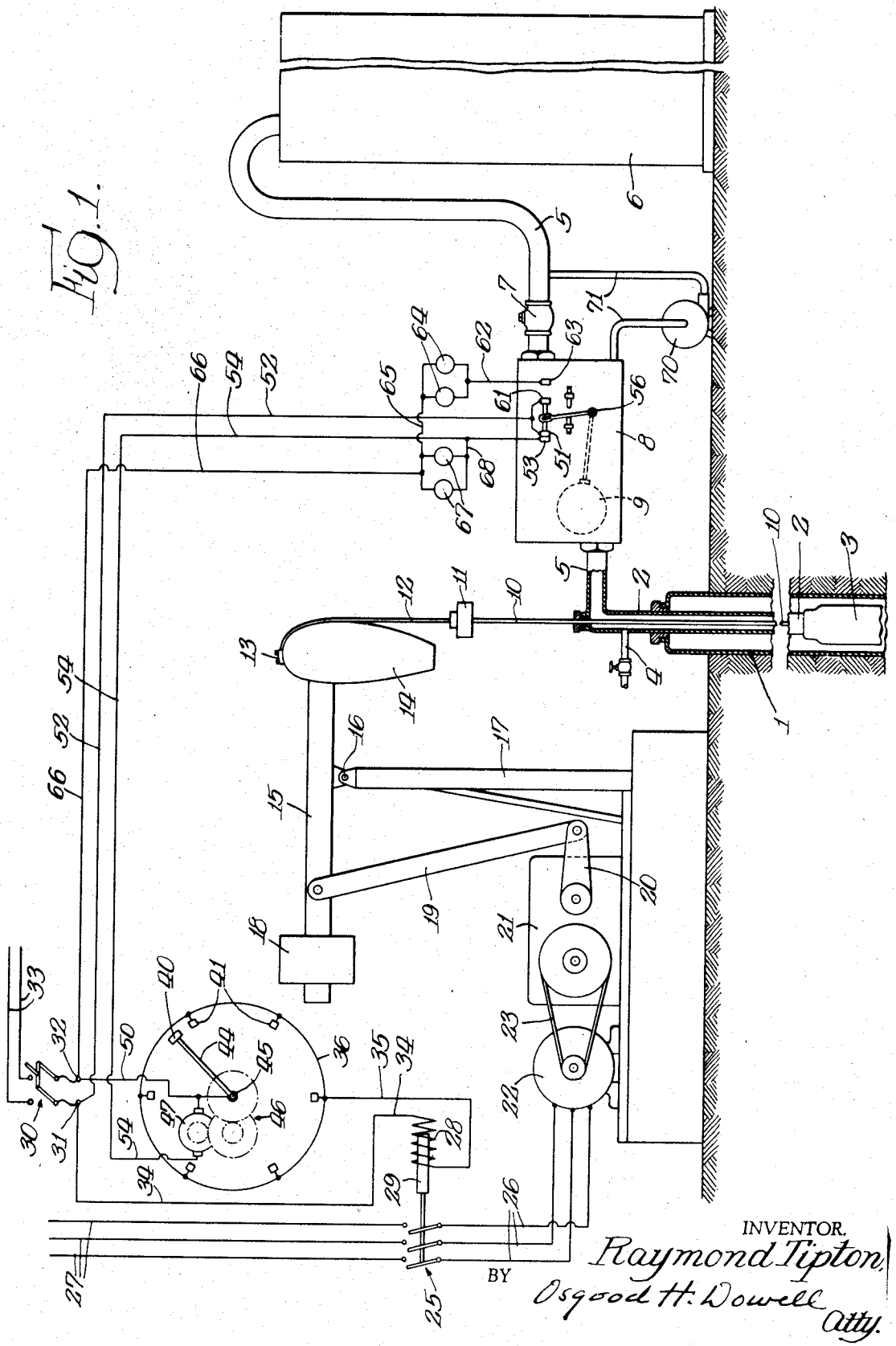
April 13, 1943. R. TIPTON 2,316,494

OIL WELL PUMP CONTROLLER

Filed May 12, 1941 3 Sheets-Sheet 1

Fig. 1.



