March 16, 1943. A. T. WATSON 2,314,113

GAS LIFT OIL WELL PUMP INTERMITTER

Filed Dec. 9, 1940 2 Sheets-Sheet 1

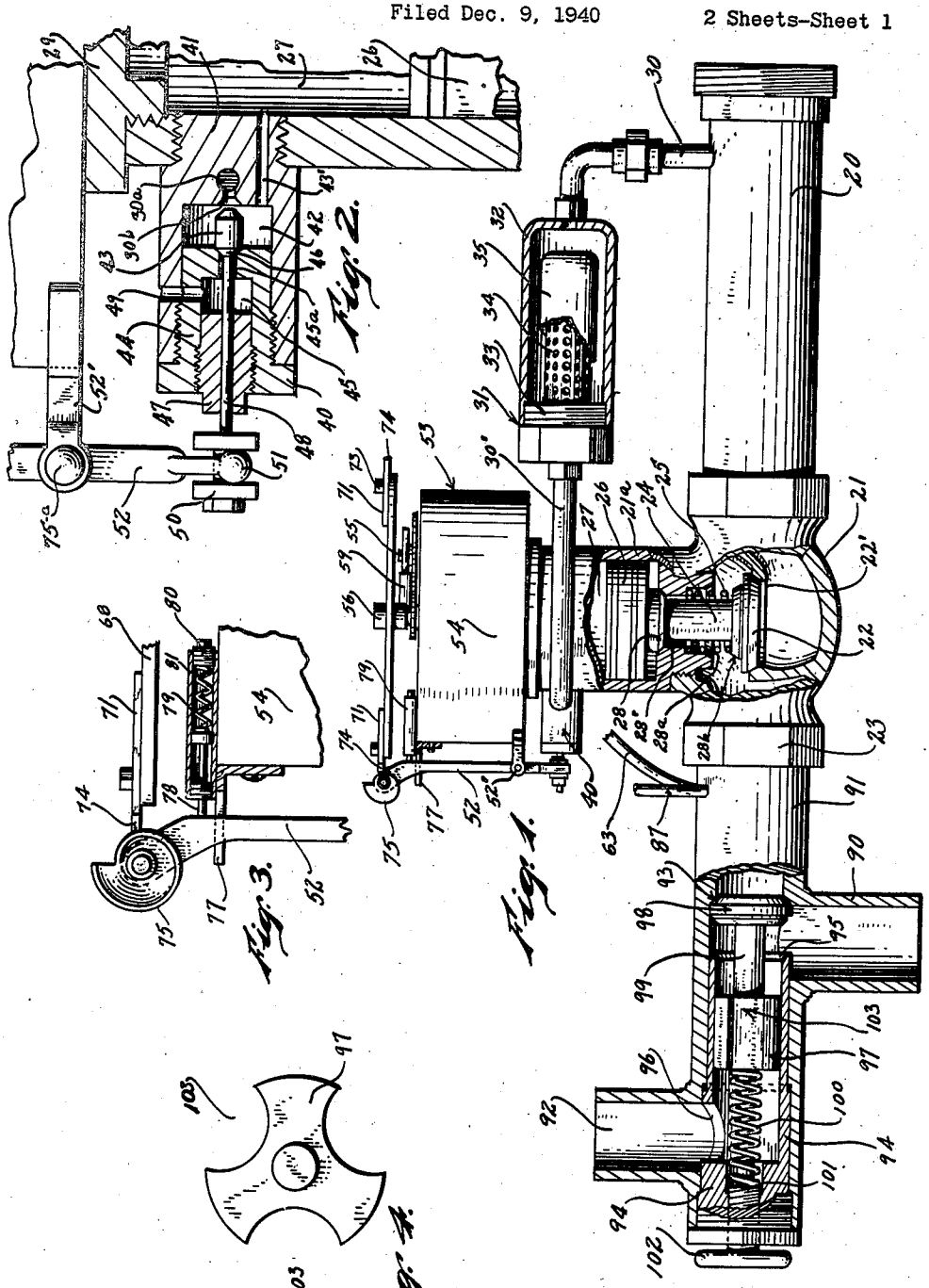


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

INVENTOR:
A. T. WATSON,
BY:
Christian R. Nielsen
ATTORNEY

March 16, 1943. A. T. WATSON 2,314,113

GAS LIFT OIL WELL PUMP INTERMITTER

Filed Dec. 9, 1940 2 Sheets-Sheet 2

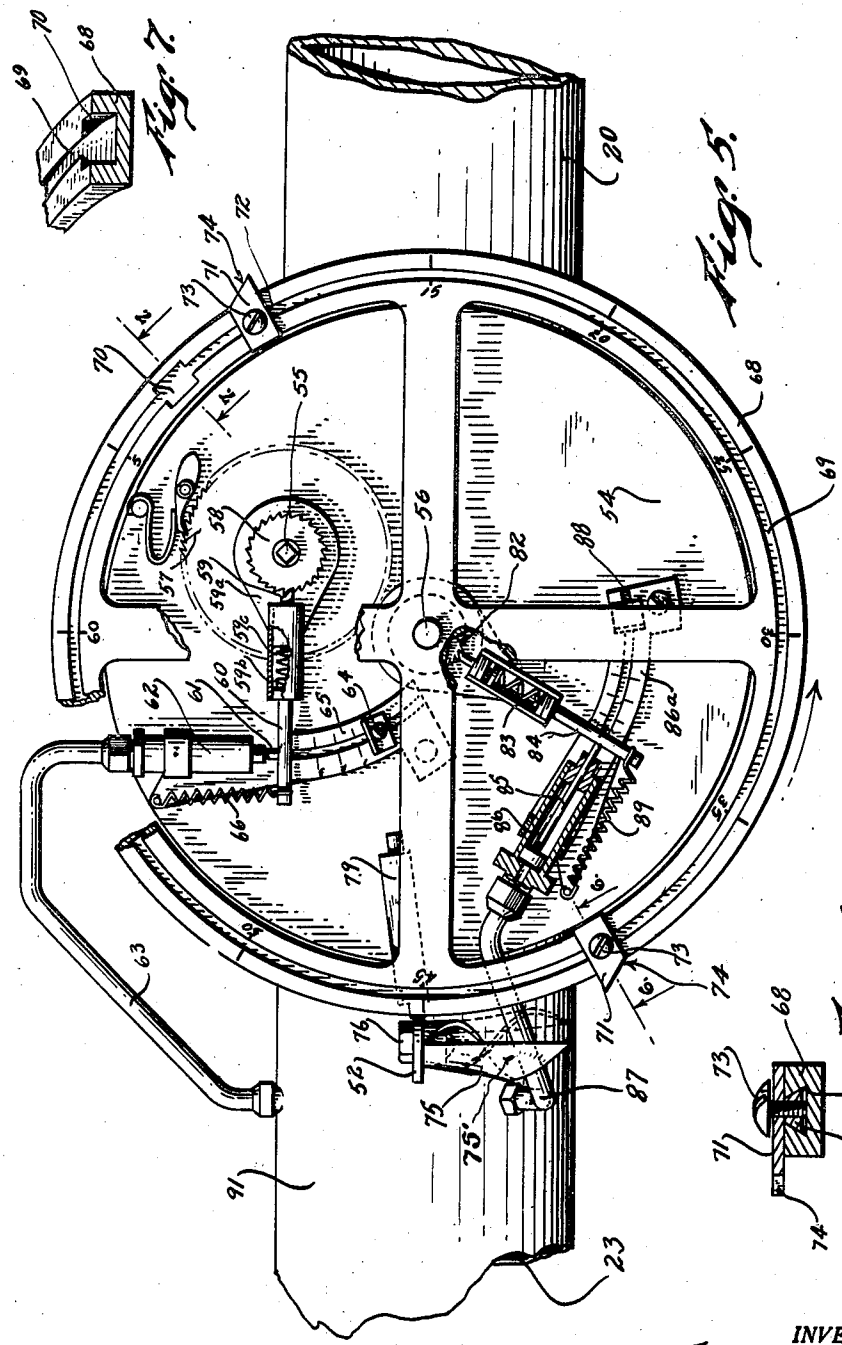


Fig. 7.

Fig. 5.

Fig. 6.

INVENTOR:
A. T. WATSON,
BY:
Christian R. Nielsen
ATTORNEY

Patented Mar. 16, 1943 2,314,113

UNITED STATES PATENT OFFICE

2,314,113

GAS LIFT OIL WELL PUMP INTERMITTER

Athelstan T. Watson, Cabimas, Estado Zulia, Venezuela

Application December 9, 1940, Serial No. 369,343

4 Claims. (Cl. 161—7)

The invention relates to pumps designed to evacuate oil wells of the oil which flows thereinto, and particularly to means for effecting and controlling the intermittent function of such pumps. It is especially useful in low production areas where the flow of oil to the wells is very slow and the types of pumps used do not warrant continuous operation.

