

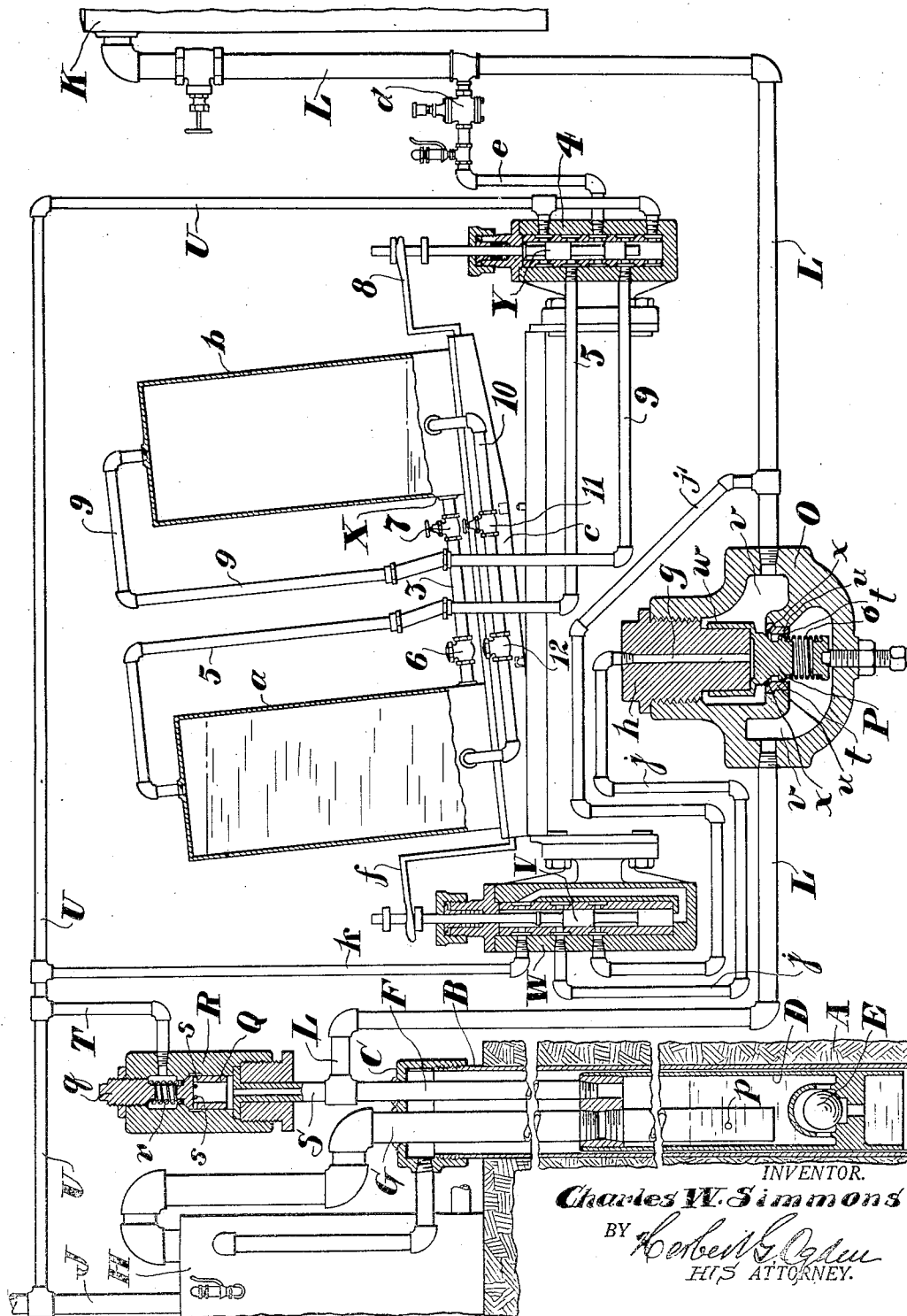
Oct. 20, 1931.

C. W. SIMMONS

1,828,206

DEVICE FOR PRESSURE FLUID CONTROL VALVES

Filed Nov. 2, 1927



UNITED STATES PATENT OFFICE

CHARLES W. SIMMONS, OF EASTON, PENNSYLVANIA, ASSIGNOR TO INGERSOLL-RAND COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY

DEVICE FOR PRESSURE FLUID CONTROL VALVES

Application filed November 2, 1927. Serial No. 230,541.

