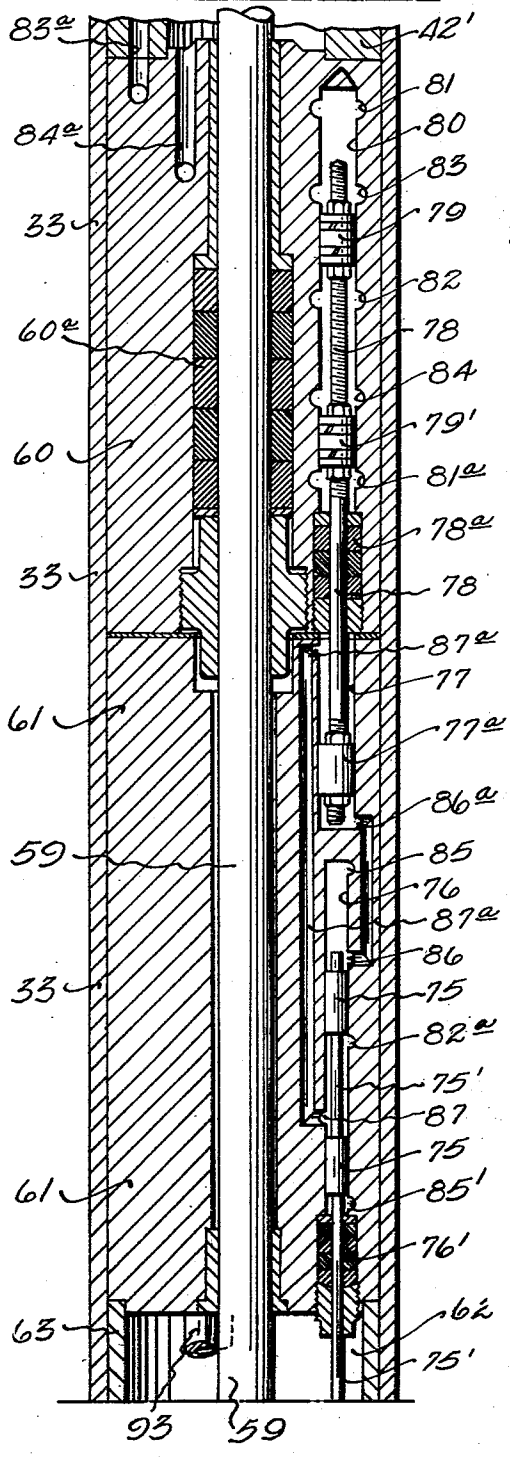
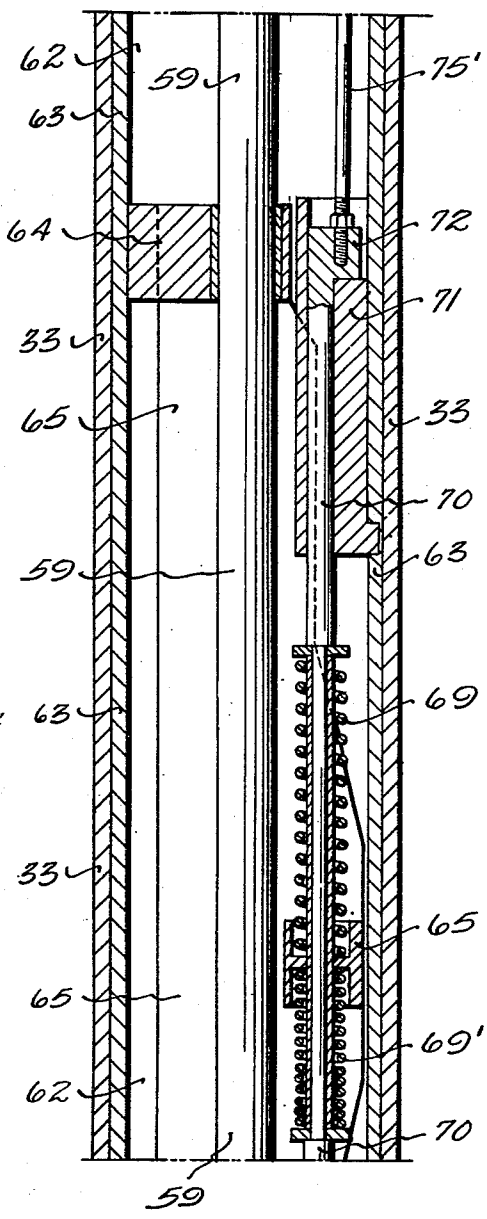


FIG. 22



RALPH P. GRAYSON
INVENTOR.

