Feb. 7, 1933. R. P. SIMMONS 1,896,108

WELL PUMPING APPARATUS

Filed Oct. 23, 1929 2 Sheets-Sheet 1

Fig. 1

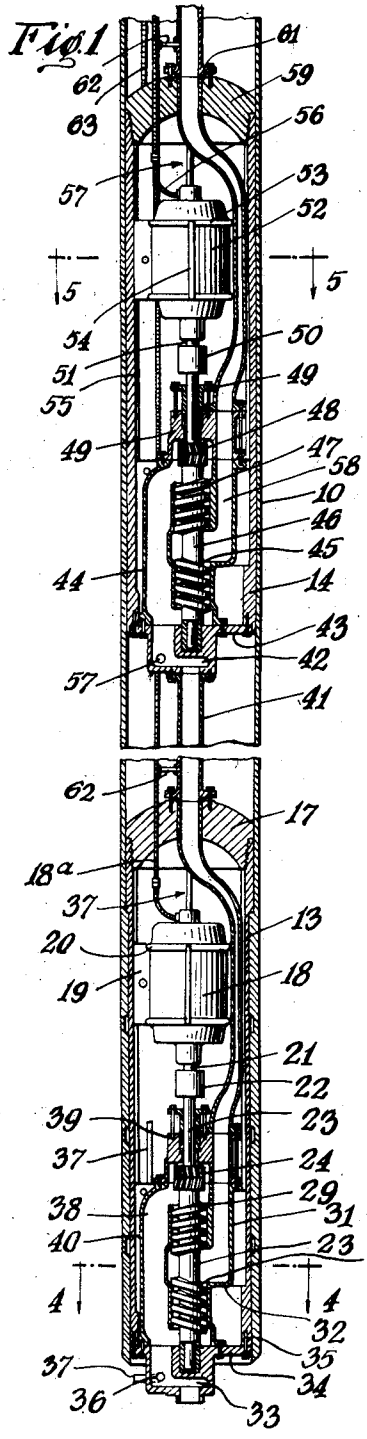


Fig. 2

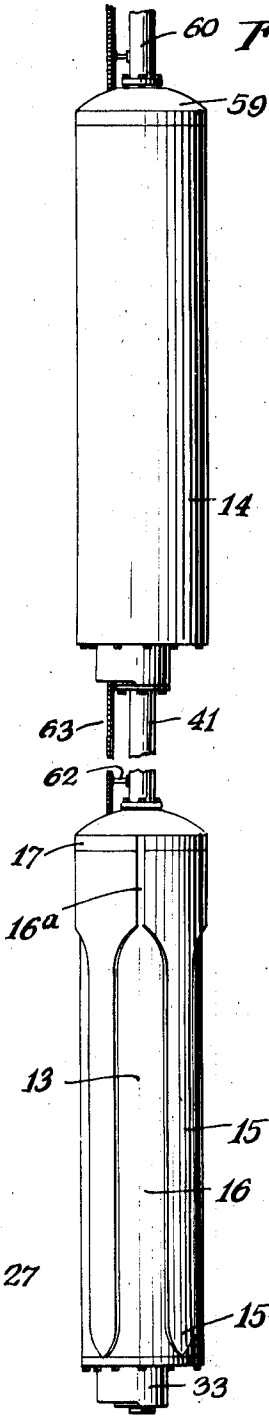
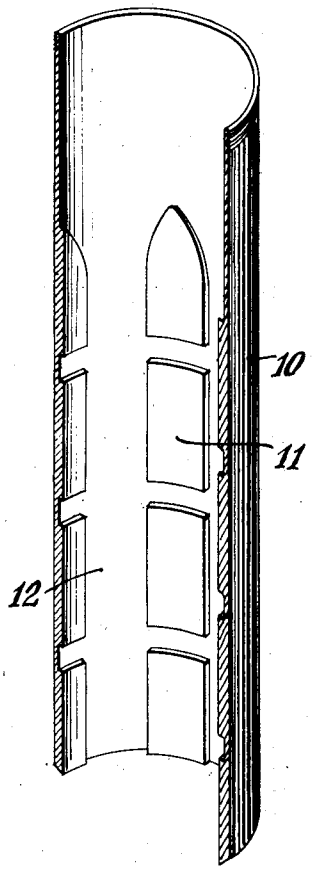