This invention relates to well pumps, but more particularly to a timing engine or device for timing the opening of the main control valve for the pressure fluid supply for the pump.

The objects of the invention are to produce a well pump having a timing engine which is simple and cheap to manufacture, but certain and positive in operation. Either compressed air or natural gas or other actuating pressure fluid may be used for the pressure supply for the pump, and another object of the invention is to enable high pressure fluid to be used for the well pump and low pressure fluid to be used for actuating the timing engine.

The pump is preferably of that type in which a tank is inserted in the well and a pressure supply pipe and a discharge pipe are connected to the tank. A main control valve controls the supply of high pressure fluid and this main valve is preferably self closing, but opens under control of an auxiliary valve, which in turn is controlled by the timing engine.

The invention is shown in one of its preferred forms in the accompanying drawing, which is a diagrammatic view, partly in vertical section and partly broken away of a well pump and timing engine illustrating the invention.

Referring to the drawing, A represents a well, for instance, an oil well which may be provided with the casing B having the cap C. A tank D having the valve E is adapted to be located in the well and the tank is provided with the pressure fluid supply pipe F and the discharge pipe G in the usual manner. The discharge pipe G is in this instance led to the gas trap H having the off-take pipe J. In the present instance it is to be assumed that compressed natural gas is used as the pressure fluid medium for pumping. The source of this gas may be the storage tank K from which the high pressure pipe L leads to the valve casing O of the main pressure fluid control valve P and from thence the supply pipe L leads to the down-take pipe F for the well tank. A well exhaust relief valve Q in the casing R is connected by the

pipe S to the main pipe F and a branch T leads from the relief valve casing R to the relief pipe U connected to the off-take J from the gas trap.

An auxiliary valve V in the casing W controls the opening of the main valve P and a timing engine represented in general by the character X preferably in the form of a rocking engine controls the auxiliary valve V and also operates the reversing valve Y which controls low pressure gas from the main pipe L for causing the flow of any suitable liquid back and forth between the timing engine tanks *a* and *b* mounted on the rocker arm *c* so that said arm is caused to rock at predetermined times. A reducing valve *d* in the branch pipe *e* leading from the main high pressure pipe L affords low pressure gas controlled by the reversing valve Y and piped to the tanks *a* and *b* for causing the flow of liquid back and forth between the tanks and thus rocking the rocker arm *c*.

With the parts of the engine and pump in the position indicated in the drawing, the tank *a* is full of liquid and the tank *b* is substantially empty so that the rocker arm *c* has been rocked to the left and the angular arm *f* has forced the auxiliary valve V to its lowermost position so that the vent or relief port *g* in the plug *h* over which the main control valve P fits in the form of a cup, is open through the pipe *j*, past the stem of the auxiliary valve and out through the pipe *k* to the relief pipe U which connects with the off-take pipe J from the gas trap H. The high pressure fluid from the main supply tank K through the pipe L in conjunction with the main valve spring *o* forces the main valve P upwardly and open to permit high pressure supply fluid to pass through the pipe L and down the pipe F to the well tank D. The pump operates on a combination of displacement and air lift principles and assuming that the well tank has filled with oil to be pumped, the supply of pressure fluid will force the oil up the discharge pipe G until the weight of this column of oil is equal to the pressure in the well tank. The small hole *p* in the foot piece of the discharge pipe is preferably so located that as the oil in the

tank is displaced and its level descends, the hole will be uncovered just prior to the time that the column of oil in the discharge pipe reaches its maximum height, as determined by the gas pressure in the tank. As soon as the hole p is uncovered some of the gas will pass through this hole, because the pressure of the gas is greater than the back pressure of the column of oil. The gas that passes through the hole p will aerate the column of oil in the discharge pipe, and gradually extend the column until it overflows at the surface and discharges the oil and gas into the gas trap H. The hole p is not large enough to pass all the gas that is supplied to the well tank, and as a result the gas pressure in the well tank will be maintained although some of the gas escapes through the small hole p . The discharge of a portion of the oil into the gas trap will momentarily lighten the weight of the column, which will permit the gas in the well tank to displace still more of the oil from the tank into the discharge pipe and thus continue the air lift action which has been started. The gas pressure in the well tank creates an artificial "submergence" as the term is used in air lift practice. When the level of the oil in the well tank has descended far enough to uncover the lower end of the foot piece of the discharge pipe, the gas will rush up this pipe with a scavenging action. Immediately following this rush of gas, the main control valve P, which is self-closing, will automatically close as will be explained.