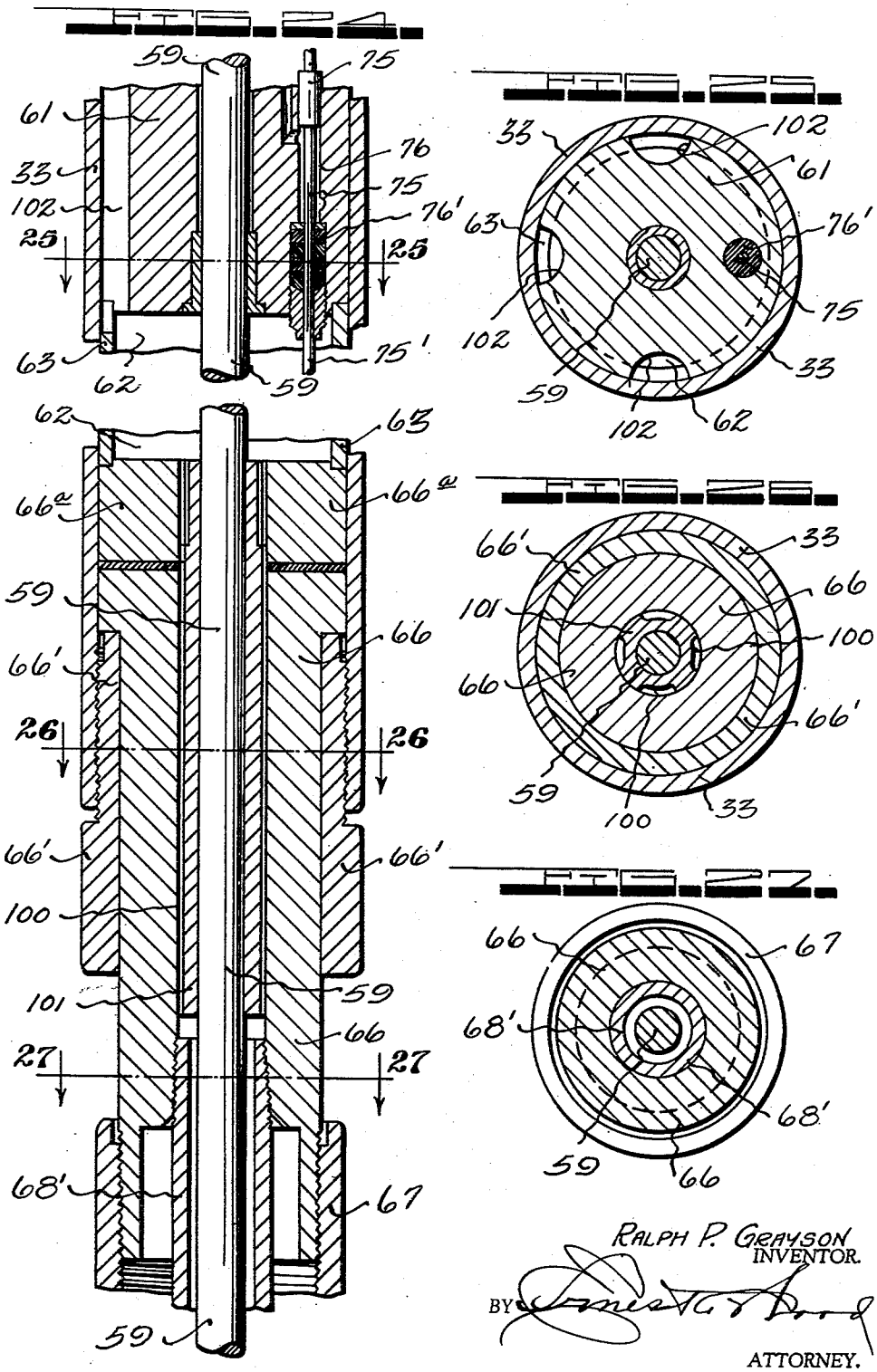
BY

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POWER WELL PUMPING UNIT

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RALPH P. GRAYSON
INVENTOR.

