Aug. 17, 1926. 1,596,303

S. B. REDFIELD

DEEP WELL DISPLACEMENT PUMP

Filed April 22, 1926 2 Sheets-Sheet 1

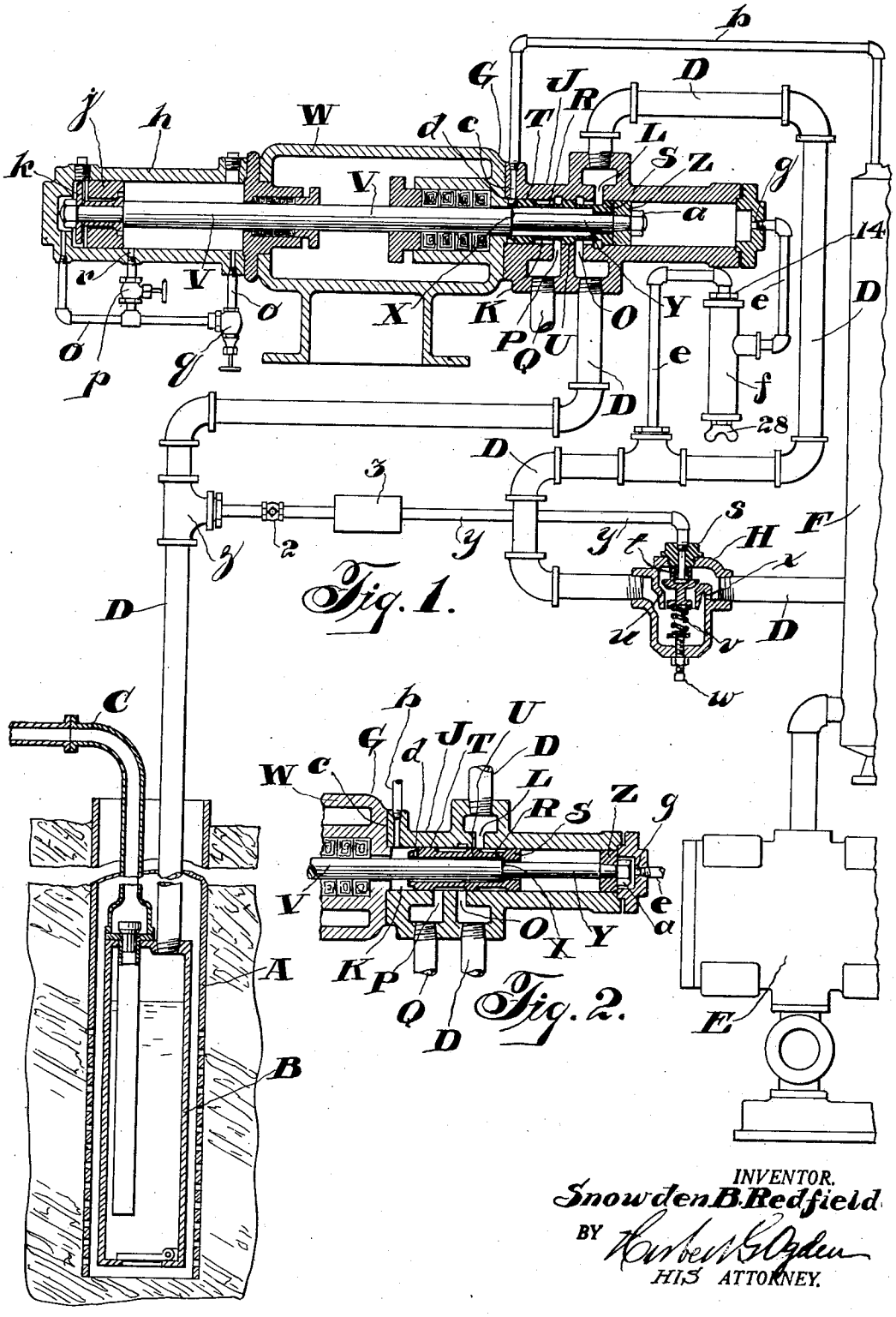


Fig. 1.