Pumps now largely used in these areas involve the formation of a chamber at about the level of the oil stratum in the well casing, with provision to permit inflow of the oil to the chamber, and means to close egress of the oil back to the sands while gas pressure is established over the oil in the chamber to force it to the storage tanks at the surface of the ground through a "flow string" or "macaroni string" tubing leading from the lower part of the chamber. A short interval of time is required for the chamber to fill to a proper level with oil, this time of refilling for a given size of chamber varying in different localities and in different wells in the same locality. An example of such pump is shown in my Patent No. 2,229,829, issued January 28, 1941.

It is therefore an object of the invention to provide means for regulating the time interval between pumping cycles, and also to regulate the portion of the cycle in which actual pumping occurs, thus permitting regulation to accord with flow of oil into the well, the gas pressure available and viscosity of the oil.

A further object is to insure against stoppage of the timing device at critical points of operation, through provision of additional force supplied from gas pressure rather than that from the timing device alone.

Another important aim is to provide automatic winding of a spring powered timing mechanism. Another important object is to present a construction of such apparatus that will assure protection of delicate parts from foreign material carried by the gas under pressure.

Simplification of construction and economy in cost of material and labor for production are further objects in view, as well as the production of an apparatus with special advantages, and that will be rugged and durable, when installed under the field conditions which expose such apparatus to severe usage.

Additional objects, advantages and features of invention reside in the construction, arrangement and combination of parts involved in the embodiment of the invention, as may be more readily understood from the following description and accompanying drawings, wherein

Figure 1 is a side elevation, partly in section of a control apparatus embodying the invention.

Figure 2 is an enlarged sectional detail of the timer-controlled valve.

Figure 3 is a detail of the cam and lever operated by the cam of the timer.

Figure 4 is an end view of a valve guide, showing passage for venting of gas from the pump chamber.

Figure 5 is a top plan of the timing device and auxiliary gas-pressure operated devices on a larger scale than Figure 1.

Figure 6 is a section on line 6—6 of Figure 5 of the mounting of adjustable cams on the rim of the timing wheel.

Figure 7 is a section on the line 7—7 of Figure 5 showing the entrance to the channel of the rim.

There is illustrated in Figure 1, a high pressure gas supply line pipe 20 communicating with a globe type main valve assembly 21. The unit 21 includes a case having a horizontal port 22' at the upper side of which there is seated a valve 22 which separates the line 20 from the outlet 23 of the case from which the gas passes to the well. Valve 22 is mounted upon a rod or stem 24, and is urged toward its seated position by a spring 25 centrally ported around the stem and seated against the upper body 21—*a* of the valve 21 which has a part screwed into the case 21. At the upper end of the valve rod 24, there is attached a piston 26 operating in a cylinder 27 formed as part of the body 21—*a*. An excess of pressure in the cylinder 27 above the piston will urge the valve 22 to seated position. The cylinder body 21—*a* is ported at 28' around the stem 24 forming communication at times with the outlet 23. A valve 28 is provided on the under side of the piston 26 which seats over the port 28' and so serves to seal off the outlet 23 from the cylinder 27 beneath the piston 26 when the valve 22 is seated. The cylinder 27 is closed by a cap 29 screwed thereinto. The lower side of the port 28' has a seat 28—*a* therearound, and a valve part 28—*b* is formed on the upper side of the valve 22, arranged to engage the seat 28—*a* when the valve 22 is unseated and the piston moved to its upper limit by gas acting through the port 28'.

A supply of high pressure gas reaches the cylinder 27 from the pressure line 20 through a bypass tube 30 connected into supply line 23, after passing through a filter 31 inserted in the bypass. Admission of gas under pressure into cyl-

inder 27 is controlled by a valve assembly 40, to be described.

The filter 31 consists of a cylindrical chamber casing 32 with which the tube 30 communicates adjacent the supply line 20, and the casing 32 has detachably engaged in its opposite end a plug 33. This plug carries thereon a foraminate thimble or chamber 34 which extends substantially the length of the casing 32, being spaced from the interior surfaces thereof. Through the plug 33 opens the end of a continuation 30' of the tubing 30, leading from the chamber 34 to the control valve assembly 40. The thimble 34 is entirely covered with a removable porous filter element 35, which may be woven or matted in closed tubular form from filter glass, asbestos, cotton or other filter material.

