Dec. 22, 1970 J. R. WALDING, JR 3,549,276

MECHANISM FOR CONTROLLING THE OPERATION OF PUMPS

Filed Nov. 25, 1968 2 Sheets-Sheet 1

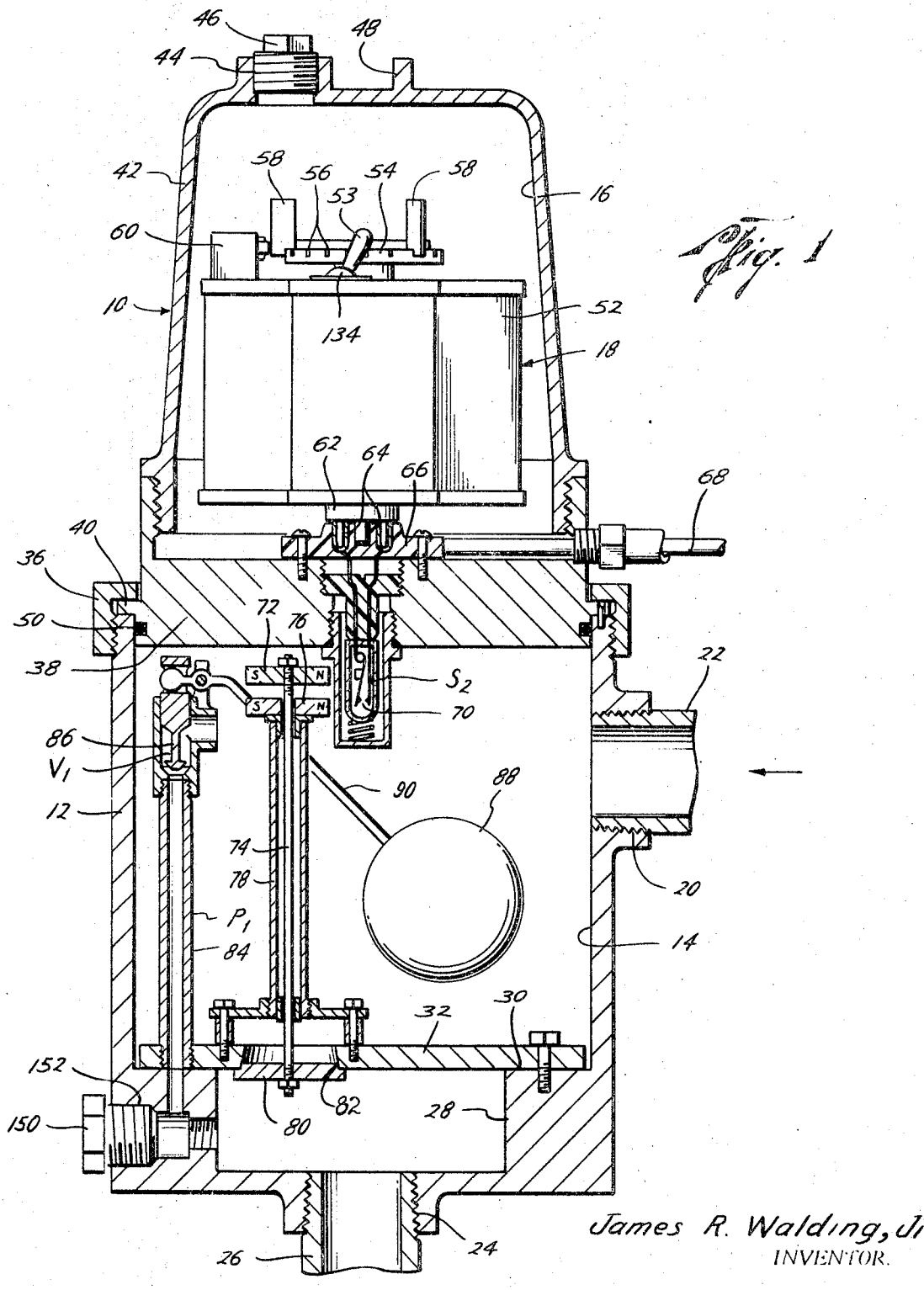


Fig. 1

James R. Walding, Jr.
INVENTOR.