Fig. 2.

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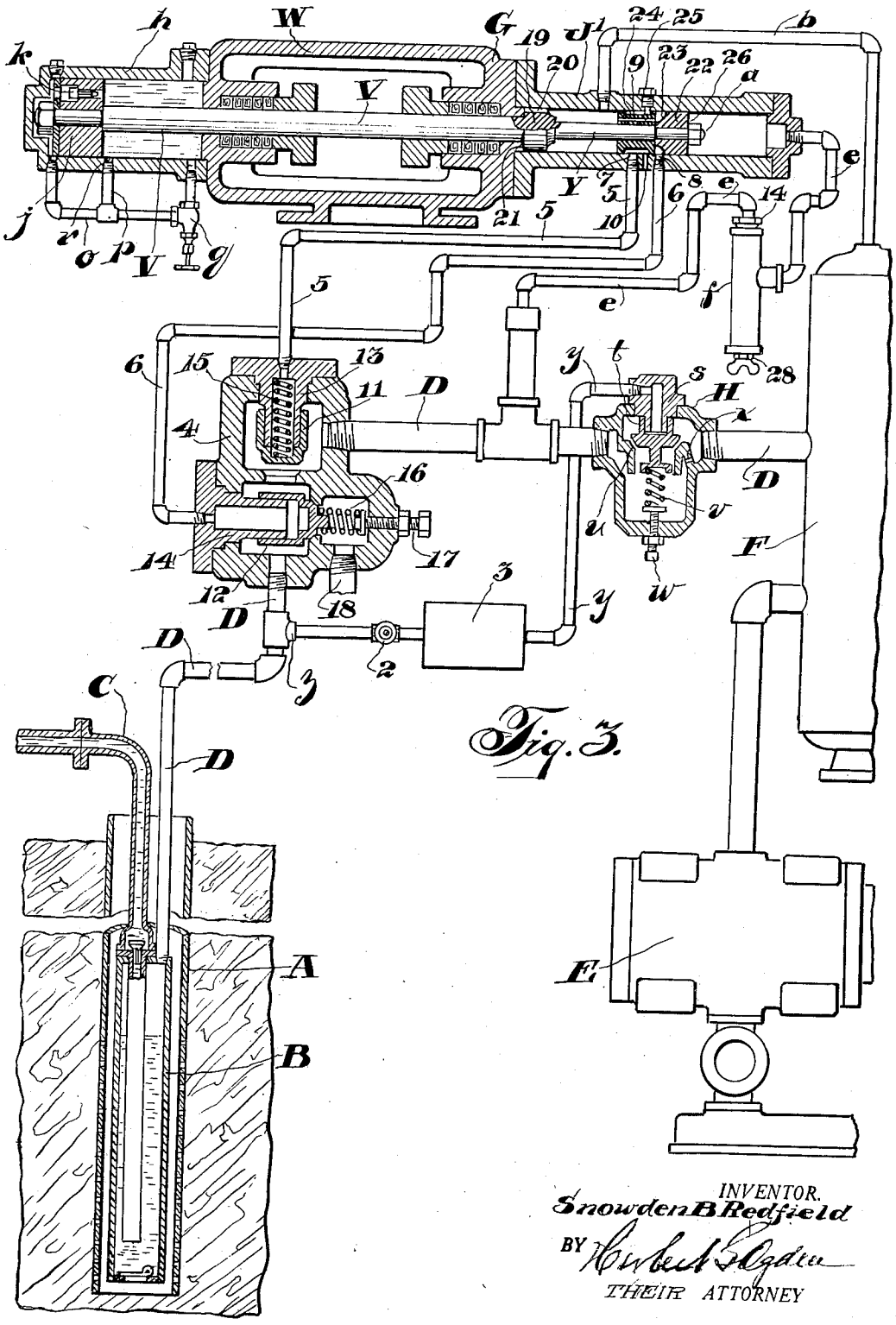


Fig. 3.

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Patented Aug. 17, 1926.

1,596,303

UNITED STATES PATENT OFFICE.