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OIL WELL PUMP CONTROLLER

Filed May 12, 1941 3 Sheets-Sheet 2

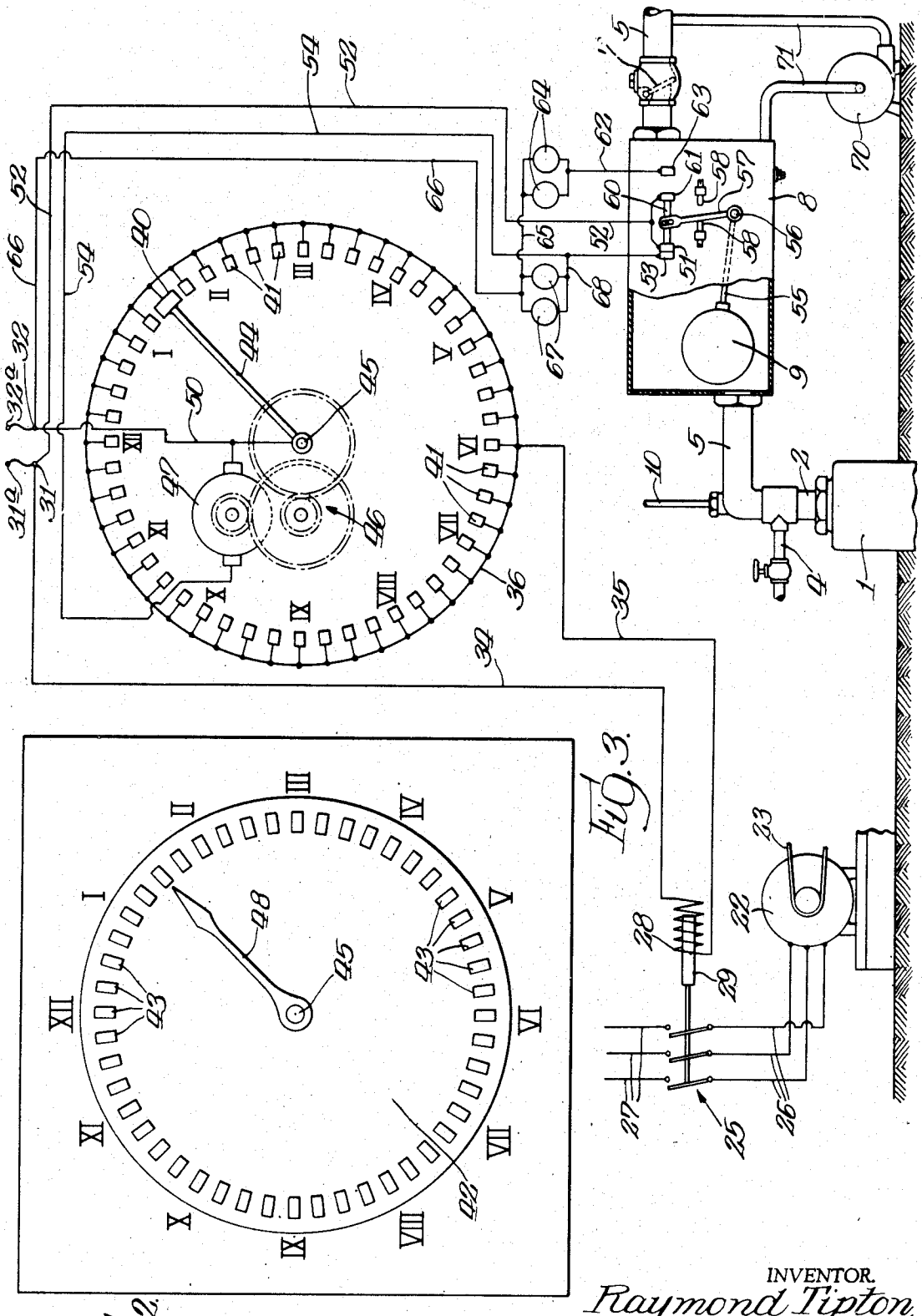


Fig. 3.

Fig. 2.

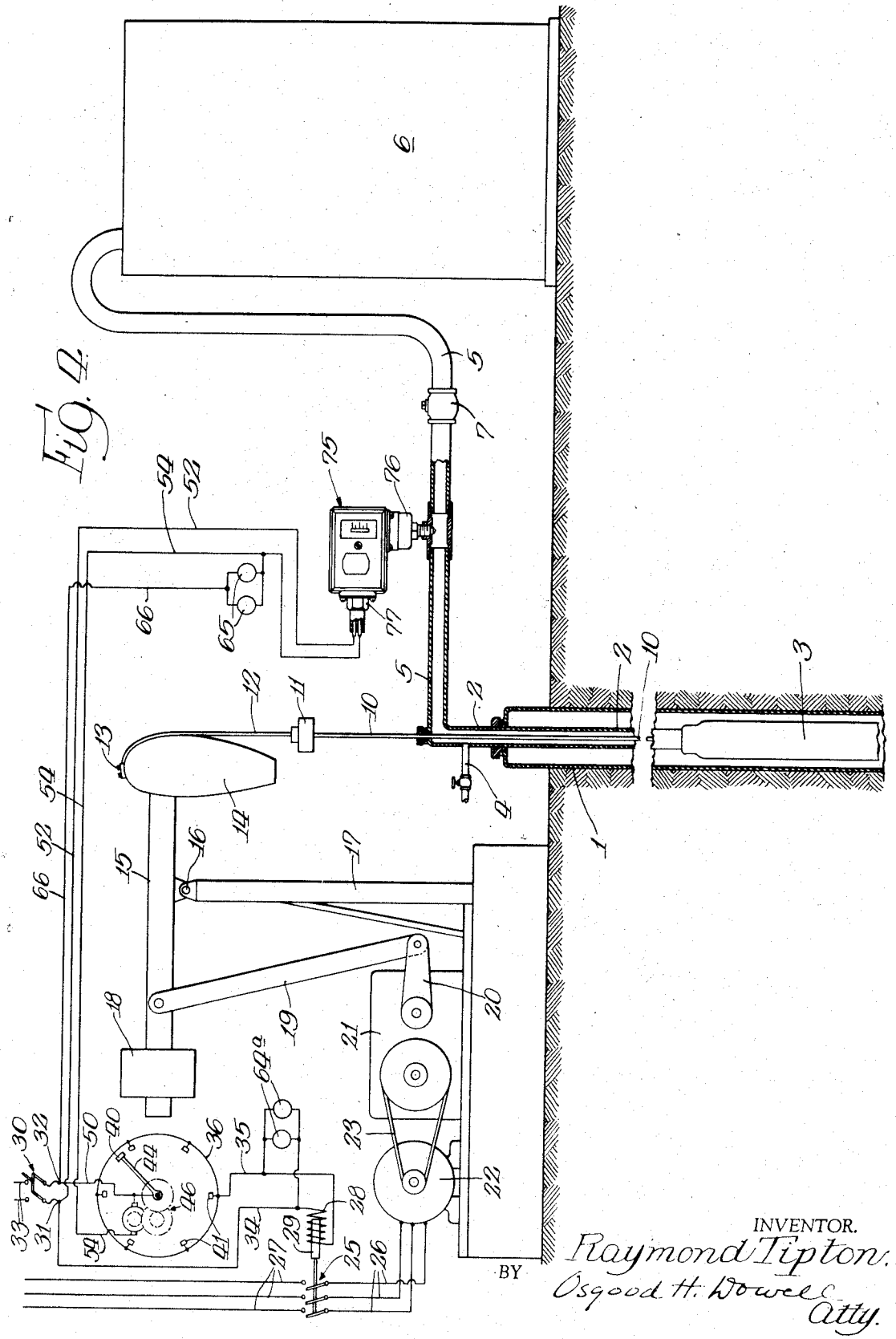
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OIL WELL PUMP CONTROLLER

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Fig. 2.



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UNITED STATES PATENT OFFICE

2,316,494

OIL WELL PUMP CONTROLLER

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Application May 12, 1941, Serial No. 393,085

9 Claims. (Cl. 103—25)

This invention relates to a system for operating and controlling an oil well pump.

After an oil well has been pumped off a number of times, it usually becomes necessary to operate the pump only intermittently or for periods of moderate duration in alternation with idle intervals of sufficient duration to allow replenishment of the oil pool at the bottom of the well. Common practice in the oil fields is to control the operation of the motors of such pumps by time switch clocks in such manner that the pumps will start in operation at certain times, continue in operation for definite periods, stop at certain times, remain idle for definite periods, and again resume operation at certain times. Predetermination of the durations of the periods of pumping and idleness is largely a matter of guess work. For example, if it be assumed that a well can be pumped off in about two hours, and that about three hours is required for replenishment of the oil pool at the bottom of the well, then the time switch clock is set to allow operation of the pump for two hour periods in alternation with three hour periods of idleness.