BY Charles E. Lightfoot
ATTORNEY

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Fig. 2

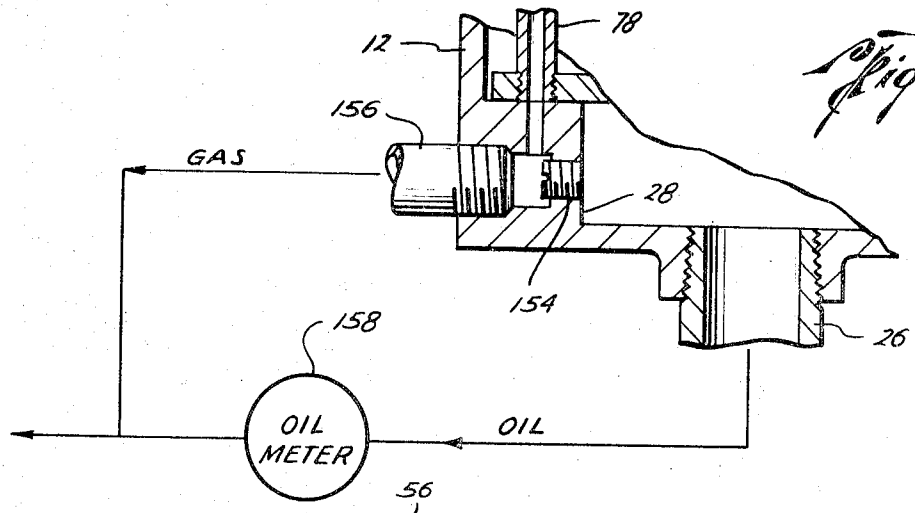
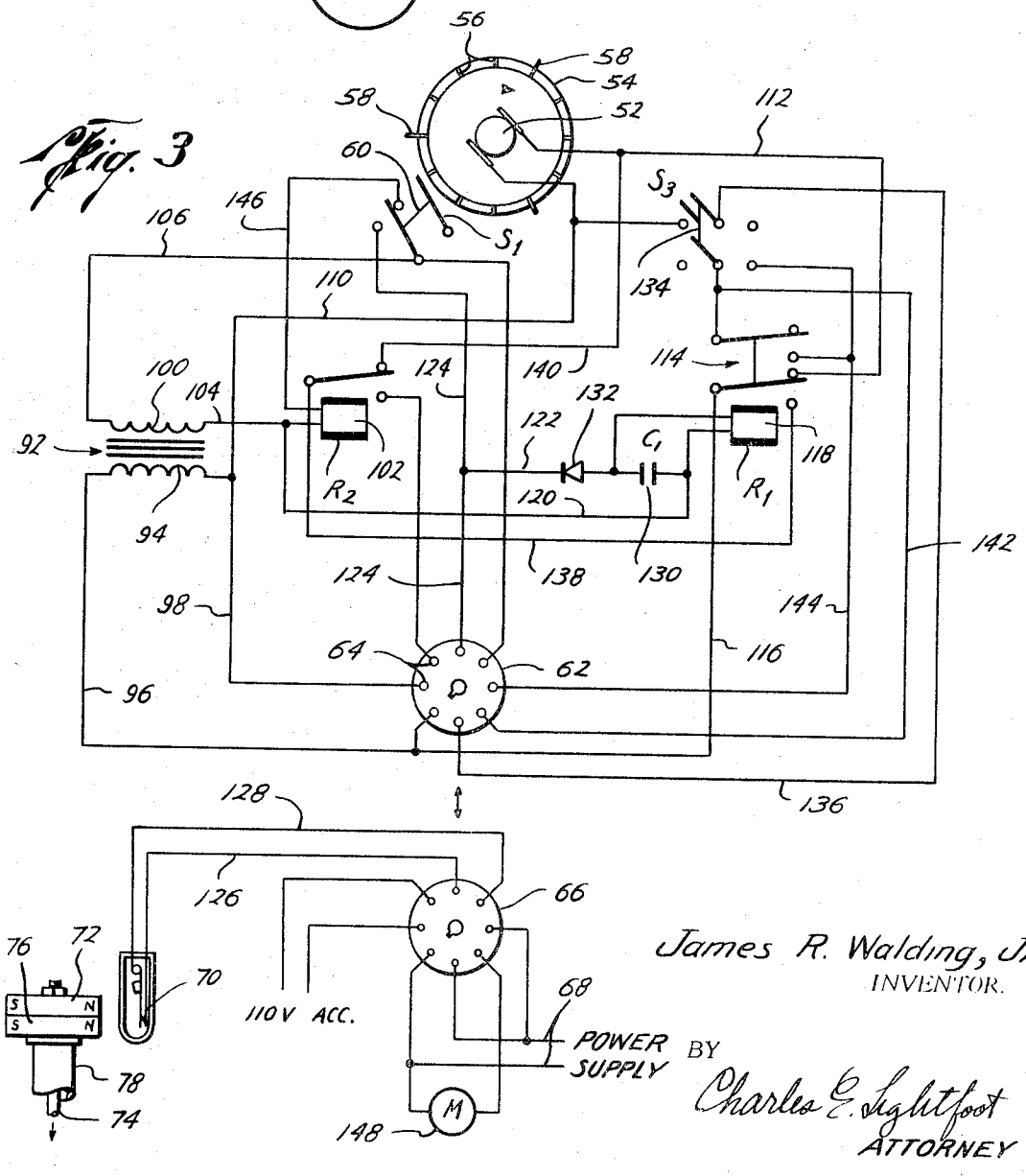