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DEEP-WELL DISPLACEMENT PUMP.

Application filed April 22, 1926. Serial No. 103,883.

This invention relates to fluid actuated displacement pumps, but more particularly to a deep well pump of this type for pumping depleted deep oil wells for instance.

The objects of the invention are to secure an efficient pumping mechanism and controlling and regulating mechanisms capable of automatically and intermittently discharging a tank or casing in the well, by alternately supplying pressure fluid to said tank and venting the tank to lower pressure or to atmosphere.

Another object of the invention is to enable the controlling and regulating devices to be set with certainty and precision to establish a predetermined interval of time to permit the automatic filling of the tank before automatic discharge, since different wells may require different filling intervals.

Other objects of the invention are to insure the cutting off of pressure fluid to the tank when the liquid contents of the tank has been discharged and furthermore to prevent the accidental or automatic cutting off of pressure when full line pressure is supplied to discharge the tank.

The invention is shown in its preferred forms in the accompanying drawings, in which

Figure 1 is a diagrammatic view partly in vertical section showing one form of the apparatus,

Figure 2 is a detail longitudinal sectional view of the timing valve in a different position, and

Figure 3 is a view similar to Figure 1 of a modification.

Referring to the drawings, the well which may have a casing A, may be a deep oil well for instance, and has located in any suitable position, a tank or casing B, shown in this instance near the bottom of the well. The discharge pipe C discharges at the surface and the main pressure fluid supply pipe D leading to the surface is supplied with pressure fluid from a main source indicated as a compressor E and receiver F.

An automatic pressure actuated timing valve G is connected to control the supply pipe D for alternately permitting pressure to be supplied to the tank B and for permitting the tank to be vented to a lower pressure or to atmosphere. The timing valve G is preferably actuated by pressure fluid supplied from the main source or receiver F and regulated means are also provided for setting the valve actuating mechanism to supply pressure to the tank B at predetermined intervals of time, in order to permit liquid to flow into the tank from the well during such time intervals, before the liquid is discharged.

An automatic choke valve H having the function of a cut-off valve is connected in the main supply pipe D preferably ahead of the controlling mechanism and is shown nearest the main source of supply, for controlling the supply of pressure fluid passing from the main source and thereby affording means for controlling the timing valve G.

In the present instance, the timing valve comprises the valve casing J having the valve chamber K to which the main supply line D from the receiver F is connected at the port L. The port O is connected to that portion of the main supply line D leading to the well and the port P is connected to the vent pipe Q leading to lower pressure or to atmosphere. A spool valve R in the valve chamber K is provided with the end heads S and T and the central head U for controlling the supply and exhaust of pressure for the well. The spool valve R is hollow as shown and a plunger rod V guided in the casing W is provided with a shoulder X and a reduced portion Y, which reduced portion passes loosely through the valve and has a plunger head Z connected thereto as by means of the nut *a*. As shown, clearance is provided between the reduced portion Y of the plunger rod and the body of the valve and also between the rod and valve head S.

Pressure fluid is supplied to the left hand end of the valve casing from the receiver F through the pipe *b* connected to the valve chest at the port *c*, and apertures *d* in the valve permit pressure fluid to pass into the valve and through the clearance spaces to the right hand face of the valve head S between said valve head and the plunger head Z. The right hand end of the valve chest J is connected by the pipe *e* to the main supply pipe D and in this branch connection there may be provided an auxiliary valve *f* for a purpose hereinafter to be described. This auxiliary valve *f* either permits line pressure to be supplied to the valve casing J at the port *g* or opens said port

automatically to lower pressure or to atmosphere to cause the actuation of the spool valve R.