Fig. 3



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Filed Oct. 23, 1929 2 Sheets-Sheet 2

Fig. 7

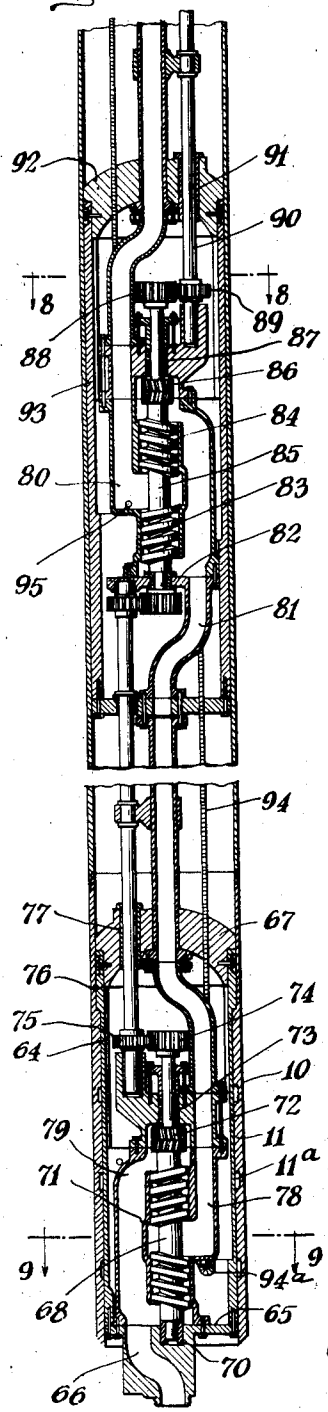


Fig. 4

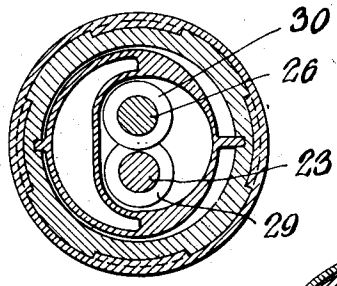


Fig. 5

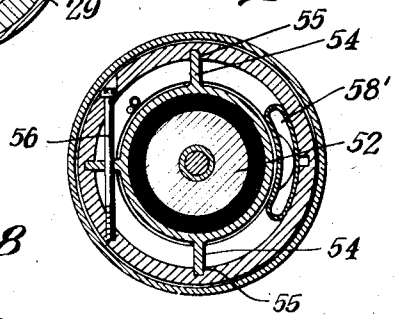


Fig. 8

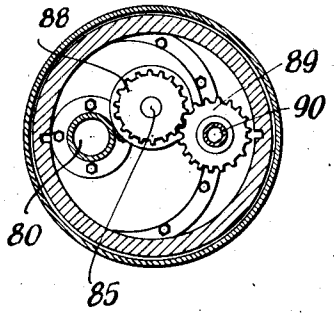


Fig. 6

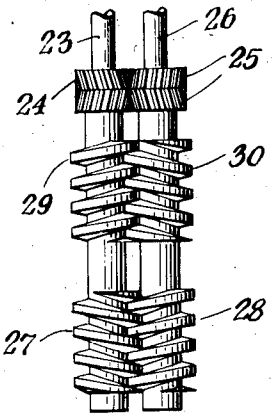
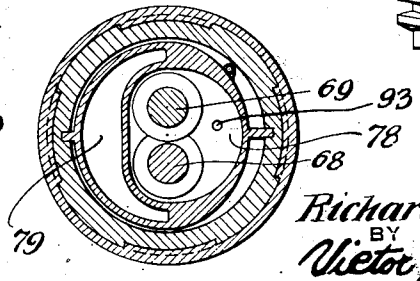


Fig. 9



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UNITED STATES PATENT OFFICE

RICHARD P. SIMMONS, OF LAURELTON, LONG ISLAND, NEW YORK

WELL PUMPING APPARATUS

Application filed October 23, 1929. Serial No. 401,926.

This invention relates to an improved system for pumping oil from natural oil reservoirs, through an oil well whose natural pressure has become insufficient to lift the oil to the head of the well.