Fig. 3



James R. Walding, Jr.
INVENTOR.

BY Charles E. Lightfoot
ATTORNEY

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MECHANISM FOR CONTROLLING THE OPERATION OF PUMPS

James R. Walding, Jr., 241 Connie St., Houston, Tex. 77022

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U.S. Cl. 417—12 6 Claims

ABSTRACT OF THE DISCLOSURE

Control mechanism for use in the operation of pumps whereby operation of a pump is discontinued upon the occurrence of a non-flow condition to prevent continued operation of the pump when no fluid is available for pumping and including means for periodically restarting the pump and continuing the operation thereof until the occurrence of non-flow conditions.

BACKGROUND OF THE INVENTION

In the operation of pumps, and particularly pumps for use in pumping oil from oil wells, such pumps are often operated continuously whether or not there is fluid available for pumping from the well.

Such continuous operation often results in extreme conditions of wear due to operating the pumps dry when the supply foil has been exhausted. Various attempts have been made to provide for operation of oil well pumps only when oil is available and to stop such operation upon the occurrence of non-flow conditions, such as by observing and recording the time required for the accumulation of a certain amount of oil in the well and providing automatic timing mechanism for turning the pump on during periods of supply and off during the occurrence of non-flow conditions.

It has been found, however, that periods of supply and non-supply cannot be accurately determined in many wells, and that the time required for the accumulation of oil and the amount accumulated varies widely, so that there is danger of running the pump dry where fixed times of operation and non-operation are provided.

The present invention has for an important object the provision of pump control mechanism by which a pump may be started periodically, and will continue to run as long as there is fluid available to be pumped, but will be stopped automatically upon the occurrence of non-flow conditions.

Another object of the invention is to provide pump control mechanism by which a pump will be started automatically after a predetermined period of non-operation, and will continue to run if fluid is available for pumping, but will cease operation if no fluid is available, or upon failure of the supply of fluid once pumping of the fluid commences, there being also means for restarting the pump after the elapse of a predetermined time interval.

A further object of the invention is to provide pump starting and stopping mechanism which is of simple design and rugged construction, which is easily maintained in operating condition and which is not substantially effected by the flow of gas from a well being operated thereby.

SUMMARY OF THE INVENTION

Briefly described the pump control mechanism of the invention comprises electrical control mechanism for an electric motor which operates a pump, which mechanism includes timing mechanism, which operates only when the motor is not running and means responsive to the flow of the fluid being pumped for causing the motor to continue in operation as long as the fluid is being pumped, but

which causes discontinuance of the operation of the motor upon cessation of fluid flow. The control mechanism includinges electrical circuitry, which is closed by the timing mechanism to initiate operation of the pump and which is opened by the timing mechanism after a predetermined time to stop the pump if no fluid is available for pumping, but which remains closed if such fluid is present until the occurrence of non-flow conditions.