Such a practice is uneconomical and otherwise objectionable because it entails continuous motor operation of the pump for definite time periods, regardless of the actual time required for pumping off the well, and also regardless of possible breakage of the pump rod or its suspension cable. Deep in the ground, usually anywhere between 2,000 to 15,000 feet, the oil pool may at times contain more oil than the pump can pump out in its limited working period. Every time the pump stops before it has pumped off the well means lost production. Assuming that it does pump out all the oil from the pool before it stops, and then stands idle for two or three hours, the flow of oil from surrounding earth strata to the pool might reach its maximum level in an hour or two, or long before the pump can start again; in which event there is unnecessary idleness and again a loss of production. On the other hand, if the flow of oil to the pool is relatively slow, the supply of oil to the pump while operating may cease long before the termination of its predetermined working period; nevertheless the motor will keep on working, which is likely to cause damage to the pump. Again, in event of breakage of the pump rod or its suspension cable, the motor will continue in operation, with possibility of damaging transmission machinery.

With the motor controlling equipment commonly used in connection with oil well pumps, there being no automatic control to stop the motors when the wells have been pumped off, and attendants being busy with numerous pumps to look after, pumping units are sometimes left running for prolonged periods or for hours when not pumping any oil, which is a very undesirable condition. The only way the attendants have for determining when a well has been pumped off is to make a test by opening a tap-off in the upper end of the discharge pipe from the pump. If oil is being pumped from the well, it will discharge from the opened tap; whereas if the well has been pumped off there will be no discharge from the tap, due to the lowering of the oil column in the pump discharge pipe by settlement and back leakage through the pump. After it has been ascertained in this manner that a well has been pumped off, an attendant can stop the pump by opening a hand switch in the motor controlling circuit; but for lack of prompt discovery of the need for stopping, because of inattention or absence of busy attendants, the pump may be left running for an objectionably long period while not pumping oil; and, furthermore, the stopping of the pump by breaking the motor controlling circuit necessitates resetting of the time switch clock for controlling the time of starting and duration of the next pumping operation.

A need therefore exists in the oil fields for a means for controlling the operation of oil well pumps in such manner that the durations of their pumping periods will be substantially or approximately in accordance with the actual time periods required for the pumping off of the wells; or, in other words, a need exists for a means of control whereby an oil well pump can continue in operation so long as it is pumping oil, but will automatically stop when it has pumped off the oil, or for breakage, in response to cessation of discharge of oil from the pump.

Objects of the present invention are to provide practicable means for controlling the motor of an oil well pump to stop automatically when the pump has ceased to pump oil; and, more specifically, to provide a controlling system whereby the pump motor will be caused to operate continuously for periods of indefinite duration, while pumping off oil, in alternation with idle periods of predetermined duration; always stopping when or soon after the well has been pumped off, suspending operation for a predetermined time interval, and then automatically resuming operation.

The invention will be best understood by reference to an illustrative embodiment thereof shown in the accompanying drawings, wherein:

Fig. 1 is a diagrammatic representation of one practicable apparatus comprising a motor driven oil well pump and controlling system therefor embodying the invention.

Fig. 2 is a face view of a time switch clock employed in the motor controlling system.

Fig. 3 is an enlarged diagrammatic representation of the motor controlling system embodied in Fig. 1.

Fig. 4 is a diagrammatic representation of another embodiment of the invention.

In the drawings, 1 denotes the casing of an oil well from which oil is pumped through the pipe 2 by a pump 3 operating in the lower end of the well. A valved tap connection 4 with the pipe 2 enables one to ascertain whether or not the oil is being pumped. Upon opening the valve of this connection, oil will discharge therefrom if the pump is receiving and pumping oil. The oil pumped and raised through the pipe 2 discharges through a delivery conduit 5 to a storage tank 6. Usually a number of oil wells deliver to the same storage tank or to a common header leading thereto. In the delivery conduit is a check valve 7 opening in the direction of flow. Between the check valve and the well, the delivery conduit includes a closed float tank 8 containing a float 9 for operating movable contacts of a switching means hereinafter referred to.

As will be understood by those familiar with the art, a conventional oil well pump is a long barreled pump of the lift type which sucks oil through a strainer from the pool at the bottom of the well and lifts it through the pipe 2 extending through the well casing; the pump piston being raised and lowered by a suspended pump rod. In the drawings, 10 designates the pump rod having a stop head 11 to limit the downward movement of the rod and to prevent it from dropping into the well in case of breakage of a suspension cable. The pump rod is suspended by the cable 12 attached by the cable anchor 13 to the cable head 14 on the rocking walking beam 15 pivoted at 16 to the supporting post 17 and counterbalanced by the counterweight 18. The pump rod is raised and lowered by the operation of the walking beam to which rocking movement is communicated through the connecting rod 19 by the crank 20 operated through reducing gearing (not shown) contained in the gear box 21 and belt driven from the driven shaft of an electric motor 22. A multiple V-belt transmission for driving the gearing from the motor is indicated at 23. All of the parts thus far described may be of conventional or any approved construction.

It is desired to control the pump motor 22 to start at a given time and to continue in operation until the pump ceases to discharge oil, as when the well has been substantially pumped off; then automatically to stop and to remain idle for a predetermined time interval; then automatically to resume operation and again to continue in operation until the pump again ceases to discharge oil; and so on indefinitely, always stopping in response to cessation of the pumping of oil, and resuming operation only after approximately a predetermined time interval of sufficient duration to allow replenishment of the oil pool at the bottom of the well. It is further desired to employ in the motor controlling system a time switch clock of a type by which the durations of the periods of idleness of the motor can be variably predetermined at will; and to utilize a type of such device substantially identical to that commonly employed in the oil fields for the different purposes of controlling the motor to operate for definite time intervals in alternation with definite periods of idleness. The electric system of control including such time switch clock will now be described.

At 25 is indicated an automatic switch for closing and opening an electric circuit for controlling the pump motor, said circuit in this instance being the motor operating circuit. The pump motor 22 may be an electric motor of any suitable type for the work. A three phase alternating current motor is shown for example, this being the type of electric motor commonly employed for operating an oil well pump. The switch 25 is therefore represented as a three pole contactor for connecting the motor circuit conductors 26 with the corresponding mains 27 from a source of power or generator of triphase alternating current. A solenoid employed for operating the switch is indicated by the solenoid winding 28 and its movable armature 29. The switch may be spring actuated to position to hold the motor circuit open. When the solenoid is energized, the switch closes the motor circuit, and the motor will start and operate the pump so long as the solenoid remains energized. Upon de-energization of the solenoid, the switch will automatically assume position to open the motor circuit, stopping the operation of the pump.