The prevailing practice in pumping oil wells which have ceased to discharge by their own natural pressure, is to withdraw the oil by a pumping unit operated by a line of coupled sucker rod sections. This pumping unit employs a piston whose diameter is less than three inches. Due to the methods of drilling now depended on a larger pumping unit at the bottom of the oil cannot be employed. The sucker rods which operate this relatively small piston pump are approximately three quarters of an inch in diameter, and must be repeatedly raised and lowered, in order to operate the pump piston. Due to the great difficulty of drilling straight holes or wells, it is found that the majority of oil wells are inclined from the vertical as much as forty-five per cent. at the maximum, and five per cent. at the minimum. In raising and lowering the sucker rod line through wells which are crooked the drag of the sucker rods against the wall of the well is materially increased, and experience establishes that eighty-five per cent. of such sucker rods break, with the result that the oil out of pumped wells ceases until the sucker rod line is restored to working condition.

Deep oil wells extend from 4,000 to 6,000 feet or more from the ground to the surface of the natural oil and gas reservoir. The total weight of the sucker rod line running through wells of such depths is enormous. Each time this sucker rod line is lowered the momentum developed by the downwardly moving mass has to be overcome when the motion of the sucker rod line is reversed, to cause the pump piston to make an upward stroke, in an oil lifting direction.

A progressive elongation of the sucker rods naturally takes place, as a result of the forces developed, and ultimately breakage takes place.

In drilling standard oil wells it is conceded at the present time to be impracticable to drill the well with the same diameter at the bottom, as at the top. As the depth of the well is increased it is found that the density of the ground also increases, so that the displacement and removal of the material, by any used method of drilling, becomes more difficult.

The practice consists, therefore, of drilling the oil well to a depth of about 1,100 feet to receive the 20 inch well casing, which is placed in position to support the wall of the well against collapse and to assist in excluding the seepage waters. The well is then deepened to 4,300 feet, while the well casing of this total length is placed, progressively, within the 20 inch well casing. This second line of well casing is about 13½ inches in diameter. The well is again deepened to receive a well casing 9 inches in diameter, and approximately 6,000 feet in length. The well is again deepened to receive a well casing 6½ inches in diameter, and approximately 6,000 feet of this is placed within the 9 inch casing. Within this last line of 6½ inch well casing a line of 3 inch tubing is placed, having a total length of approximately 6,300 feet, which extends from the head of the well to the bottom of the well, within the 6½ inch diameter well casing.

In the final 3 inch tubing is installed the piston pumping unit. This unit includes a pump cylinder of its own, and a piston reciprocates within this cylinder. This necessitates a reduction of the diameter available for the pump piston, to about 2½ inches when this piston is reciprocated by sucker rods only ¾ inch in diameter, the work done is forcing a column of oil to flow upward through the 3 inch tubing.

Each time the piston is pulled upward, it must overcome the head resistance offered by the column of oil, reaching 6,300 feet above it. The pressure of this oil against the piston head, and consequently against the sucker rod line, necessarily adds to the difficulties of operating the pumping unit and maintaining it in service. The back pressure of the column of oil upon the sucker rod line promotes breaking of it, with consequent stoppage of oil delivery from the oil well.

There are obvious practical limits to the

speed of reciprocation of the sucker rod line. It is conceded to be impracticable to increase the diameter of the pump piston, with means now at the command of the oil well operator; hence delivery of oil from an oil well which ceases to gush or discharge by the action of its natural pressure, is now limited to the lifting capacity of the small piston pumps which are now generally employed.

As oil is progressively withdrawn from an oil well the natural pressure is lowered, but the mass of the oil is not proportionately reduced. The natural pressure may drop to a point where it will be relatively insignificant for oil lifting purposes, and the volume of oil remaining in the natural reservoir at the base of the well may be sufficient to supply a large daily output for years to come.

By the system of pumping disclosed in this application I aim to provide means for withdrawing oil from an oil well, in adequate quantities, which will not be subject to the limitations now imposed upon oil well operators.

One of the objects of the present invention is to provide a large capacity oil pumping unit, which can be installed in a large diameter oil well and operated by a contained power unit, to produce a continuous flow of oil from the well, rather than an intermittent and irregular delivery of oil.

Another object of the invention is the provision of a pumping system for oil wells, including a power driven rotary pump which will not be disrupted by the back pressure of the oil column.

A still further object of the invention is the provision of a pumping system for deep oil wells, having an abnormal diameter or bore, consisting of a plurality of pumping units and flow connections between the same, whereby a lifting pressure can be progressively imparted to the oil.