Upon discontinuance of the operation of the pump the circuit is again closed by the timing mechanism after a predetermined lapse of time, to restart the pump. Means is also provided for maintaining the timing mechanism out of action during the time that the pump is running and for placing the timing mechanism back in operation upon cessation of pumping.

BRIEF DESCRIPTION OF THE VIEWS OF THE DRAWINGS

A preferred embodiment of the invention is illustrated in the annexed drawings, wherein:

FIG. 1 is a vertical, central, cross-sectional view of the fluid actuated switch means of the pump controlling mechanism of the invention showing the switch in an open position;

FIG. 2 is a fragmentary view, partly diagrammatic, of a portion of the mechanism illustrated in FIG. 1 showing the manner in which the same may be adapted for metering of gas and oil which flows therethrough; and

FIG. 3 is an electrical diagram illustrating the electrical circuitry of the control mechanism.

DETAILED DESCRIPTION OF A PARTICULAR EMBODIMENT OF THE INVENTION

Referring now to the drawings in greater detail the control mechanism of the invention includes a hollow housing or casing, preferably formed with upper and lower sections **10** and **12** respectively, of which the lower section forms a float chamber **14**, while the upper section forms an enclosure **16** for the timing mechanism, generally designated **18**.

The lower section **12** is provided with an inlet **20** adapted to be connected in communication with the discharge outlet of a suitable pump, not shown, as by means of a fluid supply pipe **22**, and an outlet **24** for connection to a discharge pipe **26**. The lower section **12** also has an internal, lower end counterbore portion **28** forming an internal annular shoulder **30**, upon which a lower closure plate **32** is seated. At its upper end the lower section **12** externally threaded to threadably receive a fitting **36**, and the upper section **10** includes a base member **38** shaped to fit within the upper end of the lower section and provided with an external annular flange **40** which seats on the upper end of the lower section and is retained thereon by the screw fitting **36**.

The upper section **10** also includes a cover **42** which is threadably attached to the base member **38**. At its upper end the cover **42** has an opening **44** closed by a screw plug **46**, and is provided externally with a suitable recess **48** or wrench receiving projection by which the cover may be screwed on or off of the base member. Suitable seal forming means, such as the O-ring **50** is positioned in an external groove in the member **38** provided therefor, to form a fluid tight seal between the lower section and base member.

The timing mechanism **18**, of the invention, includes an electric motor **52** disposed within the upper section **10** which is connected in driving relation to a timing wheel **54** having peripherally spaced notches **56** to removably receive timing elements or lugs **58** carried by the wheel for rotation therewith and which are positioned to engage a switch **60** to close the switch. The motor has a plug

fitting **62** at its lower end provided with prongs **64** which are releasably inserted in a socket member **66**, carried on the base member **38** and which is connected to a suitable electrical cable **68** through which the motor and its accessory equipment is supplied with electric current from any suitable source. The motor is contained in a suitable casing within which various components of the electrical system are also contained to form a unitary structure easily removed and replaced as a unit for purposes of maintenance.

Within the lower section **12** an enclosed switch **70** is located which is of a type to be magnetically operated, as by means of a permanent magnet **72**, carried on a vertically sliding shaft **74**, for movement toward and away from a second permanent magnet **76**. The magnets **72** and **76** are arranged with their like poles opposed so that the magnet **72** will be repelled by the magnet **76**. The magnet **76** is fixedly mounted on a tube **78** extending upwardly in the fluid chamber **14**, within which the shaft **74** is longitudinally movable, and the shaft carries at its lower end a valve **80** which closes on a valve seat **82** in the closure plate **32**, so that when the shaft is held in its upmost position by the magnets the valve **80** will be closed.

A gas outlet pipe **84** is also disposed vertically in the fluid chamber **14**, through which fluid may flow from an upper level in the chamber into the counterbore **28** and out through the discharge outlet **24**. This gas outlet pipe carries at its upper, inlet end a valve **86** which is positioned to be actuated by a float **88** attached to a pivoted float arm **90**. By this arrangement the valve **86** will be open to allow the outflow of gas from chamber **14** when the float **88** is down, and will be closed upon upward movement of the float to shut off such outflow.