The valve assembly 40 includes an integrally headed cylindrical casing 41 having a tenon on its head screwed into the wall of the cylinder 27, chambered in its outer part as at 42, a duct 43' being bored off center in the tenon, forming communication between the interior of the cylinder 27 and the chamber 42. The tube 30' is connected into the head of the casing 41 next the cylinder 27, and a passage 30—*a* extends therefrom transversely partly across the head spaced from the inner face of the chamber 42. A port 30—*b* is formed from this passage inwardly through the head of the chamber 42 on the chamber axis, and formed with a seat in the chamber, in which there may seat at times a reciprocating valve 43, as will be explained. The chamber 42 has screwed into its outer end a hollow port plug 44 stopping short of the head of the chamber to define the chamber and afford space for reciprocation of the valve 43 and being centrally ported at 45—*a* through its inner end to receive the outer face 46 of the valve 43 therein at the outer limit of movement of this valve. The plug 44 is formed with a large bore 45 in its outer part closed for a distance by a long plug 47 and the valve 43 has an operating rod 48 fixed thereon and slidable through the port 45—*a*, the plug 47 and therebeyond. A lateral port 49 is formed from the bore 45, through the walls of the plug 44 and case 41, communicating with the atmosphere.

It will be understood that movement of the rod 48 inward will result in seating valve 43 in the port 30—*b*, closing communication between the cylinder 27 and the high pressure duct 30, and so that the cylinder 27 communicates freely to the atmosphere through port 49; or on outward movement will seat valve face 46 at 45—*a*, resulting in high pressure gas being admitted freely to the cylinder 27.

The end of the rod 48 projects beyond the plug 47 and has fitted thereon two spaced collars 50 which receive therebetween a yoke 51 on the lower end of an operating lever 52 to be described.

Mounted on the closure cap 29 there is a timing unit 53, including a clock work and casing 54. Usual spring powered gears and escapement means are contained in the casing 54, and the specific construction of this clockwork is not illustrated. Referring particularly to Figure 5, respective shafts 55 and 56 project above the casing 54, the shaft 55 being at one end of the gear train of the timer, and being the power input which when rotated by key or crank, and held by a ratchet and pawl 57, supplies energy to be stored in the main-spring of the clockwork. The shaft 56 is at the output end of the gear train, being slowly rotated under control of a usual escapement. While manual winding may be employed, means is provided for automatically winding the timer by use of gas pressure during certain portion or portions of the cycle of operation. To accomplish this, a ratchet wheel 58 is fixed on the shaft 55, and a radial spring-loaded plunger ratchet 59 engaged therewith is mounted rotatably upon said shaft 55 by means of a plate 59—*a* laid close over the top wall of the case 54 and apertured to receive the shaft 55 revolubly therethrough. Fixed radially on the plate 59—*a* there is a tube 59—*b* in which the plunger ratchet 59 is reciprocable with its inner end against the ratchet; the outer end of the tube is closed by an operating lever arm 60 fixed therein and within the tube there is confined by the ratchet plunger a protractile helical spring 59—*c* which serves to hold the plunger 59 in engagement with the ratchet wheel 58. The arm 60 is operated in one direction by a plunger piston 61 slidable in a cylinder 62 mounted on the top of the case 54, the piston extending from one end of the cylinder, while the opposite end of the cylinder has a duct 63 opening thereinto and communicating freely through case pipe 91 (to be described) with the outlet 23 from the main valve 22. Movement of the arm 60 by the piston 61 is limited by an adjustable stop 64 mounted on a sector plate 65 attached to the top of the case 54, and the arm 60 and piston are held yieldingly at an initial position distant from the stop, by means of a contractile spring 66, one end of which is attached to the arm 60 and the other suitably anchored on the case 54. Gas pressure from the outlet 23 will thus urge the piston 62, push rod 61 and operating lever 60, to rotate the shaft 55 whenever the valve 22 is open. The stop 64 is adjusted so that the rewinding effected is equal to the "unwinding" of the mainspring between operations of the piston 62, being adjusted for longer stroke when the interval of time between operations of the valve 22 is greater.