The main control valve P is in the form of a cup valve having an annular flange w collapsible upon the plug h , which is screwed into the casing O. When the pressure inside the valve is relieved and there is a pressure on the outside of the valve, the valve will open. This is due to the fact that when pressure is released, the relief port g communicates through the pipe j , through the casing W, past the stem of the valve V, through the pipe k to the off-take J. Therefore the valve V is the controlling element that determines whether pressure is to exist or not within the relief port g to operate the valve P. The lower portion of the cup valve or main valve P is provided with a collar t which is a definite amount smaller in diameter than the seat bushing u inside of which the collar moves up and down.

In the open position of the valve P the high pressure gas from the main pipe L in the chamber v , passing through the valve opening between the valve seating surface x and the seat bushing u and through the restrictive space around the collar t will have a tendency to bring the cup valve P to its seat against the pressure of the valve spring o .

Immediately prior to or simultaneously with the complete displacement of oil from the well tank D the auxiliary valve V is actu-

ated in a manner to be more fully described hereinafter to establish communication between the pipe j and a branch pipe j' of the high pressure pipe L. High pressure fluid is thereby caused to flow through pipe j and the relief port g into the interior of the cup valve P to counteract the force of pressure fluid in the chamber v acting against the exterior opposed pressure surfaces of the valve and the pressure exerted by the spring o tending to hold the valve open.

When the lower end of the discharge pipe G is uncovered by the descending column of oil in the well tank D and fluid rushes up this pipe G as described, the pressure of fluid acting against the lower end of the valve P will thereupon drop considerably. This will cause pressure fluid to flow with greatly increased velocity through the restricted space between the collar t and the seat bushing u and such flow of fluid overcomes the pressure exerted by the spring o and seats the valve P.

It will be observed that the pressure area within the flange w is of somewhat greater diameter than the seating surface x so that there exists an annular pressure area on the exterior of the flange w which is opposed to the inside pressure area and to which pressure fluid is constantly admitted. In the closed positions of the valve P the force of pressure fluid within the flange w exceeds the combined forces of the pressure fluid acting on the opposed annular pressure area and the spring o thereby maintaining the valve firmly seated. However upon exhausting of pressure fluid from the interior of the flange w in a manner previously described these combined forces act to quickly open the valve P.

The gas in the well tank D, upon closing of the valve P, is now cut off from a further supply and gas in the tank will expand and continue to pass out through the discharge pipe G until the pressure in the well tank drops sufficiently to release the pressure on the ball E in the bottom of the same and permit oil to flow into the tank to fill the same. The rising level of the oil in the tank eventually fills the bottom of the pipe G, and later the small hole p and further escape of fluid through the pipe G is prevented. In order that the well tank may be completely filled with oil, means is provided in the form of an exhaust release valve Q for permitting the escape of air trapped within the tank. When the drop of pressure in the tank reaches a predetermined point, depending upon the setting of the small set screw q , the release valve spring r will force the release valve Q from its seat to permit the action above described so that the well tank is connected with the off-take J as described above.

Thus far it has been seen how high pressure fluid forces the liquid out of the well tank D, it has also been seen how the valve P closes whereupon the gas entrapped in the tank D

acts to pump fluid by expansion from the well tank. It has been seen further how the ball E is raised to permit the well tank to be refilled, and it has been still further seen how exhaust air in the well tank is released to permit this entry of new fluid into the same. At some predetermined time, as near as possible to the time when the well tank becomes substantially filled, the auxiliary valve V is actuated to allow the escape of fluid from the interior of the flange *w* thereby opening the valve P and starting the pumping operation again. The means for timing the movement of the valve V will now be described in detail.