The automatic switch 25 is a part of a pump motor controlling system including a time switch clock under control of the float 9 in the float tank 8. This system may be actuated by current derived from any appropriate source, with which the system can be connected by closing a hand switch 30 (Fig. 1) which for convenience will be referred to as the main switch, to distinguish from the various other switches of the system. Said main switch 30 is represented as a two pole knife switch, the poles of which are connected through suitable fuses with the terminals 31 and 32 of the motor controlling system. In Fig. 3 the main switch is not shown, but its poles connected with the system terminals 31 and 32 are indicated therein by the reference characters 31^a and 32^a. Said terminals 31 and 32 may be referred to as the main switch terminals. When the main switch 30 is closed, said terminals 31 and 32 are connected with the wires or conductors 33 representing the opposite sides of any appropriate energizing circuit, which may be, for example, a branch from an ordinary house lighting circuit for 120 or 240 volts alternating current.

Referring again to the automatic switch 25 for opening and closing the circuit of the pump motor 22, the solenoid 28 for operating said switch 25 is connected at one side through the conductor 34 with the main switch terminal 31, and at the other side through the conductors 35 and 36 with contacts of the time switch clock, through which connection is intermittently made with the other main switch terminal 32 as hereinafter explained.

Forming a part of the motor controlling system, a time switch clock having contacts which can be selectively adjusted, whereby the circuit controlled by the clock can be maintained open for periods of predetermined durations in alternation with the periods of closure of such circuit, is diagrammatically represented in the drawings, the face of the clock being shown in Fig. 2 and the mechanism and electrical connections thereof in Fig. 3. The particular time switch clock selected for illustration, and so diagrammatically represented, is or may be substantially identical in construction to those now employed in the oil fields for controlling a motor to operate for definite time periods in alternation with definite periods of idleness; but in the controlling system of the present invention the clock is so electrically connected and controlled that it operates quite differently from those now

so employed, and for the distinctive new function hereinbefore indicated.

This time switch clock comprises a revolving contactor 40 and an annular series of stationary contacts 41 arranged according to time divisions of an ordinary clock dial, in this instance being arranged at angular positions corresponding to the hour and quarter hour divisions of a clock dial. In Fig. 1 only the contacts 41 at the hour divisions are shown, while in Fig. 3 all of the contacts 41 are shown. Said contacts 41 are in a plane away from the path of revolution of the revolving contactor, but any one or more of them can be moved to position to be contacted by the revolving contactor in the course of its revolution.

A substantial period of time is consumed by the movement of the revolving contactor past and in contact with any of the contacts 41 which it may engage, and, if two adjacent contacts 41 are positioned to be contacted by the revolving contactor, the latter before moving from contact with one of them will have come into contact with the other. In the actual apparatus diagrammatically represented, it takes fifteen minutes for the revolving contactor to move past and out of contact with any of the contacts 41 which it may engage.

Projecting through the face of the clock dial 42 shown in Fig. 2 are a series of pins or studs 43 respectively operatively associated with the contacts 41 and correspondingly arranged. Usually the studs arranged at the hour divisions of the clock dial are distinctively colored. If desired the clock dial may be provided with indicia as represented by the Roman symbols I to XII inclusive. For convenience such Roman symbols I to XII inclusive are also shown in Fig. 3 in association respectively with the contacts 41 situated at positions corresponding to the hour divisions of the clock dial. The studs 43 can be pulled forward individually or in groups, with the effect of moving the corresponding contacts 41 to position to be contacted by the revolving contactor 40.

Said revolving contactor 40 is carried by an arm 44 from a shaft 45 driven through suitable clock work 46 from a small electric motor 47. Fixed on said shaft is a clock hand 48 parallel with the arm 44 carrying the revolving contactor, said clock hand revolving with and in fixed relation to the revolving contactor 40 but functioning merely as an indicator or pointer. The revolving contactor 40 being connected with one side of an electric circuit, and the contacts 41 being all connected with the other side of such circuit, it will be apparent that as the clock hand revolves said circuit will be closed while the revolving contactor is in contact with any one or more of the contacts 41, and open while there is no such contact.

Under present practice in the oil fields, where pump motors are controlled by time switch clocks of this description, it is necessary to pull forwardly all the studs 43 in those sectors of the clock dial which represent the intervals of time during which the motor is intended to operate; whereas in practice with the motor controlling system of the present invention it is only necessary to pull forwardly selected stops angularly spaced according to desired durations of idleness between successive operating periods. As previously indicated, the clock as thus far described is not novel in its construction; but, by virtue of the electrical connections and manner of control now to be described, the clock is novel in its use, mode of operation and functioning.

The time switch clock runs not continuously but intermittently or with periods of interruption, under control of the float 9 in the float tank 8. The clock starts running after the pump while operated by its motor ceases to pump oil. Soon after the clock starts, the pump stops, and the clock keeps on running continuously during the entire period of idleness of the pump, and until the pump again resumes its operation. But soon after the pump resumes operation the clock stops and remains still until, after the motor-operated pump again ceases to pump oil, conditions are re-established for starting the clock. The manner of thus controlling the clock by the float 9 will be hereinafter explained.

Stoppage of the time switch clock has no effect upon the circuit of the solenoid 28 for operating the automatic switch 25 which controls the circuit of the pump motor. Whether or not the clock is running, the solenoid 28 will always be and remain energized, holding the switch 25 closed, so long as contact exists between the revolving contactor 40 and any of the annular series of time switch contacts 41. One terminal 32 of the main switch 30 is connected with the revolving contactor 40 through the conductor 50, shaft 45 and arm 44 carrying said contactor. All of the annular series of stationary contacts 41 are connected to a conductor 36 which is connected to the wire 35 leading to one terminal of the solenoid 28, the other terminal of which is connected by the wire 34 with the other main switch terminal 31. Hence, in the operation of the clock, whenever the revolving contactor 40 contacts with one of the contacts 41, a circuit for energizing the solenoid 28 is established from the switch terminal 32 through conductor 50, revolving contactor 40, that one of the contacts 41 which contacts with 40, conductor 35, solenoid 28, and conductor 34 to the other switch terminal 31. Energization of the solenoid 28 causes switch 25 to close the circuit of the pump motor 22, which thereupon starts and operates the pump. The solenoid remains energized, whether or not the clock continues in operation, so long as contact between the revolving contact 40 and any of the contacts 41 exists. If therefore the clock stops with the revolving contactor 40 in contact with that one of the contacts 41 which it has engaged, the circuit of the pump motor will remain closed and the motor will continue to operate the pump. But when, after the pump ceases to pump oil, the clock resumes operation as hereinafter explained, it will move the revolving contactor 40 from contact with that one of the contacts 41 with which it was engaged, thus opening the solenoid circuit, with consequent opening of the switch 25 and pump motor circuit, stopping the pump.