The output shaft 56 is concentric with the case 54, and fixed thereon there is a wheel 67 of a diameter slightly greater than that of the casing 54, though this may be modified by discretional changes in construction of associated elements. The wheel 67 includes a rim 68 in which a concentric annular dovetail channel 69 is formed, the channel forming a dovetail narrower at the top then at the bottom. At one part the overhanging lips of the channel are removed as at 70, forming a gate slot or entrance of the same width at the top and bottom. A cam element 71 is formed with a projecting dovetail 72 which may be introduced into the gate slot and moved into the channel 69 to a desired position on the rim 68. A screw 73 through the element 72 engages the root of the groove 69 and so locks the cam device 71 in position. The upper portion of the cam 71 extends outward beyond the rim of the wheel, and is shaped with a slant face 74 of decreasing radius in the direction of rotation of the wheel 68.

The operating lever 52 earlier mentioned is a lever of the first order, pivoted at 75*a* in a bracket 52' mounted on the casing 54, and extends upwardly, substantially parallel to the side of the casing to a point slightly above the top surface of the timer. Here it is bent so that its upper end will be positioned at or adjacent the level of the upper surface of the wheel 68 and suitably spaced therefrom.

Upon the upper end of the lever 52 there is

mounted a strike, wiper, or brush 75, adapted to be engaged by the cam surface 74 and to be pressed back or outwardly thereby sufficiently to operate the valve rod 48. The wiper is projected from the upper end of the lever 52 horizontally and generally in the direction of rotation of the wheel 68, and is adjustably secured to the lever 52 revolubly on an axis normal to a plane through the lever radial with the wheel. In order to permit various periods of contact of the cam 74 with the side of the wiper, the latter is formed with a wall circular in cross section at its base on the said axis, but of varying length horizontally at different parts of its circumference, the longitudinal termination being defined by a spiral edge, so that with one side of the wiper adjusted next the wheel where the spiral edge is near the base of the wiper or next the lever 52, the cam 74 will wipe against the side of the wiper for only a short period in passing, but when the wiper is rotated on the lever 52 to bring a portion next the wheel where the spiral edge is more distant from the lever 52, the cam 74 will travel further while engaged with the side of the wiper and a longer interval of operation of the wiper results. In addition, the wiper has its sides curved and flared so that next to the wheel they are concentric with the wheel and path of the cam 74 at all positions of the wiper in its adjustment on the lever. The wiper 75 is so shaped to permit selection of the interval during which it is engaged with the cam 74. Its surface may be described as that generated by rotation of a segment of the locus of the tip of the cam 74 about the axis of a bolt 76 by which the follower 75 is attached to the lever 52, this axis lying in the horizontal plane of the cam 74. At one element of the described surface the exterior surface length of the generating segment is zero, being gradually increased in length during its geometrical revolution to provide a greater length of face on the follower next to the wheel 68. The wiper is fastened by the above-mentioned bolt 76, to the lever 52 manually after loosening the bolt and secured by tightening the bolt, so that an element of the desired length of follower surface may be presented to the path of the cam 71, thus controlling the fractional part of the period of rotation of the wheel 68 during which the valve 43 is held in closed position.

The cam is of sufficient length to force the wiper 75 outward far enough for the yoke end 51 of the lever to force the valve 43 to its seat 30—*b*, cutting off access of high pressure gas to the cylinder 27 as long as the cam engages the peripheral or wiping face 75′ of the wiper. When the cam 74 has traversed the selected length of the face 75′ the lever 52 is permitted to resume its former position, the pressure of gas through port 30—*b* effecting movement of the valve and rod 48 to seat the valve 43 at 46 in the port 45—*a*.

A guide 77 is provided on the case 54 to take the side thrust of cam 74 upon the lever 52, constraining the lever to move in a radial plane. A partial balance of the gas pressure upon the valve 43 when sealing the cylinder at the port 45—*a* is provided in a spring-pressed rod 78 urging but not moving the lever 52 outwardly from the top of the case 54, so that only a slight additional force need be added by the cam 74 to actually move the lever 52. The rod 78 is slidable in one end of a tube 79 attached to the casing 54, and the pressure exerted by this rod is selected by adjustment of a screw plug 80 in the opposite end of the tube, by which a protractile spring 81 is confined against the rod 78.