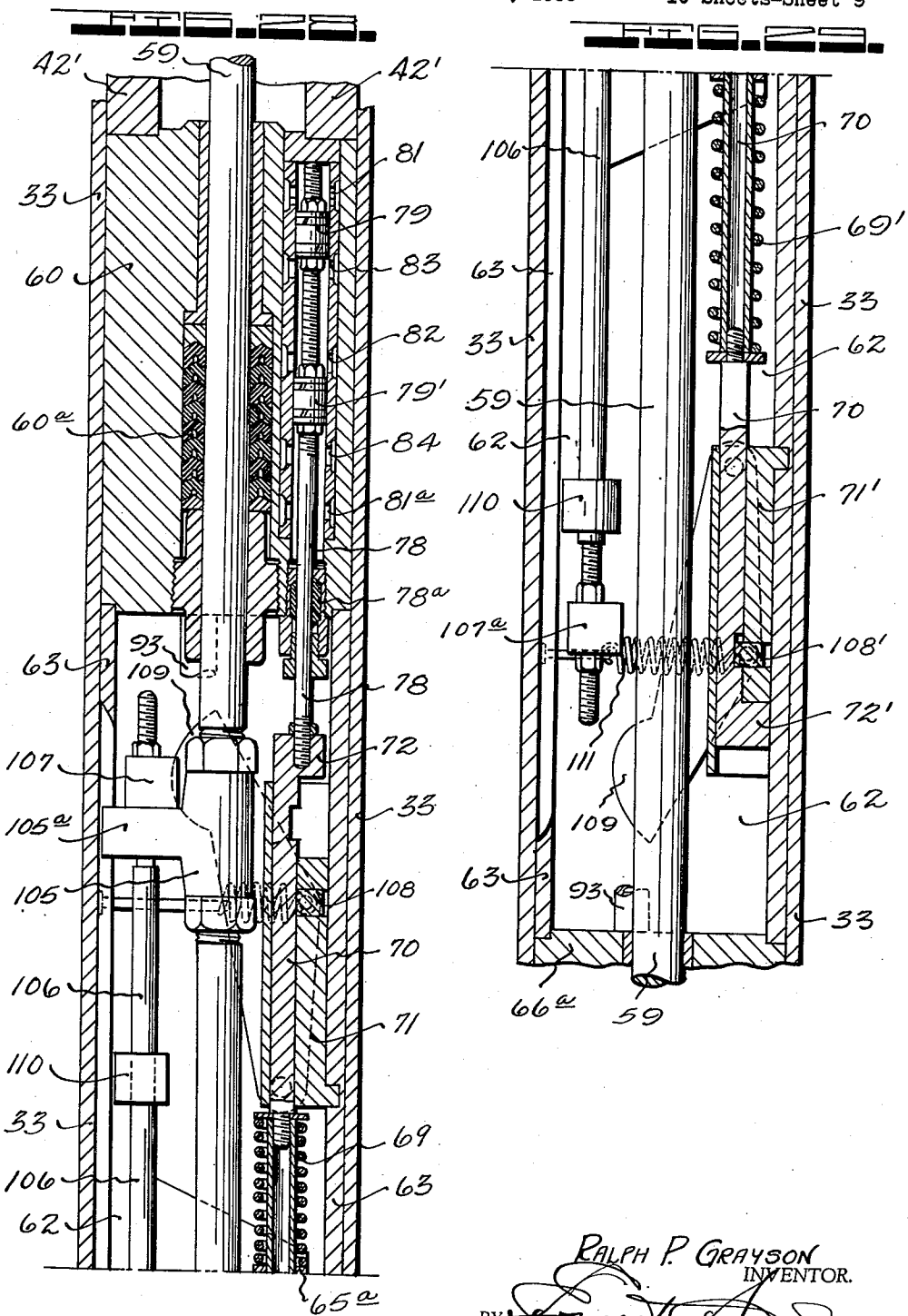
BY James G. Ford

ATTORNEY.

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POWER WELL PUMPING UNIT

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RALPH P. GRAYSON
INVENTOR.

BY Ernest G. Stout

ATTORNEY.

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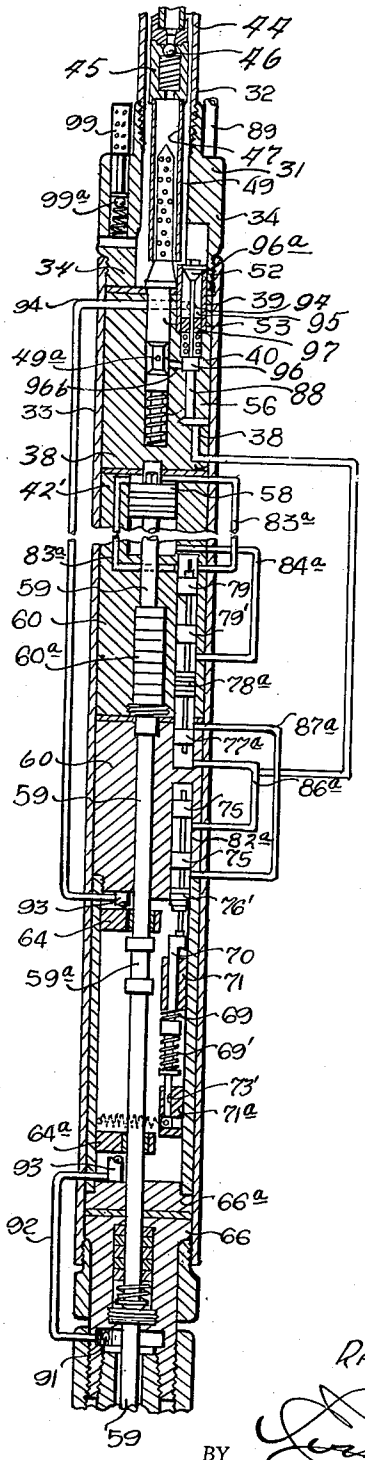


Fig. 30

RALPH P. GRAYSON
INVENTOR.