Controlled by the float 9, the circuit for operating the clock motor 47 is periodically closed through switch contacts 51 and 53 and circuit wires 52 and 54 respectively connected with said contacts; the wire 52 being connected with the main switch terminal 31, and the wire 54 being connected with one side of the clock motor which at the other side is connected through the conductor 50 with the other main switch terminal 32. Thus the clock motor circuit when closed is from terminal 32 through conductor 50 and motor and circuit wires 54 and 52 to terminal 31.

Reference will now be made to the float tank

8. The float 9 therein is carried by an arm 55 attached to a rock shaft 56 projecting through a stuffing box in a side wall of the tank. Fixed to said rock shaft on the outside of the tank is an arm 57 for moving back and forth a slide 60 carrying the movable contact 51 connected with the wire 52; the other contact 53 connected with the wire 54 being stationary. In this instance the slide 60 also carries a contact 61 for coacting with a stationary contact 63 to close a signal circuit. Both of the contacts 51 and 61 carried by the slide 60 are connected with the main switch terminal 31 through the wire 52, while the wire 62 is connected through green signal lamps 64 and conductor 65 to the wire 66 connected to the main switch terminal 32. The wire 66 is connected through red signal lamp 67 and conductor 68 to the wire 54 connected with one side of the clock motor 47. Movement of the slide 60 to the left separates the contacts 61 and 63 and brings the contacts 51 and 53 into contact with each other, thus closing the circuit of the clock motor 47 through the circuit wires 50, 52 and 54 and also closing the circuit through the red signal lamps 67, with resulting illumination of the latter. This operation takes place when the float 9 assumes a lowered position in the float tank. Movement of the slide 60 to the right separates the contacts 51 and 53, thus opening the circuits of the clock motor and red signal lamps 67, and brings the contacts 61 and 63 into contact with each other, thus closing the circuit of the green signal lamps 64 with resultant illumination of the latter; this operation taking place when the float rises to its upper position. To relieve the switch contacts from undue strain, the movement of the rocker arm 57 for shifting the contact carrying slide 60 may be limited by suitable adjustable stops 58.

As an additional feature which may be desirable in many cases to expedite the lowering of the liquid level in the float tank 8 when the pump ceases to pump oil, there is shown in association with the float tank a small auxiliary pump 70 arranged to pump oil through a small bore conduit 71 from the float tank 8 into the delivery conduit 5 beyond or at the outlet side of the check valve 7; said pump being arranged to take liquid from the tank 8 by gravity feed from the tank. This auxiliary pump if of the reciprocatory type could be operated in any appropriate way from the walking beam 15. If of the centrifugal type, which is preferred, it may be driven by any appropriate belt drive from the pump motor 22 or the shaft of the crank 20. The pump 70 will therefore operate as long as the oil well pump operates.

Mode of operation

Assuming the main switch 30 to be closed, then if and whenever the revolving contactor 40 is in contact with any of the time switch contacts 41, whether or not the time switch clock is running, a circuit for energizing the solenoid 28 is closed from the main switch terminal 32 through the conductor 50, revolving contactor 40, that one of the contacts 41 which is contacted by the revolving contactor, conductors 36 and 35, solenoid 28, and conductor 34 to the other main switch terminal 31. The solenoid being energized operates and holds the automatic switch 25 in position to close the circuit of the pump motor 22. The pump motor can operate only while the circuit of the solenoid is closed through the revolving contactor 40 in contact with one of the contacts 41. It will operate, whether or not the clock is running, so long as such contact between 40 and any contact 41 exists. It will stop the instant such contact ceases, and it will remain idle from the time the revolving contactor 40 moves from contact with one of the contacts 41 until it comes into contact with another of such contacts 41.

The time switch clock runs only intermittently, the circuit of the clock motor 47 being controlled by the float 9 in the float tank 8. While the pump is operating and pumping oil, which flows through the float tank 8 and past the check valve 7 to the storage tank 6, the float 9 being in a raised position maintains the contacts 51 and 53 separated, so that the clock motor circuit is open and the clock is dead; though the pump is operating by virtue of contact of the revolving contactor 40 with one of the contacts 41. While the float is in such raised position, it holds the contacts 61 and 63 in contact with each other, thus closing the circuit of the green signal lamps 63, which shine to indicate that the pump is pumping oil.

When the pump ceases to pump oil, due either to its having pumped off the well or to breakage of its pump rod or suspension cable, oil ceases to flow to the float tank. Back flow through the check valve 7 is prevented through the closure of that valve. Now the level of the liquid in the float tank commences gradually to lower, due to settlement of the oil column in the pump discharge pipe 2 and back leakage through the pump. Lowering of the liquid level in the float tank may be expedited by auxiliary means represented by the small pump 70 arranged to pump oil through a small bore conduit 71 from the float tank 8 into the delivery conduit 5 beyond or at the outlet side of the check valve 7. When the oil level in the float tank becomes low enough to allow the float 9 to move the contacts 51 and 53 into contact with each other, the circuit of the clock motor 47 is closed from the main switch terminal 32 through conductor 50, motor 47, wire 54, contacts 51 and 53 and wire 52 to the other main switch terminal 31. Now, the contacts 61 and 63 being separated, the green lights 63 are extinguished, and the red lamps 66 are lit to indicate that the pump is to be stopped and go into a period of idleness. The clock now running moves the revolving contactor 40 from contact with the selected contact 41 with which it was contacting, thus opening the circuit of the solenoid 28, with resultant opening of the automatic switch 25 and pump motor circuit controlled thereby, stopping the operation of the pump motor 22 and the pump. The clock now continues to move the revolving contactor 40, but the pump and its motor 22 remain idle during the entire interval until the advancing contactor 40 makes contact with the next one of the contacts 41 which is set in position to be contacted thereby. This is the condition represented in Fig. 1, where only certain selected angularly spaced contacts 41 set to be contacted are shown, and all the others, which are not positioned to be contacted by the revolving contactor, are omitted from the representation. It may be assumed also in Fig. 3 that only those contacts 41 corresponding to those shown in Fig. 1 have been set to be contacted by the revolving contactor, all the others being in their normal positions to be cleared by the revolving contactor, so that they may be ignored. With this explanation, the drawings may be understood as representing a condition where, with the time switch clock running, the revolving

contactor 40 is moving but not in contact with any of the contacts 41, so that the circuits of the solenoid 28 and of the pump motor 22 are open, the pump motor and the pump being therefore idle.