Obviously the spool valve R is normally in balanced condition, and is moved in one direction or to the left by the plunger head Z abutting against the valve head S and is moved in the opposite direction or to the right by the shoulder X on the plunger rod abutting against the inside face of the head S as indicated in Figure 2. By this means the plunger rod and the head Z have a long travel while the valve R itself has only sufficient travel to control the three ports L, O and P. The plunger Z has, in effect, differential pressure surfaces, formed by its entire face on the right hand side and by its entire face less area of rod V on the left, so that full line pressure through the pipe *b* and port *c* will force the plunger to the left as indicated in Figure 1, due to the fact that the rod V forms an unbalanced pressure area to extrude the rod V through the packing, the remainder of the pressure surfaces being balanced. A reduction of pressure on the right, as at the port *g* to a sufficient degree, will cause the plunger to move to the right as indicated in Figure 2. In the position of the parts indicated in Figure 1 pressure fluid is being supplied to discharge the well tank B while in the positions shown in Figure 2 the discharge pressure is cut off and the pipe D from the well is vented through the port P and pipe Q to atmosphere or to a point of lower pressure.

The timing mechanism of the timing valve comprises the oil dash pot *h* having the piston *j* connected to the plunger rod V and provided with the check valve *k* opening to the right. The pipe *o* connects the ends of the dash pot cylinder and a by-pass pipe *p* is connected to the cylinder intermediate its ends. A needle valve *q* may be adjusted to control the flow through the pipe *o*. The plunger rod V and plunger head Z may move quickly and freely to the right as Figure 1 is viewed, to the position indicated in Figure 2 in order to cut off the supply of pressure fluid and vent the well tank B to lower pressure or to atmosphere. The rearward or retracting movement of the plunger rod V in the opposite direction due to the closure of the check valve *k* in the piston *j* is slow in order to provide the time interval for the filling of the well tank B. As soon as the dash pot piston *j* overruns the port *r* for the branch pipe *p*, free circulation of oil may take place around the piston and the piston moves quickly to the full end of its stroke in order to cause the plunger head Z at the opposite end of the rod V to quickly move the valve R to the position indicated in Figure 1 and supply pressure to the well.

The choke valve H which controls the timing valve is provided with a guide *s* for the cup valve *t* seating upon the seat *u*. A spring *v* having an adjusting screw *w* tends to open the valve. The wall of the seat is provided with a small port *x* and a pipe *y* from the back of the cup valve *t* connects with the downtake pipe D at the point *z*. A restriction at the point 2 is provided in the pipe *y* and also a small receiver 3.

In the operation of the device so far described, let it be assumed that the parts are in the position indicated in Figure 1 so that pressure fluid is flowing down the main supply pipe D and the oil is being discharged up through the discharge pipe C from the well tank. The movable parts of the timing valve are in their left hand or well discharge positions. When the oil or contents of the well tank B has been discharged, there will be a rush of pressure fluid down the well which will cause the cup valve *t* of the choke valve H to be blown shut by the draft or current of air passing through the valve. This will cause a substantial pressure drop in the main pipe line D between the choke valve and the well and also in the short pipe *e* connected to the right hand end of the valve casing J. Pressure fluid at full line pressure is supplied through the pipe *b* and through the hollow valve R to the inner pressure surface of the plunger head Z which will cause the said plunger head to move outwardly or to the right against the reduced pressure on the opposite side of the head. Near the end of the stroke of the plunger rod V the shoulder X will strike the inner face of the valve head S and will move the valve to change the relationship of the ports L, O and P so that the supply of pressure fluid down the well will be cut off and the down-take pipe D will be vented to lower pressure or to atmosphere through the vent port P.

The flow of pressure fluid to the well having been stopped by the valve R, the pressure will build up in the main pipe line between the choke valve H and the timing device, due to the leakage of pressure fluid through the small port *x* in the choke valve wall, which will equalize the pressure at both ends of the valve casing J and owing to the differential pressure faces of the plunger head Z will move the plunger head Z inwardly or to the left at a slow rate due to the action of the dash pot *h*.

When the pressure in the main line between the choke valve H and the timing valve cylinder J becomes equal to the receiver pressure, the cup valve *t* in the choke valve casing will open under the influence of the valve spring *v*. At this time the pressure in the well is at a minimum so that the space behind the cup valve *t* is exhausted of pressure through the pipe *y* connected to the main pipe D. The cup valve *t* will

therefore remain in open position, since the force maintaining it open will be the difference in pressure between the receiver pressure and the minimum well pressure, multiplied by the area of the valve guide *s* in the choke valve casing H.