A still further object of the invention is the provision of a pumping system for deep oil wells, consisting of a power driven pumping unit capable of being installed in position at the bottom of the well, and a compressed air service connection with this unit for supplying air under lifting pressure to the oil stream, to impart additional lifting energy to the oil.

A still further object of the invention is the provision of a deep well pumping system, wherein a plurality of motor driven pumping units are installed at different working levels and connected together to provide a continuous flow of oil, and each supplied with air under lifting pressure, so that the flow of oil upwards will be assisted by the action of the compressed air discharged into the delivery flow line of the pumping system.

A still further object of the invention is to provide a well casing of abnormal diameter with means for locking the motor driven pumping unit therein against relative rotative movement, but to permit of relative vertical movement.

A still further object of the invention is to provide simple means for reducing the earth pressure against the main well casing.

A still further object of the invention is the provision of a housing for the electrical motor, which will be oil and water tight, and yet permit of efficient operation of the rotary pumping mechanism.

Another object of the invention is the provision of means for mounting the pumping mechanism in a follower well casing, so that the pumping mechanism will be held positively against relative rotation therein, and yet relative slidable movement permitted, whereby the level of operation of the pumping mechanism may be varied, or it may be readily withdrawn from the well, without requiring the withdrawal of the well casing.

A still further object of the invention is the provision of a well pumping apparatus with vertical screw pumps operating in coupled pairs in opposing order, and means for supplying compressed air to the fluid column set in motion by said pumps within the pump casing, so as to assist the lifting action developed by the pumps.

A further object of the invention is the provision of improved means for interlocking the pump casing to an auxiliary casing fitting in the well casing.

Other objects and advantages of the invention will be hereinafter specifically pointed out, or will become apparent, as the specification proceeds.

With the above indicated objects in view, the invention resides in certain novel constructions and combinations and arrangement of parts, clearly described in the following specification and fully illustrated in the accompanying drawings, which latter show an embodiment of the invention as at present preferred.

In the drawings:—

Fig. 1 is a vertical sectional view through the combined pump mechanism and the interlocking well casing.

Fig. 2 is a side elevation of the housings for the upper and lower pump mechanisms.

Fig. 3 is a view in perspective of the lower section of the well casing, showing the internal locking keys and keyways thereof.

Fig. 4 is a transverse sectional view taken on line 4—4 of Fig. 1, looking in the direction of the arrows.

Fig. 5 is a similar view taken on line 5—5 of Fig. 1, looking in the direction of the arrows.

Fig. 6 is a detail side elevation of the twin pump screws.

Fig. 7 is a vertical sectional view through a modified form.

Fig. 8 is a transverse sectional view, taken on line 8—8 of Fig. 7, looking in the direction of the arrows.

Fig. 9 is a transverse sectional view taken on line 9—9 of Fig. 7, looking in the direction of the arrows.

Referring to the accompanying drawings illustrating the invention in detail, 10 designates the lower section of a well casing, which is constructed with radially spaced internal longitudinal keys 11 and keyways 12.

The pump mechanism is enclosed in two housings, a lower one 13 and an upper one 14. The lower housing 13 is formed with external longitudinal keys 15 and keyways 16, radially spaced from each other. The lower ends of the keyways 15 are formed with tapered terminals 15*a* and the upper ends of the keyways 16 communicate with longitudinal slots 16*a* which extend through the head 17 of the housing 13.

The head 17 is threaded in the cylindrical housing 13 and is shown to be of dome shape. In this housing, an electric motor 18 is mounted by means of vertical carrying ribs 19 formed on the housing 20 of said motor. The shaft 21 of this electric motor extends downwardly and is connected by the shaft coupling device 22 to the pump shaft 23, the lower end of which is equipped with helical driving gears 24, which engage similar gears 25 on the parallel shaft 26, shown in Fig. 6. The pump shaft 23 carries a lower lifting screw 27, which engages a similar lifting screw 28 on the shaft 26. The shaft 23 also carries another lifting screw 29, having a reverse pitch, which engages a similar lifting screw 30 on the shaft 26. The lower lifting screws 27 and 28 are spaced from the upper lifting screws 29 and 30, and the lower end of the discharge pipe 31 has communication by its lateral intake 32 with said space. Oil is supplied to the pressure chamber in which the four screws operate through the intake 33, formed in the end plate 34 secured by the screws 35 to the cylindrical housing 13. Compressed air is supplied to this inlet at 36 from a conduit 37, which extends to the surface of the well.