The pump and its motor will remain idle until, by the operation of the clock, the revolving contactor 40 will advance into contact with the next one of the contacts 41 which is set to be contacted thereby. When the revolving contactor 40 comes into contact with such next selected contact 41, the solenoid 28 becoming energized will actuate the switch 25 to close the circuit of the pump motor, which will therefore resume operation of the pump. Then, while the revolving contactor 40 is moving in contact with such next selected contact 41, the pump pumps oil which rises in the pipe 2 and after a while again flows into the float tank 8, lifting the float and causing separation of the contacts 51 and 53, thereby breaking the circuit of the clock motor. So the clock stops, with the revolving contactor 40 in contact with one of the contacts 41, and therefore the stoppage of the clock has no effect upon the pump motor, which will keep on running and will continue to operate the pump for an indefinite period so long as it pumps oil. But when the motor driven pump again ceases to pump oil, the float 9 will soon again be lowered to position to bring the contacts 51 and 53 into contact with each other, as already explained, again closing the circuit of the clock motor, resumption of the operation of which will move the revolving contactor 40 from contact with that selected one of the contacts 41 engaged thereby, thus again causing opening of the pump motor circuit and stoppage of the pump.

Summarizing briefly, the pump operates while the clock is dead, the revolving contactor 40 being at rest in contact with one of the contacts 41. Soon after the pump ceases to pump oil, the float 9 goes down, thus starting the clock which moves said contactor 40 from said contact, thus stopping the pump motor. The pump remains idle while the clock continues to run. After a predetermined interval of time, the contactor 40 comes into contact with the next one of the stops 41 set to coact therewith, starting the pump. After the pump resumes operation, oil rising in the pipe 2 will flow into the float tank, raising the float and stopping the clock, but without effect upon the pump motor by virtue of the then existing contact between the contactor 40 and said next one of the contacts 41.

During the pumping periods, the green signal lamps 64 are lit, and the red lamps 67 extinguished. The green lamps 64 will be extinguished when, as a result of cessation of the pumping of oil, the float lowers sufficiently to separate the contacts 61 and 63. When the float lowers sufficiently to bring the contacts 51 and 53 into contact with each other, for closing the circuit of the clock motor, the red lamps 67 are lit, and they will remain lit during the ensuing interval of idleness; the red lamps being connected in circuit with the wires 66 and 54 when the float is down, and the green lamps being connected in circuit with the wires 66 and 62 when the float is up.

From the foregoing description of the mode of operation of the pump motor controlling system, it will be apparent that every time the circuit of the pump motor 22 is closed the motor will run continuously and operate the pump until it ceases to pump oil, and will automatically stop when the well has been pumped off, or in response to cessation of the pumping of oil, as soon as the lowering of the liquid level in the tank 8 allows the float 9 to assume its lowered position and bring the contacts 51 and 53 into contact with each other; and that the pump motor and pump will then remain idle for a time interval of predetermined duration, namely from the time of movement of the revolving contactor 40 out of contact with a selected contact 41 to the time it comes into contact with the next selected one of such contacts 41; and will then automatically resume operation and again operate continuously until it again pumps off the well or, on account of breakage, ceases to pump oil. By selective setting of the contacts 41 of the clock time switch, the pump can be controlled to operate for indefinite periods terminating in response to the pumping off of the well, in alternation with either equal or unequal idle periods of predetermined duration. For example, the pump may be controlled to start into operation every one and three quarters hours after it has ceased operation by setting the clock time switch so that the revolving contactor will successively contact with selected contacts 41 angularly spaced according to such desired idle intervals or situated at every other hour division of the clock dial. Assume for instance in the drawings that the contacts 41 angularly situated at the two o'clock, four o'clock, six o'clock, eight o'clock and twelve o'clock positions of the clock hand are set to be successively contacted by the revolving contactor, while all the other contacts 41 are in their normal position so that they would not be contacted. With the time switch so adjusted, the pump will start its successive working periods as the clock hand successively reaches said positions. Every time the pump starts it will operate for an indefinite period until it ceases to pump oil, and it will then stop. It will then remain idle one and three quarters hours, that being the time consumed by the movement of the revolving contactor 40 from contact with one of the selected contacts 41 into contact with the next; due to the fact that, with the particular time switch clock selected for illustration, fifteen minutes is required for the revolving contactor to move past and in contact with an individual contact 41.

When an oil well pump stops, it sustains a standing column of oil in the pipe 2, but, as previously mentioned, the level of the oil column lowers as a result of back leakage through the pump. Usually or frequently there will be a lowering of the liquid level in the float tank several inches in a few minutes or as much as six inches in five minutes. The apparatus comprising the float tank and associated equipment may be so designed that the float will need to drop only a short distance to bring the contacts 51 and 53 into contact with each other, for stopping the operation of the pump. The lowering of the liquid level in the float tank by back leakage through the pump may therefore be utilized for controlling the operation. But to insure promptness in stopping the pump after it has ceased to pump oil, it is desirable to employ the auxiliary pump 70 or other appropriate auxiliary means for prompt lowering of the liquid level in the float tank.

On the other hand, it is assumed that after the pump has been idle only a few hours since the last pumping of the well, the resumption of the pumping operation will cause the oil col-

umn to rise and oil to flow into the float tank and lift the float 9 sufficiently to separate the contacts 51 and 53 within less than fifteen minutes, during which time the revolving contactor 40 is moving past and in contact with that one of the contacts 41 with which it has engaged. To suit conditions, if any, where a greater time interval than fifteen minutes would be required after the pump starts for the oil to flow into the float tank, the revolving contactor 40 could be proportioned to remain in contact for a longer time with an individual contact 41; or, with the particular time switch clock selected for diagrammatic illustration and herein described, the contacts 41 could be utilized in suitably angularly spaced pairs set to be successively contacted by the contact 40, each of such pairs comprising two adjacent contacts, so that a half hour would be consumed in the movement of the revolving contactor past and in contact with the contacts or one or the other of the contacts of each such pair.