The electrical circuitry of the invention includes a transformer **92**, whose primary **94** is connected to a source of electrical current which may be the usual 110-volt alternating current source, through conductors **96** and **98** through cable **68**, and whose secondary **100** is connected to a relay coil **102** through a conductor **104**, and to the switch **60** through a conductor **106**. The timer motor **52** is of a type to be operated by 110-volt alternating current through conductors **98** and **110** and through a conductor **112** through a relay, generally designated **114**, and conductor **116**. The coil **118** of relay **114** is connected to the secondary **100** of transformer **92**, through conductors **104** and **120**, and through conductors **122**, **124**, **126**, switch **70** and conductors **128** and **106**. A suitable capacitance **130** is connected across relay coil **118**, and a suitable rectifier **132** is connected into conductor **122** by which the capacitance is maintained in a charged condition during energization of the coil **118** from the transformer **92**, and whereby the coil will remain energized for a predetermined time after the supply of current from the transformer **92** to coil **118** has been cut off.

A manually operable switch **134** is connected into the circuitry which may be opened to place the entire apparatus in inactive condition, or moved to one position to initiate the operation of the timing mechanism or another position to place the pump in operation independently of any of the automatic control mechanism of the device.

The switch **134** is shown in FIG. 3 in its fully open position, in which position the operation of the equipment is shut down. To initiate operation of the apparatus, the switch **134** is moved to the left, from the position of FIG. 3, closing the circuit to the timer motor or clock **52**, through conductor **136** and switch **134** and through conductor **112**, relay **114** which is now in the position shown in FIG. 3, and conductor **116**. The timer motor then continues to run, rotating the wheel **54** to engage one of the timing elements **58** into engagement with switch **60** to move the same to the left from the position of FIG. 3, which causes relay coil **118** to be energized from the secondary **100**, through conductors **106**, **124**, **122** and rectifier **132**, and conductors **120** and **104**. Energization of coil **118** moves the relay **114** down from the position of FIG. 3 to close another clock or timer circuit through conductor **116**, relay **114**, conductor **138**, relay **102**, now in up position, and conductor **140** and through switch **134** and conductor **136**. The circuit through conductor **112** to the timer motor will now be open.

The energization of coil **118** also closes a circuit through conductor **142**, relay **114**, now in down position, and conductor **142** to supply current from the supply line **68** to the pump motor designated **148** to operate the well pump, not shown.

With the pump thus in operation the timer continues to run until the timer element **58** which is holding switch **60** in its left hand position releases the switch to allow the same to move to its right hand position, seen in FIG. 3, whereupon relay **102** will be energized through conductors **104** and **146** and switch **60** and conductor **106**. The relay **102** will then be moved to its down position, opening the timer motor circuit and stopping the timer.

Meanwhile, if the operation of the well pump results in the pumping of liquid into the chamber **14** through inlet pipe **22**, such liquid will exert a downward pressure on valve **80** to move the same downwardly to open position, pulling magnet **72** down toward magnet **76** to position magnet **72** to close switch **70**. The closing of switch **70** completes a circuit to maintain relay coil **118** energized through conductors **106**, **124** and **122** and rectifier **132** and through conductors **120** and **104**, thus keeping the pump motor running.

The pump motor then continues to run as long as the flow of liquid is supplied to chamber **14** in sufficient amount to maintain valve **80** open. Upon discontinuance of the supply of liquid from the well to chamber **14**, the level of liquid falls therein until valve **80** is closed by the repulsive force of the magnets **72** and **76**, whereupon magnet **72** is moved upwardly to allow switch **70** to open. Opening of switch **70** opens the cirmcuit from the transformer secondary **100** to relay coil **118**, so that after a time lapse determined by the discharging of the capacitance **130** through the relay coil, the coil will be deenergized to allow the relay **114** to move to up position, closing the timer motor circuit to restart the timer and opening the pump motor circuit to stop the pump. Thus, pumping will be discontinued upon failure of the liquid supply from the well and the timer will be restarted. When the next successive timer element **58** then reaches the switch **60** the pump motor will again be started to pump any liquid which has accumulated, the timer motor being then stopped until the pump motor again stops, whereupon the timer is again restarted.

Thus, the pump will be started periodically whether or not there is liquid available for pumping and will continue to pump as long as liquid is available, but pumping will be discontinued in the event that no liquid is available or when the liquid supply fails.