BY Ernest G. Hood

ATTORNEY

Patented Nov. 9, 1943

2,333,857

UNITED STATES PATENT OFFICE

2,333,857

POWER WELL PUMPING UNIT

Ralph P. Grayson, Brooklyn, N. Y.

Application February 10, 1939, Serial No. 255,658

3 Claims. (Cl. 103—46)

This invention relates to a power producing apparatus and more particularly to an apparatus for lifting well fluids through the medium of gas pressure originating at the surface and applied to operate the movable elements of apparatus in the well.

The principal object of the invention is to provide means functioning as a governor to control the movements of the main piston should the well fluid fall below the intake port of the apparatus, thereby reducing materially the speed of the piston and consequently wear on the parts.

Another object of the invention is to provide an apparatus of this character which will operate in a well of any depth with equal efficiency with "dry" tubing; with no possibility of mixing the operating fluid with the well fluid while the former is applied in operating the apparatus.

Another object of the invention is to provide for introducing the apparatus by means of tubing into a well with means for resisting influx of well fluid into the apparatus above a predetermined point as the latter is lowered into a well inclined to flow, yet without interfering with the rise of the well fluid outside the tool, and which fluid is removed from the well by a lateral connection at the well casing head, under control of a conventional oil saver.

Still another and important object of the invention is to provide means for maintaining a pressure differential between the well fluid and operating fluid to expedite exhaust of operating fluid into the column of oil in which the tool may be submerged. This means is effective in preventing locking or "centering" of the mechanism which would require that the tool be withdrawn and reset for further operation.

Still another object of the invention resides in the ease and readiness by which the parts of the apparatus can be assembled and especially is this feature important of the elements near the top of the assembly which are so related that in preparing the pressure tube for introducing a pressure medium into the tool, necessary manipulations of parts of the tool can be effected without displacing any parts such as packing and the like.

Yet another object of the invention is to afford a trap in which particles of scale or other foreign matter is prevented from entering and thereby clogging the ports or passages through which operating pressure is constrained to pass.

Yet another object of the invention is to provide for introduction into the tool of casing fluid should it be desired to swab the tubing prior to the introduction of the air line, preparatory to operating the apparatus.

Yet another object of the invention is to provide an apparatus of the nature set forth which may readily be adapted to any type of reciprocable well pump.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a transverse vertical sectional view of the extreme upper end of a device constructed in accordance with the present invention.

Figure 2 is a similar view and a continuation in part of Figure 1.

Figures 3, 4, 5, 6 and 7 are views similar to Figure 1 and continuations thereof.

Figure 8 is a detail sectional view of a portion of Figure 1 and taken at right angles thereof.

Figure 9 is a horizontal cross sectional view taken on the line 9—9 of Figure 1.

Figures 10, 11 and 12 are views similar to Figure 9 taken on their respective lines of Figure 1.

Figures 13 and 14 are horizontal cross sectional views taken on the line 13—13 and 14—14 of Figure 2.

Figures 15 and 16 are horizontal cross sectional views taken of their respective lines of Figure 3.

Figure 17 is a horizontal cross sectional view taken on the line 17—17 of Figure 4.

Figures 18, 19 and 20 are horizontal cross sectional views taken on their respective lines of Figure 5.

Figures 21, 22 and 23 are transverse vertical sectional views showing the control valves and trigger mechanism in their lowered positions.

Figure 24 is a transverse vertical sectional view of a slightly modified form of the device.

Figures 25, 26 and 27 are horizontal cross sectional views taken on their respective lines of Figure 24.

Figure 28 is a transverse vertical sectional view of still another modification of the present invention,

Figure 29 is a view similar to Figure 28 and a continuation in part thereof, and

Figure 30 is a schematic diagram of the operating parts of the invention and illustrating the course of operating fluid therethrough.

In the drawings, the numeral 30 designates the usual well casing having the power pumping unit 31 comprising the present invention inserted therein. The usual well tubing 32 extends axially through the casing 30 and has the unit 31 threaded thereon. The pumping unit 31 is comprised primarily of an outer shell or jacket 33 being internally screw threaded at its upper end. An upper member 34 comprising the top of the unit and having the tubing 32 secured thereto is attached to the jacket 33 by means of screw threads. The tubing 32 is secured to an upwardly extending boss 35 on the member 34, said boss having a bore 36 extending therethrough. This bore 36 is enlarged at 37 within the member 34 whereby the fluid being pumped from a well may enter therein as will hereinafter be explained. An elongated cylindrical member 38 is inserted in the jacket 33 and secured therein by the internal screw threads of said jacket, but separated from the member 34 by a suitable gasket 39. An axial bore 40 extends through the member 38 and communicates with an axial passage 41 in a member 42. A seat 43 is formed at the extreme lower end of the bore 40 in the member 38.