To insure operation of the timer and continued rotation of the wheel 68 while the cam 74 functions after initial engagement with the wiper, an auxiliary device is provided. This includes a ratchet wheel 82 fixed to the shaft 56, and an associated ratchet 83 engaged therewith and oscillatable thereabout on a mounting similar to that of the ratchet 59. An operative lever 84 extends therefrom into the path of a piston plug 85 which is carried in a cylinder 86, and actuated by introduction of gas under pressure to the cylinder from the outlet 23, through a tube 87. Cylinder 86 is fastened to the timer casing 54 as is also a graduated arcuate track 86—*a* over which the lever 84 travels, being limited in operative movement by an adjustable stop 88 on the track. The stop 88 is positioned so that angular travel of the lever 84 is at least equal to angular travel of the cam 74 along the wiper 75, and is accurately subdivided to facilitate this. A spring 89 returns the lever and piston to initial position. Thus, an additional torque is supplied to the timer immediately after initial movement of the lever 52 and during the remainder of the interval when the timer is engaging and actuating the control lever 52, preventing the valve from staying open at the port 30—*b*, should the timer fail during this interval. The added force is not sufficient to "speed up" the timer, but merely supplies moderate extra work useful at this time.

The outlet 23 from the valve 21 communicates by means of a pipe 90 with the conventional pump chamber at the bottom of the oil well, not illustrated. The pipe 90 is also used as a vent for the well pump chamber, as will appear.

The outlet 23 of the main valve 21 has engaged therein a special valve case body in the form of a double T, including a rectilinear cylindrical pipe body 91, the pipe 90 being one branch, near the valve 21, and another branch 92 being formed a distance outwardly thereof opening to the atmosphere. The bore in the body 91 across the pipe 90 and outwardly thereof is enlarged and a seat 93 thus formed just outwardly of the pipe 90. A valve mounting sleeve 94 closed at its outer end is engaged slidably in the body 91, stopping in proper spaced relation to the seat 93 and having a corresponding opposed seat 95 formed on its end edge. The sleeve is secured in place by threaded engagement with the outer end of the body 91, and is laterally ported at 96 in alinement with the branch outlet 92 to form communication between the pipe 90 and the atmosphere at times. Mounted on a sliding ported block 97 in the sleeve there is a double valve 98 interposed between the seats 93 and 95 for alternate seating engagement therewith, the valve being connected to the block by a reduced stem 99. Confined between the block and the outer end or head of the sleeve there is a protractile helical spring 100, engaged partly in a bore 101 formed through the head of the sleeve and closed by an adjusting hand screw 102 against which the spring seats and by which pressure of the spring on the valve 98 may be varied as required. The cylinder 94 communicates freely with the atmosphere through the outlet 92, the guide 94 having longitudinal port grooves 103 to permit flow of gas thereby.

In operation, the apparatus being assembled as illustrated and connected by pipe 90 to the pump chamber in the well, and the shaft 55 operated to initially wind the timer clock device, the cams

74 are provided in suitable number and at proper intervals about the rim 68, so that the time interval between operations of the lever 52 will be such that the pump chamber in the well refills under the particular rate of flow of oil into the well which has been found to occur in the particular instance. The wiper is also adjusted by rotation and secured so that the length of time during which the cam 74 remains in engagement with its side portion and holding the valve 43 closed, is sufficient for all oil accumulated in the pump chamber in the well during the interval between operations to be forced to the surface by the available gas pressure. As natural gas at well pressure is available for this operation, and as such pressures vary in different localities, this adjustment is material in adapting such a device to general use throughout the various oil fields. To facilitate the adjustment of the cams 74, the face of the wheel 68 may be calibrated and marked to indicate intervals of minutes or multiples of minutes as indicated in Figure 5, where it is contemplated to adjust clockwork to rotate the wheel one turn in one hour, and with the adjustment of the cams indicated in this view the charge in the well pump chamber would be discharged every half an hour. With the proportions of the wiper 75 as illustrated, the period of oil lift or pumping may extend from one minute or less to three or more minutes, but by varying the proportions of the parts these capacities as to time may be extended.