During the time that the plunger rod V is traveling to the left, the dash pot casing *h* is filling with oil through the pipe *o*, and this time interval is controlled by the needle valve *q*. The last quick movement of the dash pot piston *j* to the left will reestablish the flow of pressure fluid down the well, and normally this reestablishment of the flow down the well will cause another rush of pressure fluid through the pipe D to reproduce the movements hereinbefore described. At this time however, the pressure in the well tank B will be at the minimum and therefore the pressure in the guide *s* behind the cup valve *t* in the choke valve casing will be at a minimum and the cup valve will remain in this open position, and will prevent the draft from blowing shut the cup valve *t* so that the reestablishment of the flow down the well will be effected while the cup valve *t* is maintained in open position and is prevented from closing at this time. After pressure has been reestablished in the well and behind the cup valve *t*, the next sudden draft of pressure fluid due to the blowing out of the liquid in the tank B, will cause the cup valve *t* to close as hereinbefore described because the cup valve is then in a balanced condition due to the reduction of pressure beneath it. The seat area of the cup valve *t* is greater than the guide area so that when this valve closed the first time, causing the drop in pressure in the main line for actuating the timing valve, the cup valve will remain closed until the pressure in the pipe D to the left of the choke valve has become nearly equal to the receiver pressure due to the leakage through the small port *x*, even although the pressure in the guide *s* of the cup valve *t* has been reduced.

The purpose of the small receiver 3 and the restriction 2 in the pipe *y* leading from the well pipe to the choke valve guide *s* is to provide a small time element for the pressure change in the choke valve guide *s*. This time element is desirable both during the decrease of that pressure, and the reestablishment of that pressure in order to make sure that the pressure in the main line pipe D shall pass through its complete change a little more rapidly than does the pressure in the choke valve guide *s*.

The operation of the device in Figures 1 and 2 has been described so far without reference to the auxiliary valve *f* in the pipe *e* connecting the main supply pipe D with the outer end of the valve casing J, but if desired, this auxiliary valve may be used. For purposes of illustration, the auxiliary valve *f* may be of the type shown in U. S. Patent No. 1,138,278 granted May 4, 1915 to J. H. Castle and W. G. Rodgers, which is so constructed that the valve operates to admit a certain predetermined receiver pressure to the regulating mechanism, such as the timing valve cylinder J, until the receiver pressure again falls a certain amount below that required to operate the auxiliary valve, in which case the auxiliary valve returns to its original position, allowing the regulating mechanism to exhaust to atmospheric pressure. I have merely indicated the valve chest by the letter *f* and the adjustable plug 14 and the spring cup 28, which two latter reference numbers correspond to similar parts similarly numbered in the said patent, it being understood that any other suitable auxiliary or pilot valve may be used in the location indicated by the valve *f*. This valve *f* is used in case it be desired to actually open the right hand end of the timing valve casing J to atmosphere or some other low pressure system for actuating the timing valve, instead of depending alone upon the reduction of pressure in said end of the timing valve casing.

In the modification of the invention shown in Figure 3 an additional trip valve mechanism 4 is indicated connected in the main supply line D and connected by the pipes 5 and 6 to the ports 7 and 8 respectively in the timing valve casing J′ controlled by the valve 9 so that these pipes 5 and 6 are alternately supplied with pressure fluid from the pipe *b* leading to the receiver F or vented to atmosphere through the vent 10. By this means the operation of the timing valve controls the supply valve 11 and the exhaust valve 12 operating on the guides 13 and 14 respectively in the trip valve casing. A spring 15 aids in closing the supply valve 11 while a spring 16 having the adjusting screw 17 tends to open the exhaust valve 12 to permit the main supply pipe D for the well to exhaust to lower pressure or to the atmospheric vent 18 provided in the trip valve casing.