A pumping medium such as air or gas under pressure is introduced into the device by means of the usual tubing or "macaroni string" 44. The lower end of the string is connected by means of screw threads to a valve housing 45 having a spring controlled ball valve 46 therein. A second string 47 is suitably secured to the lower end of the valve housing and has a packing medium 48 in its lower end. Disposed within the lower string 47 is an inlet 49 having perforations 50 at its upper end. The string is enlarged at 51 to form a shoulder above a coni-form enlargement 52 integral with the inlet 49. Depending downwardly from the member 52 is a cylindrical inlet tube 53 reduced at its lower end as shown. The lower string 47 is seated at 51 of the enlargement 52 while the packing medium 48 provides a suitable seal whereby the pressure medium has outlet only through the perforations 50 of the member 49. A suitable packing medium 52*a* is provided on the lower end of the coni-form member 52 while the member 53 is in sliding contact with the bore 40. An axial opening extends from the inlet 49 through the members 52 and 53 and finds outlets through radial ports 49*a* provided in the reduced lower end of the member 53. By referring to Figure 11 it will be seen that the ports 49*a* communicate with a radial passage 96*b* which in turn is connected to a high pressure inlet port 88.

A valve member 54 is provided with the passage 41 of the member 42. This valve has an upwardly extending stem 55 which stem cooperates with a member 55', this member 55' having intimate contact with the lower reduced end of the member 53 (Figure 1). A suitable packing medium 55*a* is disposed between the stem 55 and spacer member 55'. A coil spring 56 tends at all times to exert an upward pressure on the valve 54, said valve being capable of contacting the valve seat 43 in the bore 40 of the member 38.

A piston cylinder 57 is provided with a member 42', while a suitable motor piston 58 is disposed therein. The usual pump or "sucker" rod 59 is suitably secured to the piston 58, said rod extending downwardly through members 60 and 61 and thence into an open chamber 62 formed by an internal sleeve 63. It is to be noted that all parts hereinafter described which are disposed within the chamber 62 are operated in oil. That is, the chamber 62 is completely filled with lubricating oil whereby the parts therein are constantly and thoroughly lubricated. This sleeve 63 has an outer diameter but slightly less than the inner diameter of the jacket 33. A suitable stuffing box 60*a* is disposed within the member 60 packing off the pump rod 59. A rod connection 59*a* is disposed immediately below a sliding bearing member 64 while a member 64*a* complementary to the member 64 is disposed within the lower end of the chamber 62.

The members 64 and 64*a* are separated by plates 65 (Figures 4, 5, 18 and 19). These plates are suitably secured to the members 64 and 64*a* by bolts, screws or other suitable means. On the plates 65 and midway between the members 64 and 64*a* is a spring controlled member 65*a* (Figure 17). This member controls the flow of the pressure medium as will hereinafter be explained. The bottom of the chamber 62 is closed by a member 66 cooperating with a member 66*a*. These members are retained in position by a bottom cap member 66', said member being externally threaded to cooperate with internal screw threads in the lower end of the jacket 33. A suitable stuffing box is positioned axially within the member 66.

A connecting collar 67 suitably connects the bottom hole strainer 68 to the device 31. Disposed within the strainer 68 is a working barrel 68' having the usual travelling valve 68*a* and standing valve 68*b*, suitably positioned therein.

In operation as the rod 59 moves downwardly under pressure, the rod connector 59*a* will strike the member 64*a* immediately prior to the completion of a predetermined stroke of the pump. The action of the connector 59*a* striking the member 64*a* will transmit a downward motion of the plates 65. The spring controlling member 65*a*, being connected to the plates 65, will move downwardly therewith. This movement of the member will release compression of a coil spring 69 and compress a second coil spring 69'.

By observing Figure 4, it may be seen that as the spring 69' is compressed, a downward pressure will be brought to bear upon a member 70. This member 70 is slidingly mounted in an upper bearing 71 and a lower bearing 71*a* and is provided with outwardly extending stops 72 and 72' formed integral therewith.

Provided immediately above the stop 72' are semi-circular cut-outs 73 and 73'. By observing Figure 5, it will be seen that a latch 74 controlled by a spring 74' is engaged within the lower notch 73.

The downward movement of the plates 65, members 64 and 64*a*, and 65*a* will exert a downward pressure on the member 70 through the medium of the spring 69'. This downward pressure will become sufficient to release the latch 74 against tension of the spring 74' thereby permitting movement of the member 70. This downward movement is continued until such time as the latch will engage in the upper notch 73' thereby stopping the downward movement.