The oil enters through the inlet 33 and a part of it will flow through the space around each of the screws 27 and 28, and thence into the discharge pipe 31, and a part of the oil will flow through the by-pass 38 over the upper screws 29 and 30 and then downwardly through the spaces around and between these screws to the discharge pipe 31. The pump shaft 23 operates in a gland 39 carried by the inner casing 40, which encloses the upper and lower pump screws. The electric motor 18 is energized through a feed cable 18*a*.

The discharge pipe 31 extends through the head 17 and is coupled to a line section 41, which extends upwardly and connects with the intake 42 of the end plate 43 of the booster pump casing 44, arranged within the housing 14. In this casing 44, the twin roller lift screws 45 are arranged, one upon the shaft 46 and the other upon a shaft not shown, but which is of similar construction to the shaft 26. The shaft 46 carries a lifting screw 47 of reverse pitch to the lifting screw 45, this engages the companion lifting screw similar to the lifting screw 30, shown in Fig. 6. The pump shaft 46 carries helical gears 48, which engage corresponding gears of the companion shaft of the upper or booster pump unit. The pump shaft 46 operates in a gland 49 mounted upon the inner casing 44 and this gland is coupled by the shaft coupling device 50 to the motor shaft 51 of the electric motor 52. The housing 53 of this motor is provided with vertical and parallel integral ribs 54 which are keyed in the housing 14, which is formed with keyways 55 to receive said keys 54. The motor housing is also bolted in place by one or more bolts 56, shown in Fig. 5. The motor 52 is energized by means of a feed cable 56*a*.

The oil enters the inlet 42, in which air induction pipe 57 has communication and then describes a course similar to that described in detail with reference to the lower pump unit, and is discharged through the discharge pipe 58 upwardly through the detachable head 59 of the housing 14. The delivery pipe 60 is coupled at 61 to this head and conducts the oil to the surface of the well.

Compressed air enters the lower pump casing through the induction pipe 36 and the upper pump casing through the induction pipe 57, and also at delivery pipe 60 through a number of induction pipes or connections 62, similar to the one shown in Fig. 1, and conducts air from a compressed air conduit 63 to the rising oil column. In this way, an air lift is combined with the motor driven screw pump units and the hydrostatic pressure created by the well itself is neutralized so that the pressure acting upon the oil can be released to discharge the same to the surface of the well.

The upper housing 14 is shown to be a smooth cylindrical surface as the two pumping units are supported in the well casing by means of the interlocking keys formed on the lower well casing section 10, and the lower housing 13.

In Figs. 7, 8 and 9, I show a modified construction which includes the well casing 10 having the internal longitudinal keys 11, which are formed with the transverse keyways 11*a*. This well casing section is also provided with the internal longitudinal keyways 12. as shown in Fig. 3, but not appearing in Fig. 7. In this well casing section, the lower housing 64 is mounted, and this housing is provided with similar external keyways and keys to that of the lower housing 13. The lower end of the housing 64 is

equipped with an end wall 65 which provides the oil inlet 66. The upper end of this housing carries a detachable dome-shaped end wall 67. A pair of vertical screw shafts 68 and 69 are journalled in bearings 70 provided in said end walls 65 and operate in the auxiliary casing 71 within the housing 64. The upper end of the shaft 68 carries helical gears 72 which engage similar gears on the shaft 69. The shaft 68 extends through a bearing 73 and on its upper end carries a gear 74 which is engaged by the gear 75, mounted on the shaft 76, which is journalled in the bearing 77 provided in the dome head or end wall 67. Oil, after entering the inlet 66, flows through the lower pair of screw pumps into the discharge pipe 78 by one part, and through the by-pass 79 flows downwardly through the upper set of screw pumps into said discharge pipe 78, and thence upwardly into the booster pump casing 80 through the connecting pipe 81, which is carried by the end wall 82 of said casing 80. In the booster pump casing 80, the lower twin lifting screws 83 and the upper twin lifting screws 84 operate; one of each of said sets, being carried by the pump shaft 85 and the others being carried by a parallel vertical shaft similar to the shaft 26, shown in Fig. 6. The upper end portion of the shaft 85 immediately above the upper screw pumps 84 carries a pair of helical gears 86 which engage similar gears on the companion shaft and said shaft 85 then extends through the bearing 87 carried by the pump casing 80, and is equipped with a gear 88 which is engaged by the gear 89 on the driving shaft 90, which is journalled to operate in a bearing 91 of the detachable dome shaped end wall 92 of the upper housing 93.