In the event that there is no liquid being pumped, but the well is producing gas, the float **88** will be in its lowered position holding the valve **86** open, so that the gas may readily flow through the apparatus. By this arrangement full gas production from the well will be permitted whether the well is producing liquid or not.

A somewhat modified arrangement is illustrated in FIG. 2, for use under circumstances in which it is desired to meter the amount of liquid which flows through the apparatus, and to allow the flow of gas whether or not liquid is being produced.

In this arrangement a plug **150** which is threadably inserted in an opening **152** in the lower section **12** leading from the pipe **84** to the exterior is removed and an inner plug **154** is threadably inserted to close off communication between the outlet **152** and the counterbore **28**. A gas outlet pipe **156** is then connected into the opening **152**, which pipe is connected into the liquid outflow line **26** from the counterbore **28**. A suitable meter **158** for measuring the outflow of liquid may be provided

in the outflow line **26** upstream from the connection of the gas outflow line thereto.

By this arrangement gas may flow from chamber **14** through pipe **84** and out through pipe **156** without passing through the meter **158**, while all liquid passing through the apparatus will be measured by the meter.

The conductors **96** and **98** may also serve for the connection of any desired accessory equipment into the power supply, such as well logging instruments, chemical feeders, or the like, for which a suitable electrical outlet fitting may be attached to conductors **160** and **161** of the socket member **66**, as indicated in FIG. 3.

It will thus be seen that the invention, constructed and operated as described above, provides automatically operating pump control mechanism by which an intermittently occurring liquid supply may be pumped without operation of the pump during periods when there is no available liquid to be pumped.

The invention is disclosed herein in connection with a particular embodiment of the apparatus, which is intended by way of illustration only, it being evident that the same is capable of modification within the spirit of the invention and the scope of the appended claims.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. In a system having a pump and a motor for operation thereof for pumping liquid from a well,

a receptacle into which liquid from the well may be pumped and having an outlet for the outflow of liquid therefrom and a separate outlet located above said liquid outlet through which gas may flow from the receptacle,

means in the receptacle responsive to an increase in the level of liquid therein to close said gas outlet during thte inflow of liquid into the receptacle and to a decrease in such level to open the same upon cessation of such inflow,

means for starting said motor at a predetermined time,

means for stopping the motor in response to the cessation of the flow of liquid into the receptacle, and

means for preventing the stopping of said motor within a predetermined time after the starting of the motor.

2. The system as claimed in claim **1** wherein said means for preventing the stopping of said motor includes means in said receptacle responsive to the outflow of liquid therefrom.

3. In a system having a pump and an electric motor for operation thereof for pumping liquid from a well,

a receptacle into which liquid from the well may be pumped and having an outlet for the outflow of liquid therefrom and a separate outlet above said liquid outlet through which gas may flow from the receptacle,

a valve positioned for movement into and out of closing relation to said gas outlet,

means in the receptacle positioned for coaction with said valve and the liquid supplied to the receptacle to close the valve in response to an increase in the level of such liquid and to open the valve in response to a decrease in such level,

means for supplying current to said motor at a predetermined time to operate the motor,

means for discontinuing such current supply at a predetermined time after the starting of the motor, and

means for preventing such discontinuance during the outflow of liquid from said receptacle.

4. The system as claimed in claim **4**, wherein said means for supplying current to said motor includes an electrical circuit for said motor and means for closing said circuit at a predetermined time, and

said means for discontinuing the supply of current to said motor includes means for opening the circuit at a predetermined time after the circuit has been closed.

5. The system as claimed in claim **3**, wherein said means for supplying current to said motor includes an electrical circuit and means for closing said circuit at a predetermined time, and

said means for preventing discontinuance of such current supply includes switch means for closing said circuit in response to the outflow of liquid from the receptacle.

6. The system as claimed in claim **3** wherein said means for supplying current to said motor and for discontinuing such supply includes

an electrical circuit for said motor,

electrically operated timing means for opening and closing said circuit,

means for supplying current to said timing means in response to the discontinuance of the flow of liquid into said receptacle, and

means for discontinuing the supply of current to said timing means during such flow.

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ROBERT M. WALKER, Primary Examiner

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