A piston rod 75' being suitably connected with double plug pistons 75 is connected to the upper stop 72 of the member 70. The pistons 75 are in sliding contact with a bore 76 formed in the lower end of the member 61 and suitably packed off therein by a stuffing box 76'. Downward movement of the member 70, as has hereinbefore been explained, will of course change the posi-

tions of the pistons 75 due to the connection 75' with the member 70.

Disposed immediately above and in axial alinement with the bore 76 is a second bore 77. A plug piston 77a is disposed within the bore 77 of the member 61 and has an upwardly extending piston rod 78 connected to a double set of pistons 79 and 79' disposed within a cylinder bore 80 provided in the member 60. Exhaust ports 81 and 81a are provided at the upper and lower ends of the bore 80. The bores 80 and 77 are suitably separated by a stuffing box 78a. High pressure fluid is introduced into a central port 82 communicating with the bore 80 and from suitable ports and passages hereinafter described. Upper ports 83 are disposed between the exhaust port 81 and the high pressure inlet port 82. This port 83 communicates with a port 83a which port further communicates with the upper end of the piston cylinder 57. A lower port 84 similar to the port 83 is disposed between the high pressure inlet port 82 and the lower exhaust port 81a. This port 84 communicates with a port 84a which in turn has its outlet in the lower end of the cylinder piston 57. A second high pressure inlet port 82a is disposed within the cylinder 76. Upper and lower exhaust ports 85 and 85' communicate with the upper and lower ends of cylinder 76. A port 86 communicates with a port 86a disposed within the lower end of the cylinder bore 77. A port 87 similar to the port 86 communicates with a port 87a having its outlet in the upper end of the cylinder bore 77.

Thus it may be seen that the high pressure inlet ports 82 and 82a communicate with a common high pressure inlet port 88. Thus as air is introduced into the inlet 49 and reaches the ports 49a, said air will pass into the common port 88 extending downwardly through the members 34, 38, 42, 60 and 61, respectively. In its passage through the member 60 the port 82 is connected therewith, and at the termination of the port 88 in the member 61, the port 82a is connected therewith.

By referring to Figures 2, 3 and 4, it will be seen that in the position shown the piston 58 is in its raised position as is the travelling valve 68a. The passage of air in this position is from the port 82 to the port 83, thence to the vertical passage 83a communicating with the upper end of the cylinder bore 57. Thus, the pressure will be exerted against the upper side of the piston 58 forcing the same downwardly. As has been explained, downward movement of the piston 58, piston rod 59 and rod connection 59a will lower the plates 65 to change the position of the member 70. As this change occurs the plug pistons 75 are lowered to the position shown in Figure 21. Due to the lowering of the member 70 these pistons have been lowered by the connection 75' to close off the port 86 from the high pressure port 82a. Simultaneously, the lower piston 75 has opened the port 87 communicating with the port 87a having outlet near the upper end of the cylinder bore 77.

Thus, the high pressure flow is from the port 82a to the port 87 through a communicating passage to the port 87a thereby exerting its pressure on the upper side of the cylinder 77a forcing the same downwardly. Pressure that had been built up below the piston 77a is returned through the port 86a and 86 to the cylinder bore 76, then from the cylinder bore 76 out through an upper exhaust 85 which communicates with a common exhaust passage 89.

As the piston 77a is forced downwardly, the position of the double piston 79 and 79' will be changed to the position shown in Figure 21. Thus it will be seen that the passage of the high pressure medium from the port 82 has been changed to find outlet in the port 84 which port, as has been stated, communicates with the passage 84a having outlet in the lower end of cylinder chamber 57, thereby exerting pressure on the bottom side of the cylinder tending to raise the same. The pressure that had been built up within the cylinder bore 57 is released through the passage 83a to the port 83 into the cylinder bore 80, thence from the cylinder bore 80 to the upper exhaust port 81 communicating with the common exhaust 89.

From the foregoing it will be seen that the plate 65 and members 64, 64a and 65a in combination with the member 70 and springs 69 and 69' may be referred to as a trigger mechanism. This trigger mechanism serves to actuate the pistons 75 within the cylinder 76 thereby adjusting the pistons 79 and 79' in the cylinder 80 through the medium of the piston 77a in the cylinder 77. Thus, with the pistons 75 in the position shown in Figure 3, pressure is forcing the piston 58 downwardly thereby producing the down stroke of the pump. As has been explained, at the downward stroke of the pump, the direction of the pressure medium is changed whereby pressure is exerted to the under side of the piston 58 raising the same thereby producing the upward stroke of the pump.