The follower 75 being between cams 74, the upper end of the lever 52 is at the radially inward limit of its movement, valve end 46 is seated at port 45—*a*, while communication between the high pressure line 30 and the top of the cylinder 27 through the port 30—*b* and the passage at 43' is permitted. The piston 26, due to this aggregate pressure predominating over that acting against the lower side of the valve 22, is at its lower limit of movement, and the valve 22 is closed, being also urged to this position by the spring 25. Foreign matter in the gas will have been removed by the filter 35 before the gas reaches the valve mechanisms. Pressure from the line 20 not being communicated to the outlet 23, the spring 100 causes the valve 98 to close at 93, and to permit free venting of the chamber of the well pump through 90, 91 and 92, and thus to fill with oil which accumulates in the well. The cam 74 now engages the wiper 75, operating the lever 52, being somewhat aided by the spring pressed rod 78 and rod 47 to open the valve 43 at port 45—*a* and to close the valve 43 on the port 30—*b*, permitting free venting to the atmosphere of the cylinder 27 through port 45—*a*. Pressure in line 20 is now sufficient to raise the valve 22 against the force of the spring 25, admitting gas under pressure into the outlet 23. Pressure is communicated also through the tubing 63' to the cylinder 63 advancing the lever 60 to its stop 64, which has been set to result in rewinding the timer to the extent that it has run since the last winding operation.

Through tubing 87 also, gas is permitted to operate the piston 85 and ratchet 83 to insure continued rotation of the shaft 56 and wheel 68.

Pressure in the outlet 23 opens the valve 98 against the pressure of spring 96 and seats this valve at seat 95. Pressure is thus communicated to the well pump chamber, the gas displacing oil therein as known in the art, and forcing it to the surface through suitable piping, not shown.

When the cam 74 has traversed the engaging surface of wiper 75, the pump chamber having been emptied of oil in this time, the lever 52 is permitted to move inwardly and is so operated by high pressure gas from the line 30 acting against the closure at 43. The seat 46 is then closed by the valve 43 and high pressure is again communicated to the cylinder 27, thrusting the piston 26 downwardly and, aided by spring 25, closing the valve at 22. As pressure in the pipe 90 and outlet 23 is reduced due to further oil displacement or other leakage, springs 66 and 89 return their respective levers 60 and 84 to initial positions. Similarly, spring 100 unseats the valve 98 at 95 and urges it to seat at 93, venting the upper part of the pump chamber and permitting it to refill with oil, after which the cycle is repeated.

In the operation of the auxiliary power device from duct 87 is may be explained that as soon as the valve 43 is unseated at its outer end 46, over the port 45—*a*, the outrush of gas therepast will at once relieve pressure over the piston 26, so that if the clock mechanism should be stopped the valve 22 will soon be opened enough to supply high pressure gas to the under side of the piston and through the outlet 23, and so through ducts 63 and 87, the latter immediately operating the wheel 69 until the cam 74 has cleared the wiper 75.

The spring may be so proportioned that it will cause maximum pressure of the rod 78 against the lever 52 when the latter is at full inner limit of movement at its upper end, and relatively little pressure, or none, thereagainst after it has moved a distance, because as soon as the valve 43 is unseated at the port 45 there is a rapid fall in the gas pressure tending to hold it seated there, and much less force is required to complete the movement of the valve until it approaches its seat in the port 30—*b*; the force of the spring 81 will not be required at this time, however, as the gas pressure acting through the duct 87 will complete the movement. This absence of action of the spring 81 when the valve 43 is in the right hand part of its movement as viewed in Figure 2 will facilitate movement of the valve to its opposite position by gas pressure acting thereagainst, because the momentum developed in the valve and connected parts by its initial movement after the cam 74 clears the wiper 75, will enable the force of the spring 81 to be easily overcome with lessened liability of interference by this spring with the closing of the atmospheric vent through port 45—*a*. Of course, the adjustment at 80 will also enable overcoming of such tendency, but with the differential action of the spring as explained a much greater load may be taken by the spring 81 from the clock mechanism in operating the lever 52 at the initial operation of the cam when such aid is most needed.

It should be also noted that in the operation of the piston and valve 22, while a very slight unseating of the valve 43 will reduce the difference in pressures above and below so that movement of the valve 22 may be initiated very slowly, there will no delay in completion of the movement of the valve 22 pending completion of the movement of the lever 52. On the contrary, as soon as the valve 22 has become unseated, the valve 28 will also be unseated, and through the port 26—*a* maximum high gas pressure will be quickly communicated to the under side of the piston 26 throughout its area, resulting in a quick operation of the piston and opening of the valve

22 to the full. Seating of the valve 28—*b* at completion of this movement will minimize leakage past the piston toward the atmospheric vent at 49, while the valve 43 is disengaged from the port 45—*a*. When the piston moves downward, the port 26—*a* relieves all back pressure thereunder to the outlet 23, and when the valve 28 is seated any tendency to leak past the piston toward the outlet 23 is counteracted.