15 While the pump is discharging, starting with the position of the parts as shown in the figure with the reversing valve Y in the position indicated, low pressure gas is being supplied on top of the liquid in the timing tank *a* and said liquid is being forced through the pipe 3 into the timing tank *b*. The low pressure gas from the reducing valve *d* passes through the pipe *e* to the valve casing 4 of the reversing valve and thence to and through the pipe 5 to the top of the tank *a*. The connecting pipe 3 between the tanks is provided with a check valve 6 and a needle valve 7 so constructed and positioned that the liquid takes the path through the pipe 3 to the tank *b* under the conditions named. The needle valve 7 is adjusted to permit the liquid to pass within a predetermined time. When the tank *b* is substantially full and the tank *a* is substantially empty the rocker arm *c* will rock to the opposite position in which case the reversing valve Y will be forced downwardly by the arm 8 while the auxiliary valve V will be carried upwardly by the arm *f* to establish communication between the pipes *j* and *j'*.

40 This last action of transferring fluid from one tank to the other takes place simultaneously with the discharge of fluid from the well tank D and the setting of the needle valve between the two tanks must be so predetermined that the lower arm tips at the time or nearly at the time when the tank D is empty.

45 With the reversing valve Y in its lower position the low pressure gas from the pipe *e* will pass to and through the pipe 9 and thence to the upper portion of the timing tank *b* so that the liquid in said tank will be forced through the pipe 10, needle valve 11 and check valve 12, into the tank *a*. The check valve 12 and needle valve 11 are so positioned and adjusted that the liquid is forced to take this path in preference to the path in pipe 3 and the needle valve 11 is so adjusted that a predetermined time is required for the passage of the liquid. During this time while the fluid is passing, the well tank D has been filling and at the precise moment that the tank *a* is substantially full and the tank *b* is empty, the rocker arm again tips back to its original position to lower the valve W and

raise the valve Y and the pumping operation is commenced, by virtue of the fact that the vent *g* within the cup valve P is opened to the off-take J through the pipes *j* and *k* and the main valve P is forced open to start the pumping operation.

This completes in detail the description of the operation of the device, but in view of the complicated nature of the same and in order to enable an artisan to more conveniently understand the nature of the device or construct the same, it is thought that a short résumé of the operation, based solely upon the fundamental principles of high pressure and expansive pumping will be in order.

With the valve P and the valve V opened, the valve Y and valve Q closed, high pressure fluid travels from the tank K to the well tank D and forces oil in the well tank to the tank H slowly. When the liquid in the tank D reaches the level of the small hole *p* or shortly thereafter the velocity of fluid passing through the line L is increased and this increased velocity closes the valve P. From this point on, the pump action of the fluid is due only to its expansive capacity. While the oil has been discharging through the pipe G, low pressure fluid passing through the reducing valve *d*, has been filling the tank *b* at a predetermined rate. About the time the tank D is empty, the rocker arm *c* tips, closing the valve V, and opening the valve Y. About this time the valve Q opens to permit exhaust for filling the tank D. A period of inoperation, except for the filling of the tank D, results at this time. While the tank D is filling, tank *b* is discharging into the tank *a*. When the rocker arm again obtains unstable equilibrium, the same tips, opening the valve V to relieve the pressure in the valve P and permit the same to open to commence the pumping operation.

I claim:

1. In a timing device, the combination with a pressure fluid supply pipe, of a pressure fluid control valve, an auxiliary valve controlling said valve, and a timing engine operatively connected to actuate the auxiliary valve, comprising a rocker arm, tanks on said arm adapted to alternately contain liquid to overbalance the rocker arm, a reversing valve connected to be actuated by the rocking of the tanks for controlling the flow of liquid from one tank to the other, whereby the opening of the main control valve is dependent upon the operation of said timing engine.

2. In a timing device, the combination with a pressure fluid supply pipe, of a self closing pressure fluid control valve, an auxiliary valve controlling the opening of said main valve, and a timing engine for actuating said auxiliary valve, comprising a rocker arm, tanks on said arm adapted to be alternately

filled and emptied, a reversing valve connected to be actuated from one end portion of the rocker arm for controlling the flow of liquid from one tank to the other, and operative connections for actuating the auxiliary valve from the other end portion of the rocker arm, whereby the opening of the main control valve is dependent upon the operation of said timing engine.