As the pump is actuated, as has been hereinbefore explained, fluid will enter the strainer 68 through perforations 90 provided in the wall of the strainer, thence upwardly through the standing valve 68b, past the travelling valve 68a, upwardly to ports 91 provided in the lower end of the member 66, said ports communicating with vertical fluid passages 92 (Figure 20) provided in the members 66 and 66a. The passages 92 communicate with vertical tubes 93 (Figures 17, 18 and 19). These tubes communicate with vertical fluid passages 94 provided in the members 61, 60, 42 and 38, respectively (Figures 9, 10, 11, 12, 13, 14, 15 and 16), the passages 94 communicating with a governor mechanism 95 provided in the members 38 and 34. The tubes 93 extend the complete vertical length of the chamber 62, whereby the well fluid is kept separate from the lubricating oil within the chamber 62. That is, the tubes provide the passage means through the lubricating oil within the chamber 62.

The governor 95 comprises a metering valve 96 at its lower end and a fluid outlet valve 96a at its upper end, and two valves being connected by a common valve stem 96'.

A stuffing box 97 suitably separates the valves 96 and 96a. By observing Figure 8 it will be seen that as the pressure medium passes from the inlet 49 out through ports 49a, this pressure medium will enter a passage 96b, passing the metering valve 96 and into the common high pressure inlet passage 88. It is to be noted that the valve 96 is never completely seated whereby as long as the compressor (not shown) is operating the pressure medium is actuating the piston 58 at all times. At such time as a sufficient amount of fluid passes from the fluid passages 94 into the governor 95, this fluid will raise the valve 96a as well as the metering valve 96, thereby allowing a greater amount of pressure medium to enter into the high pressure inlet port 88. From the foregoing, it may be seen that in the event no

fluid is being pumped the amount of pressure input is decreased by the action of the valve **96** but is not completely cut off. The provision of the governor **95** eliminates any possibility of the pump "slapping" or "banging" due to a greatly decreased load. The pump, as has been stated, will be actuated so long as a compressor (not shown) is introducing a pressure medium and as the volume of fluid being pumped is increased so will the pressure input increase.

By observing Figure 1, it will be seen that an exhaust valve **98** is provided. This valve communicates with the common exhaust outlet **89** hereinbefore described. The provision of this valve enables the exhaust of the pressure medium to enter the well casing around the tubing but in the event a fluid level of the well stands above the top of the exhaust valve **98**, this valve will prohibit passage of that fluid into the pressure lines of the device.

In the event that the user of the device desires to run what is known as a "dry string," he would then desire to set a packer (not shown) in the well casing **30** and "swab out" the casing above the packer. For accomplishing this a valve **98***a* is provided. A strainer **99** is suitably secured to the upper end of the valve **98***a* while spring actuated ball and seat **99***a* are disposed below the valve **98***a*. Thus, by observing Figure 1 it will be seen that on the up stroke of the "swab" (not shown) within the tubing **32** a vacuum is created to unseat the ball **99***a* thereby allowing fluid standing within the well casing **30** to enter through the strainer **99**, valve **99***a* and into the bore **37** and upwardly through the tube **32**.

In Figures 24 to 27 a slightly modified form of the invention is shown. In this form of the invention the tubes **93** provided within the chamber **62** are eliminated as is the lubricating oil within that chamber. The working barrel **68'** is connected directly to the member **66**. The rod **59** is actuated in the same manner as the hereinbefore described device. As fluid passes up the working barrel it enters ports **100** provided in the outer periphery of a bushing **101** surrounding the pump rod **59** and supporting the same the vertical length of the members **66** and **66***a*. The well fluid then enters the chamber **62** thereby lubricating the mechanisms within that chamber hereinbefore described. Peripheral grooves **102** are provided in the member **61**, which member is disposed immediately above the chamber **62** closing the same.

Thus, it will be seen that the provision of many ports through the members **61**, **66***a* and **66** are eliminated as well as the tubing within the chamber **62**. This form may be used only in comparatively clean wells in which only a small amount of dirt or grit is found whereas if a well containing a large amount of sand in the fluid were operated in this manner, the damage to the moving parts within the chamber **62** by the gritty fluid would make this form impractical.

In Figures 28 and 29 still another form of the invention is shown. In this form the eccentric valve mechanism including the piston **75** is eliminated as well as the actuating piston **77***a* with its accompanying cylinder bore **77**. The structure of the pump actuating piston with its accompanying valve including the piston **79** and **79'** is retained throughout. The piston rod **78** is extended downwardly to be secured to the top of the stop **72** in lieu of the control valve rod **75'**. In this form a pump rod connector **105** is substituted for the connector **59***a*, this connector having an outwardly extending boss or lug **105***a* formed integral therewith. The rod connector serving to perform the same operation as the members **64**, **64***a* and rod connector **59***a* described in the first form in conjunction with a vertical rod **106**. An upper cross arm **107**, secured to the upper end of the rod **106**, substitutes for the member **64** while a lower cross arm **107***a* similarly secured to the vertical rod, substitutes for the member **64***a*. The vertical rods **106** displace the plates **65**.