Air is supplied to the lower pump casing 71 by the induction device 94*a* from the air conduit 94 and is also supplied to the pump casing 80 through the induction pipe 95 so that an air lift is combined with the multiple screw pump lifts.

The inner locking element between the lower pump housing and the lower section of the well casing positively prevents the pump units from rotating within the well casing and permits of easy forced interlocking and sliding connection with the well casing. This arrangement enables the well engineer to withdraw the pumping units from the well and substitute any other equipment required, without withdrawing the well casing.

The pump units are spaced apart at a distance of a thousand feet more or less, and in connection with the modified form, the driving shaft 90 is continued by sections coupled thereto to the surface, and are operated by means of any suitable power source at the surface.

The hereinbefore described construction admits of considerable modifications without departing from the invention; therefore, I do not wish to be limited to the precise arrangements shown and described, which are, as aforesaid, by way of illustration merely. In other words, the scope of protection contemplated is to be taken solely from the appended claims, interpreted as broadly as is consistent with the prior art.

I claim:—

1. The combination with a well casing of a motor, a housing enclosing the same and interlocked in the well casing against relative rotative movement, and pumping means enclosed by said housing and having driving connection with the motor.

2. The combination with a well casing of a housing slidably interlocked to the well casing against relative rotative movement and adapted to be supported thereby with its lower end adjacent to the lower end of the well casing, and power driven pumping means within the housing.

3. The combination with a well casing having internal longitudinal keys and keyways therein circumferentialy spaced from each other, a housing having corresponding external keys and keyways adapted to be slidably interlocked with the internal keys and keyways of the casing and be supported thereby against downward movement in the casing and to permit vertical movement thereof, and motor driven pumping means enclosed by the housing.

4. The combination with a well casing having internal opposed longitudinal keys and keyways therebetween terminating near the lower end of the casing to provide stops, a housing slidably interlocked to said keys and keyways and engaging said stops, and motor driven pumping means within the housing.

5. The combination with a well casing of a housing slidably interlocked thereto for limited downward movement and against relative rotative movement, and pumping means arranged in the housing.

6. The combination with a well casing of a housing slidably interlocked thereto against relative rotative movement, means for preventing the housing from dropping through the lower end of the casing, and pumping means operating in the housing.

7. A well apparatus including a housing having motor driven pumping means therein and external interlocking elements for coupling said housing to a well casing against relative rotative movement.

8. The combination with a deep oil well having a casing therein, and a pumping unit disposed at the bottom of the well and removably locked with the casing to positively prevent angular or turning movement of the pumping unit relative to the casing but to permit relative axial movement to provide for withdrawal of the pumping unit from the top of the well, the interlocking connection

consisting of intercurrent keys on the exterior of the pumping unit and interior of the well casing respectively.

9. The combination with a deep oil well having a casing therein, and a pumping unit disposed at the bottom of the well and removably locked with the casing to positively prevent angular or turning movement of the pumping unit relative to the casing but to permit relative axial movement to provide for withdrawal of the pumping unit from the top of the well, the interlocking connection consisting of intercurrent keys on the exterior of the pumping unit and interior of the well casing respectively and said keys being tapered on relatively opposite ends to serve as pilots to direct the keys of the one between the keys of the other.

10. The combination with a deep oil well having a casing therein and a pumping unit disposed at the bottom of the well and removably locked with the casing to positively prevent angular or turning movement of the pumping unit relative to the casing but to permit relative axial movement to provide for withdrawal of the pumping unit from the top of the well, the interlocking connection consisting of intercurrent keys on the exterior of the pumping unit and interior of the well casing respectively and said keys being tapered on relatively opposite ends to serve as pilots to direct the keys of the one between the keys of the other, the keys on the pumping unit increasing in width at their upper ends to practically close the space between them and function as abutments for the tapered ends of the keys on the well casing.

In testimony whereof I hereby affix my signature.

RICHARD P. SIMMONS.