With the parts of the trip valve in the position indicated in Figure 3 showing the supply valve 11 open and the exhaust valve 12 closed, pressure fluid is passing down the pipe D to the well to discharge the well tank B and with the valves 11 and 12 in reversed positions, supply of pressure fluid to the well is cut off and the well pipe D is vented to lower pressure or to atmosphere at the vent 18.

The construction of the timing valve is different in some particulars from the construction of said valve shown in Figures 1 and 2 and in Figure 3 the reduced portion Y of the plunger rod V is provided with a rearward head 19 having a slot 20 to permit

pressure from the pipe *b* to pass to the smaller rearward pressure surface 21 of said head 19. The forward head 22 of the rod is cut away or beveled at the inner surface 23 so that in the left hand position of the dash pot piston *j* the beveled portion 23 of the head 22 overlies the valve opening of the pipe 6 leading to the exhaust valve 12 of the trip valve and pressure fluid is supplied through the aperture 24 in the valve 9 and thence through the pipe 6 to hold the exhaust valve 12 closed. In this position of the parts the supply valve pipe 5 is open to lower pressure or to atmosphere through the vent 10. A stop 25 is preferably provided for limiting the movement of the valve 9 which valve is moved back and forth through a short distance by the heads 19 and 22 respectively. A reduction of pressure at the outer end of the timing valve casing J' due to a fall in pressure in the main supply line D and in the pipe *e* will cause the plunger rod V to move outwardly or to the right as Figure 3 is viewed, owing to the full line pressure on the rearward surface 23 of the plunger head 22. Full line pressure in the outer end of the timing valve casing J' against the forward pressure surface 26 of the plunger head 22 will move the plunger rod V to the left or inwardly due solely to pressure on an area equal to the end surface of rod V, since the heads 21 and 22 then have the same pressure on both sides.

The operation of the modified form of apparatus shown in Figure 3 is in all respects similar to that described in connection with Figures 1 and 2 except that the intermediate step of supply and exhaust due to the trip valve 4 is included in the modification.

In the operation of the system, shown in both the original form and the modification, the sudden rush of pressure fluid accompanied by the pressure drop in the main supply line which starts the operation of the timing device, occurs twice per cycle. This sudden rush of pressure fluid and consequent pressure drop occurs once when the oil is completely or almost all blown out of the well tank B and at this time the auxiliary valve *f* if such valve is used in automatically tripped for opening the outer or right hand end of the timing valve casing J' to lower pressure or to atmosphere so that utilization is made of this pressure drop in the cycle and such pressure drop is desirable for operating purposes. The other time that the sudden rush of pressure fluid and pressure drop occurs is during the reverse operation, that is, when the trip valve 4 is operated to supply fluid down the well pipe D to start the discharge of oil. There will probably be just as great a rush of pressure fluid, and perhaps greater accompanied by pressure drop, when the new pressure fluid starts down the well, as there was with the oil all blown out of the well tank B. This second or subsequent rush of pressure fluid and consequent pressure drop would originally cause the trip valve 4 to reverse again and immediately stop the supply of pressure fluid to the well which cannot be permitted and is prevented by my construction.

After the oil is discharged from the well tank B a sudden rush of pressure fluid causes the cup valve *t* of the choke valve H to close due to the draft of air through the valve thus producing the pressure drop in the main supply pipe D beyond the choke valve which operates the auxiliary valve *f* causing the timing valve to operate and thus operate the trip valve 4. In order to prevent a second closing of the cup valve *t* at the time pressure fluid is again supplied to the well tank B the pipe connection *y* including the receiver 3 and restriction 2 are provided. This pipe *y* will supply the same pressure above the cup valve *t* as exists in the well.