In this form upper and lower latches **108** and **108'** respectively, are substituted for the single lower latch **74**. It will be noted that the latches **108** and **108'** are rectangular in shape, it therefore being necessary to employ cams **109** pivotally secured to the latches whereby the members **107** or **107***a* may unseat the latches **108** or **108'** depending on the course of travel of the rod connector **105**. Suitable bearings **110** serve to guide the rod **106** in its vertical movement.

The operation of this form is identical with those hereinbefore described except for the fact that the pump piston control valve **79** and **79'** are actuated directly through the medium of the springs **69'** and **69**. Thus as the connector **105** travels downwardly just prior to the termination of its stroke, the boss **105***a* will cause a downward movement of the rod **106** and its accompanying upper and lower cross arms. The cross arm **107***a* will strike the lower cam **109** thereby releasing the latch **108'** from its retaining notch thereby allowing the compressed spring **69** to force the member **70** downwardly. Downward movement of the member **70** is continued until such time as the upper latch **108** falls into its accompanying groove thereby stopping the movement of the member **70** and simultaneously changing the course of the pressure medium in cooperation with the pistons **79** and **79'**. It is to be noted that the latches **108** and **108'** are controlled by coil springs **111**.

From the foregoing it will be seen that the structure hereinbefore described will handle any desirable amount of well fluid being pumped.

Manifestly, the construction as shown and described is capable of some modification and such modification as may be construed within the scope and meaning of the appended claims is also considered to be within the spirit and intent of the invention.

What is claimed is:

1. A fluid operated well pump including in combination with a string of tubing, a body comprised of axially aligned sections arranged to be suspended by said tubing below the fluid level in a well, a cylinder in said body, a main piston in said cylinder, a main piston rod, a working barrel, a standing valve therein, a travelling valve reciprocated by said piston in said working barrel, a pair of elongated, axially aligned chambers disposed in said body in parallel relation to said cylinder communicating one with the other and with said cylinder, a pair of valves in one of said chambers spaced apart on a common stem, a high pressure fluid passage through said body communicating with said latter chamber to admit fluid pressure for actuating said valves to thereby control the introduction of fluid pressure into said cylinder, a pair of plug pistons in the other of said axially aligned chambers, a common piston rod therefor, means carried jointly by said latter piston rod and said main piston rod for controlling the movements of said plug pistons to thereby control the fluid pressure actuating said

valves and to determine the extent of travel of said main piston, means for exhausting operating fluid pressure above said body, means through said body effecting passage of well fluid upwardly therethrough in a course separate from said high pressure fluid and valve means responsive to the pressure of the well fluid discharged by the pump for restricting the inflow of high pressure fluid in accordance with changes in well fluid pressure.

2. A fluid operated well pump including in combination with a tubing string, a body suspended thereby below the fluid level in a well, a working barrel, a standing valve therein, a travelling valve in said working barrel, a fluid passage for conveying well fluid from said working barrel through said body to the surface, a cylinder in said body, a piston therein, a piston rod connecting said piston and said travelling valve, a pair of intercommunicating and elongated chambers connected to and parallel with said cylinder, valves in said chambers, means for introducing a surface pressure medium into said body separate from said well fluid, spring means controlled by said piston for actuating one of said valves to admit said pressure medium to one of said chambers to actuate the valve therein and to thereby introduce said pressure medium into said cylinder to actuate said piston, said spring means also effective to limit the travel of said piston, means for exhausting said pressure medium from said body, and means responsive to the pressure of the well fluid discharged by the pump to control the reciprocating speed of said piston in accordance with the varying pressures of said well fluid.

3. A fluid operated well pump including in combination with a tubing string, a body comprised of axially alined sections suspended by said tubing string below the fluid level in a well, a main cylinder in said body, a piston therein, a working barrel depending from said body, a standing valve therein, a travelling valve operated by said piston in said working barrel, means for introducing a surface fluid pressure medium into said body, said body having chambers therein parallel to said main cylinder and having communication with each other and with said main cylinder, valves in said chambers, means under constant spring tension operative to actuate one of said valves to admit fluid under pressure to an adjacent chamber to actuate the valve therein and to operate said piston by introduction of fluid pressure into said main cylinder, said spring tensioned means and said valves being also effective to limit the travel of said piston, a fluid pressure exhaust, means for conveying well fluid from said working barrel, through said body to the surface in a course separate from the operating fluid pressure and means responsive to the pressure of the well fluid discharged by the pump to govern the reciprocating speed of said piston.

RALPH P. GRAYSON.