If the auxiliary pump 70 and connections should be omitted, then, while the clock is still with the revolving contactor 40 in contact with one of the contacts 41, the oil well pump will continue to operate so long as it continues to pump oil in a material amount or at a sufficient rate to keep the float tank full and the float in its elevated position. Pursuant to or after cessation of such pumping at such rate, and consequent lowering of the liquid level in the float tank, the float will drop to its lowered position, closing the circuit of the clock motor and causing the revolving contactor to move from the contact 41 with which it was engaged, thus stopping the oil well pump as previously described. If the auxiliary pump 70 be employed, then while the oil well pump is operating the auxiliary pump 70 is removing oil from the float tank at a certain rate relatively low as compared with the rate of pumping by the oil well pump. When the oil well pump ceases to pump oil into the float tank as fast as the oil is being removed from the tank by the auxiliary pump 70, there will be a lowering of the liquid level in the float tank and soon the clock circuit will be closed with ensuing stoppage of the operation of the motor of the oil well pump. Hence the statements that the oil well pump operates so long as it continues to pump oil and that the clock circuit opens pursuant to such pumping and closes pursuant to cessation thereof, are to be considered in a broad sense as applying to either or both of the different conditions which have just been referred to, as well as to the condition to be described with reference to Fig. 4. By employing a turnplug valve in the inlet conduit to the auxiliary pump 70, the rate of flow to the auxiliary pump may be varied to vary the control exercised by the float.

The invention promotes economical operation of an oil well; allows operation in a manner to obtain maximum production; eliminates uncertainty as to whether the well is pumped off or not; prevents the useless and costly running of the pump when not pumping any oil; reduces labor of attendants, decreases operating and maintenance costs, and provides a great measure of protection against damage of the pump and pumping unit. If the pump should start and for any reason whatever not pick up the oil, then the longest time it could possibly run is the fifteen minute interval while the contactor 40 passes in contact with an individual contact 41.

In the organization which has been described, a means controlled by the pumping of oil by the pump, to open the circuit of the clock motor pursuant to such pumping and to close such circuit pursuant to cessation thereof, is provided by a switch operated by a float in a tank connected with the pump discharge line; the tank being connected and arranged so that when oil is pumped from the well it flows into or through the tank or maintains a relatively high liquid level therein, and when the pump ceases to pump oil and the column in the discharge pipe lowers the oil will flow back from said tank into said discharge pipe; auxiliary means being provided, as represented by the pump 70, for expeditiously emptying the tank or lowering the liquid level therein pursuant to the cessation of pumping of oil. Instead of this specific apparatus, other means controlled by the pumping of oil from the well to open and close the circuit of the clock motor pursuant to such pumping and cessation thereof may be employed. For example, instead of a float controlled switch, there may be employed a pressure actuated switch controlled by pressure in the delivery conduit 5. There are known and in use in industry, for controlling electric circuits by fluid pressure, pressure actuated switches which can be regulated or adjusted to close at any predetermined pressure within a certain range of pressures and to open at any predetermined higher pressure within such range. One example of such a switch is that known as the "Square D regulator," Class 9100, direct action type, manufactured by the Square D Company of Detroit, Michigan. It comprises a magnetically influenced single pole switch actuated by means including a bellows type diaphragm on which fluid pressure acts in opposition to a spring the tension or force of which can be adjusted, and has in association with the switch adjustable means whereby in conjunction with the adjustment of the spring tension the switch is controlled to close at a predetermined pressure within a certain range of pressures and to open at a predetermined higher pressure within such range. Assuming such device to be installed in connection with the delivery conduit 5, so as to be controlled by the pressure in such conduit, and arranged for controlling the circuit of the clock motor by connecting the circuit wires 52 and 54 with the contacts of such pressure actuated switch, instead of with the contacts 51 and 53 of the float actuated switch previously described, and assuming that the device is adjusted to operate as above stated, it will be apparent that the circuit of the clock motor will be opened in response to a predetermined pressure in the conduit 5 attained while the pump is pumping oil to the storage tank 6 and to close at a predetermined lower pressure resulting from the cessation of the pumping of oil by the pump.

Fig. 4 diagrammatically represents a motor driven oil well pump and controlling system for the pump motor in which such a pressure actuated switch is employed in lieu of the float and float tank previously described. In Fig. 4, the pump, its motor 22 and means for driving the pump from the motor, and the electrical controlling system for the motor, including the time switch clock and its circuit connections and the clock motor and its circuit connections, are all identical to those previously described and are designated by the same reference numerals as in the preceding figures. But instead of the float and float tank, there is employed in Fig. 4 a

"Square D regulator" the box or casing of which is designated by the numeral 75. This device is connected with the delivery conduit 5 between the pump discharge pipe and the check valve 7, so that the switch contained in the box 75 will be controlled by the pressure in said conduit. The circuit wires 52 and 54 of the clock motor circuit, instead of being connected to contacts of a float controlled switch, are connected to the contacts of the single pole pressure actuated switch contained in the box 75. It may be assumed that the mechanism contained in the box 75 is set so that the switch will close at a relatively low pressure, for instance half a pound, resulting from the cessation of pumping of oil, and will open at a predetermined relatively higher pressure, for instance six pounds, attained when the pump is pumping oil against head in the vertical part of the delivery conduit leading to the storage tank 6. It will be apparent that the switch in the box 75 will be opened when, after the starting of the pump, the oil flows into the vertical part of the delivery conduit to a sufficient height to provide the necessary head for the pressure of six pounds, and that, upon cessation of the pumping, the check valve 7 being then closed, the switch in the box 75 will close, thus starting the clock. The operation of the apparatus in Fig. 4 is identical with that described in the preceding figures, except that the opening and closing of the clock motor is controlled by pressure conditions in the delivery conduit 5, instead of by switch actuated by a float in a tank connected with the pump discharge pipe.

In Fig. 4, the numeral 76 designates the diaphragm pot in which works the bellows type diaphragm for actuating the mechanism in the box 75, said diaphragm being exposed to pressure of liquid in the conduit 5 through a bore in the nipple of the diaphragm pot, and, as before stated, operating against a spring resistance. The numeral 77 designates an apertured fitting through which extend the insulated circuit wires 52 and 54 which are connected with the contacts of the single pole pressure actuated switch within the box 75.

In lieu of the green lamps 64 and circuit connections thereof shown in the preceding figures, Fig. 4 employs green lamps 64a connected across the lines of the circuit of the solenoid 28, so that the green lamps are lit while the pump is being operated.

Obviously the illustrative apparatus are susceptible of various modifications in details of construction and arrangement to suit various different requirements and conditions; moreover it is not indispensable that all of the features of the invention be used conjointly, since different features thereof may be advantageously used in various different combinations and subcombinations.