10 3. In a timing device, the combination with
a pressure fluid supply pipe, of a self-closing
pressure fluid control valve, an auxiliary
15 valve controlling the opening of said main
valve, and a timing engine for actuating said
auxiliary valve, comprising a rocker arm,
tanks on said arm, connections for passing
liquid under pressure back and forth from
20 one tank to the other, a reversing valve con-
nected to be actuated from one end portion
of the rocker arm for controlling the flow of
liquid back and forth from one tank to the
other, and operative connections for actu-
25 ating the auxiliary valve from the other end
portion of the rocker arm, whereby the open-
ing of the main control valve is dependent
upon the time required for the liquid to flow
from one rocker arm tank to the other and
back again to the first tank.

4. In a timing device, the combination with
30 a pressure fluid supply pipe, of a self-closing
pressure fluid control valve, a vent for one
side of said valve, an auxiliary valve control-
ling the opening of said vent for opening said
main valve, and a timing engine for actuating
35 said auxiliary valve, comprising a rocker
arm, tanks on said arm, connections for pass-
ing liquid under pressure back and forth from
one tank to the other, a reversing valve con-
nected to be actuated from one end portion
40 of the rocker arm for controlling the flow of
liquid back and forth from one tank to the
other, and operative connections for actu-
ating the auxiliary valve from the other end
portion of the rocker arm, whereby the open-
45 ing of the main control valve is dependent
upon the time required for the liquid to flow
from one rocker arm tank to the other and
back again to the first tank.

5. In a timing device, the combination
50 with a high pressure fluid supply pipe, of a
self-closing pressure fluid control valve, a
vent for one side of said main valve, an aux-
iliary valve controlling said vent, and a tim-
ing engine for actuating said auxiliary valve,
55 comprising a rocker arm, tanks on said arm,
connections for passing liquid under low
pressure back and forth from one tank to
the other, a reversing valve connected to be
actuated by movement of one end of the
60 rocker arm for controlling the low pressure
actuating fluid for the liquid in the tanks,
and operative connections between the aux-
iliary valve and the other end of the rocker
arm, whereby the opening of the main high
65 pressure fluid control valve is dependent

upon the time required for the timing engine
liquid to flow from one rocker arm tank to
the other and back to the first rocker arm
tank.

6. In a timing device, the combination with 70
a pressure fluid supply pipe, of a main pres-
sure fluid control valve in the supply pipe
for controlling the flow of pressure fluid
therethrough, a time controlled auxiliary
75 valve for permitting opening of the main
valve, means actuated by the fluid in the sup-
ply pipe for closing the main pressure fluid
control valve to discontinue the supply of
pressure fluid through the supply pipe, means
80 for maintaining said valve in closed position,
and means for opening said main pressure
fluid control valve.

7. In a timing device, the combination
with a pressure fluid supply pipe, of a main
pressure fluid control valve in the supply
85 pipe for controlling the flow of pressure fluid
therethrough, a time controlled auxiliary
valve for permitting opening of the main
valve, means actuated by fluid in the supply
pipe for closing said main valve, a third
90 valve connected through said auxiliary valve
to the main valve for maintaining the main
valve in closed position, and timing mech-
anism for operating said auxiliary valve to
permit the same to open said main valve. 95

8. In a timing device, the combination
with a source of pressure fluid supply, of a
main valve to control the flow of pressure
fluid from said source, an auxiliary valve to
100 control the opening of the main valve, a
pressure actuated timing mechanism con-
nected to actuate the auxiliary valve, and a
reversing valve to control the pressure fluid
supply to the timing mechanism and being
105 actuated thereby.

9. In a timing device, the combination
with a source of pressure fluid supply, of a
main valve to control the flow of pressure
fluid from said source and having a pressure
110 area exposed to pressure fluid for holding
said valve closed, a pressure actuated timing
mechanism for controlling the pressure fluid
supply to the pressure area, and means con-
nected to the timing mechanism and actuat-
115 ed thereby for controlling the pressure fluid
supply to the timing mechanism.

In testimony whereof I have signed this
specification.

CHARLES W. SIMMONS.

120

125