In the operation of the apparatus, when the oil is discharged out of the well tank B the rush of pressure fluid occurs as stated, but since there is the same pressure both above and below the cup valve *t* the valve is free to close with the draft. This closing of the cup valve *t* shuts off the supply and as stated causes the necessary pressure drop to operate the timing valve and trip valve. When the supply valve 11 of the trip valve 4 closes, pressure will slowly pass through port *x* and when pressures before and behind valve *t* approximate equality, the valve spring *v* will again cause the cup valve *t* to open ready for the next operation and it must remain open. When the time period for allowing oil to run into the well tank has elapsed the trip valve 4 will open due to the operation of the timing valve and start the pressure fluid down the well, but at this time there will be no pressure in the well due to the previous exhausting of pressure. There will consequently be no pressure above the cup valve *t* so that the cup valve will remain open and the pressure holding the cup valve open may amount to considerably over 1000 lbs. depending upon the receiver pressure. The choke valve cannot be blown shut by the draft and the sudden rush of pressure fluid down the well will not close the choke valve so that a pressure drop sufficient to cause the operation of the auxiliary valve *f* or the timing mechanism will not be produced. The auxiliary valve *f* if used should be set to operate at some substantial low pressure, so that any slight pressure drop produced by the rush of pressure fluid when the choke valve is held open, cannot operate the auxiliary valve *f*.

In accordance with this invention, one of the pulsations produced by the expulsion of

oil will cause the choke valve to close and reverse the operation of the system. With a second rush of pressure fluid however, due to filling the well again with pressure fluid the choke valve is prevented from closing and the apparatus will operate continuously through its cycle of operations. This feature in itself is of great importance in the practical operation of this displacement pump.

I claim:

1. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, and a trip valve mechanism connected in the main supply pipe and controlled by said timing valve for controlling the supply and venting of pressure for the said tank.

2. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, and an automatic choke valve connected in the main supply pipe nearest the main source of supply for controlling the supply of pressure fluid passing from the main source, and thereby controlling the timing valve.

3. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, a trip valve mechanism connected in the main supply pipe and controlled by said timing valve for controlling the supply and venting of pressure for the said tank, and an automatic choke valve connected in the main supply pipe nearest the main source of supply for controlling the supply of pressure fluid passing from the main source, and thereby controlling the timing valve.

4. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, and an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automatically after the liquid has been discharged from the tank in the well.

5. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, and an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automati-

cally due to increased flow of pressure fluid down the well when the tank has been discharged of its liquid contents.

6. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, a trip valve mechanism connected in the main supply pipe and controlled by said timing valve for controlling the supply and venting of pressure for the said tank, and an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automatically after the liquid has been discharged from the tank in the well.

7. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, a trip valve mechanism connected in the main supply pipe and controlled by said timing valve for controlling the supply and venting of pressure for the said tank, and an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automatically due to increased flow of pressure fluid down the well when the tank has been discharged of its liquid contents.

8. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automatically after the liquid has been discharged from the tank in the well, and means for causing said choke valve to open upon reduction of pressure in the well tank during the tank filling interval.

9. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, an automatic choke valve connected in the main supply pipe nearest the main source and adapted to close automatically due to increased flow of pressure fluid down the well when the tank has been discharged of its liquid contents, and means for causing said choke valve to open upon reduction of pressure in the well tank during the tank filling interval.

10. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, an automatic choke valve

connected in the main supply pipe nearest the main source and adapted to close automatically after the liquid has been discharged from the tank in the well, means for causing said choke valve to open upon reduction of pressure in the well tank during the tank filling interval, and means for preventing the choke valve from closing when pressure fluid under line pressure is supplied to the well tank for discharging the tank.

11. In a deep well displacement pump, the combination of a well and a tank in the well, a main pressure fluid supply pipe and a discharge pipe connected to said tank, a main source of pressure fluid connected to said main supply pipe, an automatic pressure actuated timing valve controlling said supply pipe for alternately permitting pressure to be supplied to the said tank and for permitting the tank to be vented to lower pressure, connections from the main source of pressure fluid to said timing valve for actuating the valve, regulated means for setting the valve actuating mechanism to supply pressure to the tank at predetermined intervals of time in order to permit liquid to flow into the tank from the well during the time interval permitted before being discharged, an automatic choke valve connected in the main supply pipe nearest the main source of supply for controlling the supply of pressure fluid passing from the main source and thereby controlling the timing valve, and means for preventing the choke valve from closing when pressure fluid under line pressure is supplied to the well tank for discharging the tank.

In testimony whereof I have signed this specification.

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