I claim as my invention:

1. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit controlled thereby, means controlled by said clock through said circuit to stop the pump motor when the clock hand reaches a certain position and to start the pump motor when the clock hand reaches a certain succeeding position, an electric circuit for actuating said clock, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping and for closing it pursuant to cessation of such pumping, whereby during such pumping of oil by the pump the clock stops and stands still and the motor operates the pump independently so long as it pumps oil and upon cessation thereof the clock resumes operation and moves its hand to position to stop the motor which then remains idle for a definite time interval until the clock hand moves to position to start the motor.

2. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit alternately closed and opened by said clock, means controlled by said clock through said circuit to successively stop the pump motor as the clock hand successively reaches certain positions and to successively start the pump motor as the clock hand successively reaches certain other positions intermediate those first mentioned, an electric circuit for actuating said clock, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping and for closing it pursuant to cessation thereof, whereby during such pumping of oil by the pump the clock stops and stands still and the motor operates the pump independently so long as it pumps oil and upon cessation thereof the clock resumes operation and moves its hand to a position to stop the motor which then remains idle for a definite time interval until the clock hand moves to position to start the motor; said clock embodying means selectively manipulatable for determining the clock hand positions at which the pump motor starts and stops and by which the periods of idleness of the pump can be of predetermined durations.

3. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit controlled thereby to be opened for periods of definite duration in alternation with periods of closure of said circuit, means controlled by said clock through said circuit for starting and stopping the pump motor upon closing and opening of said circuit, an electric circuit for actuating said clock, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping and for closing it pursuant to cessation thereof, whereby during such pumping the clock stops and stands still and the pump motor operates the pump indefinitely so long as it pumps oil and upon cessation thereof the clock resumes operation and causes opening of said first mentioned circuit and stoppage of the pump motor which will remain idle for a definite time interval until the clock again closes said first mentioned circuit.

4. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit controlled thereby, means controlled by said clock through said circuit to stop the pump motor when the clock hand reaches a certain position and to start the pump motor when the clock hand reaches a certain succeeding position, an electric circuit for actuating said clock, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping and for closing it pursuant to cessation of such pumping, whereby during such pumping of oil by the pump the clock stops and stands still and the motor operates the pump independently so long as it pumps oil and upon

cessation thereof the clock resumes operation and moves its hand to position to stop the motor which then remains idle for a definite time interval until the clock hand moves to position to start the motor, and different electric signals and circuits therefor controlled by said means controlled by the pumping of oil, the circuit of one of said signals being closed by the closing of said clock actuating circuit and the circuit of the other signal being closed after the opening of the clock actuating circuit and while the oil is being pumped and discharged from the well.

5. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit controlled thereby, means controlled by said clock through said circuit to stop the pump motor when the clock hand reaches a certain position and to start the pump motor when the clock hand reaches a certain succeeding position, an electric circuit for actuating said clock, an electric signal connected across the lines of said clock actuating circuit, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping and for closing it pursuant to cessation of such pumping, whereby during such pumping of oil by the pump the clock stops and stands still and the motor operates the pump independently so long as it pumps oil and upon cessation thereof the clock resumes operation and moves its hand to position to stop the motor which then remains idle for a definite time interval until the clock hand moves to position to start the motor, said signal being actuated pursuant to cessation of pumping of oil and thereafter during and until termination of the ensuing period of idleness of the pump.

6. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, an electrically operated time switch clock, an electric circuit controlled thereby, means controlled by said clock through said circuit to stop the pump motor when the clock hand reaches a certain position and to start the pump motor when the clock hand reaches a certain succeeding position, an electric circuit for actuating said clock, an electric signal connected across the lines of said clock actuating circuit, another electric signal and separate circuit therefor, automatically operated switch means which in one position closes the clock actuating circuit and signal circuit in connection therewith and in its opposite position closes the other signal circuit, and means controlled by the pumping of oil by the pump for operating said switch means to assume the first mentioned position pursuant to cessation of such pumping of oil and assume the second mentioned position pursuant to resumption of the pumping of oil and discharge thereof from the well.

7. A system for controlling a motor operated oil well pump comprising, in combination with said pump and its motor, a time switch clock comprising an electric motor and movable contactor operated thereby and spaced stationary contacts successively contactable by said movable contactor, an electric circuit closed by contact of said movable contactor with any of such stationary contacts, means controlled by said clock through said circuit to start and stop the pump motor upon closing and opening of said circuit, a circuit for operating said clock motor, and means controlled by the pumping of oil by the pump for automatically opening said clock motor circuit pursuant to such pumping, whereby to stop the clock with its movable contactor in contact with one of said stationary contacts, and for closing said clock motor circuit pursuant to cessation of such pumping of oil, whereby to cause said movable contactor to move from contact with the stationary contact with which it was engaged and to suspend operation of the pump motor for a definite time interval until the movable contactor comes into contact with the next stationary contact which is contactable thereby.

8. A system for controlling a motor operated oil well pump comprising, in combination with said pump and an electric motor for operating it, an automatically operated switch for closing and opening the operating circuit of said motor, means electrically energizable controlling said switch to close upon energization of said means and to open upon deenergization thereof, an electric circuit for energizing said means, a time switch clock for alternately closing and opening said last mentioned circuit, said clock comprising an electric motor and traveling contactor operated thereby and spaced stationary contacts successively contactable by said traveling contactor, the circuit for energizing said means being made by contact of said traveling contactor with any of said stationary contacts; an electric circuit for actuating said clock motor, and means controlled by the pumping of oil by the pump for automatically opening said clock actuating circuit pursuant to such pumping, whereby to stop the clock with its movable contact in contact with one of such stationary contacts, and for closing said clock motor circuit pursuant to cessation of such pumping of oil, whereby to cause said travelling contactor to move from contact with the stationary contact with which it was engaged and to suspend operation of the pump motor for a definite time interval until the travelling contactor comes into contact with the next stationary contact which is contactable thereby.

9. In an oil well pump controlling system, the combination comprising an oil well, a pump therein for pumping oil from the pool at the bottom of the well, a pump discharge pipe extending up through the well casing and through which oil is raised by the pump, a delivery conduit extending from the upper end of said pipe, a check valve therein arranged to open in the direction of flow and to prevent back flow past said valve, a float chamber included in said conduit between said pipe and check valve, said chamber being arranged for back flow therefrom to said pipe when as a result of cessation of discharge from the pump a sufficient lowering of the level of the oil column takes place, a float in said chamber, a motor and means operated thereby for operating said pump, and electrical means controlling said motor and controlled by said float to stop the motor pursuant to a lowering of the float, and means for expediting the lowering of the level in said tank comprising a small bore passage from said tank to said delivery conduit beyond said check valve and an auxiliary pump for pumping liquid from the tank through said passage to said delivery conduit.

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