While I have presented a specific embodiment of the invention with great particularity, it will be understood that various modifications of construction, proportions, shapes, sizes and materials of parts as well as substitution of equivalents and rearrangements, may be made without departing from the spirit of the invention as set forth more particularly in the appended claims.

It will be seen that due to the construction of my timer, if a failure of the clock mechanism should occur, there is a minimum liability of it causing stoppage of the control while the gas supply line is opened to the well pump chamber, as the auxiliary gas power applied immediately after opening of the valve 22 will insure completion of the pumping action and conclusion of that action after a proper interval, so that stoppage of inflow of oil to the well will not occur, nor will blow-through of gas to the oil lift line, with attendant interference with discharge from other wells, admission of gas to oil transportation lines, and risks incident to such faulty operation or action.

The assembly including the valve 43 has in use been termed a "pilot valve" since it controls the operation of the main valve; and the devices at the ratchet and cylinder 59—62 and 82—86 may each be termed a servo-motor broadly. The valve 98 may be considered a back pressure valve or check valve, or a pressure responsive valve. The interior of the cylinder 27 and valve 21 may be termed a pressure chamber in this device, and the piston and valve 22 may be termed a pressure responsive means.

The mechanism in the case 54 may be termed a motor or spring motor, or horological motor. The ratchets 59 and 82 function substantially as clutches. It will be understood that the term "wheel" will include a spider or one or more levers or arms rotating in a similar situation.

I claim:

1. In a system of the character described, a horological motor including a driven wheel, having a peripheral cam thereon, a high pressure fluid source, a conduit therefrom, a valve to intermittently open the conduit and to close the same, means to operate the valve including a yieldingly mounted wiper in the path of the cam, said means constructed to open the valve on initial engagement of the cam and wiper, to hold the valve open during such contact, and to close the valve on termination of said contact, said wiper consisting of a member rotatable on an axis normal to a radius of the wheel and having a peripheral surface concentric with its own axis longitudinally to an arc concentric with the axis of the wheel, and constituting the wiping surface against which said cam engages and rides, said surface being varied in length from a radius of initial engagement by the cam at different parts of its circumference, whereby the time of engagement of the cam therewith may be varied by rotative adjustment of the wiper on its own axis, and means to secure the wiper in adjusted positions on its axis.

2. The construction of claim 1, in which a plurality of cams are secured on said wheel adjustable to vary the interval between the termination of one contact of a cam with said wiper and the beginning of the next contact of a cam therewith.

3. In a system of the character described, a control timing device consisting of a spring motor including a winding shaft and a driven shaft, a high pressure fluid source, a control conduit therefrom, a valve to close and open said conduit, means operative between said driven shaft and the valve to operate the latter intermittently, a system control device in operative relation to the said conduit beyond the valve and responsive to pressures admitted past said valve, a reward cylinder, a piston reciprocable therein, a duct having communication controlled by said system control device with said high pressure fluid source and said cylinder, a lever oscillatable on said winding shaft, said piston in operative relation to the lever for movement of the latter in one direction by pressure fluid in the cylinder, means to return the piston and lever to initial positions under low pressure in the conduit when said valve is closed, and a clutch operative in one direction between the winding shaft and said lever.

4. In a system of the character described, a timing device consisting of a motor having a driven shaft, a high pressure fluid source, a control conduit therefrom, a valve to open and close said conduit, means operative between said driven shaft and the valve to operate the latter intermittently, a system control device in operative relation to the said conduit beyond the valve and responsive to pressures admitted past said valve, an auxiliary motor cylinder, a piston reciprocable therein, a duct having communication controlled by said system control device with said high pressure fluid source and said cylinder for movement of the piston in one direction at times by fluid pressure admitted through said duct, a lever oscillatable on the driven shaft, a clutch operative in the direction of normal rotation of the shaft between the lever and the shaft, said piston connected to the lever for movement of the latter in said direction under propulsion of the piston, whereby to augment the power of the motor, and means to return the lever and piston to initial positions at intermission of pressure in said duct.

ATHELSTAN T. WATSON.