

May 1, 1951

A. S. PARKS
CONTROL APPARATUS

2,551,334

Filed May 24, 1947

4 Sheets-Sheet 1

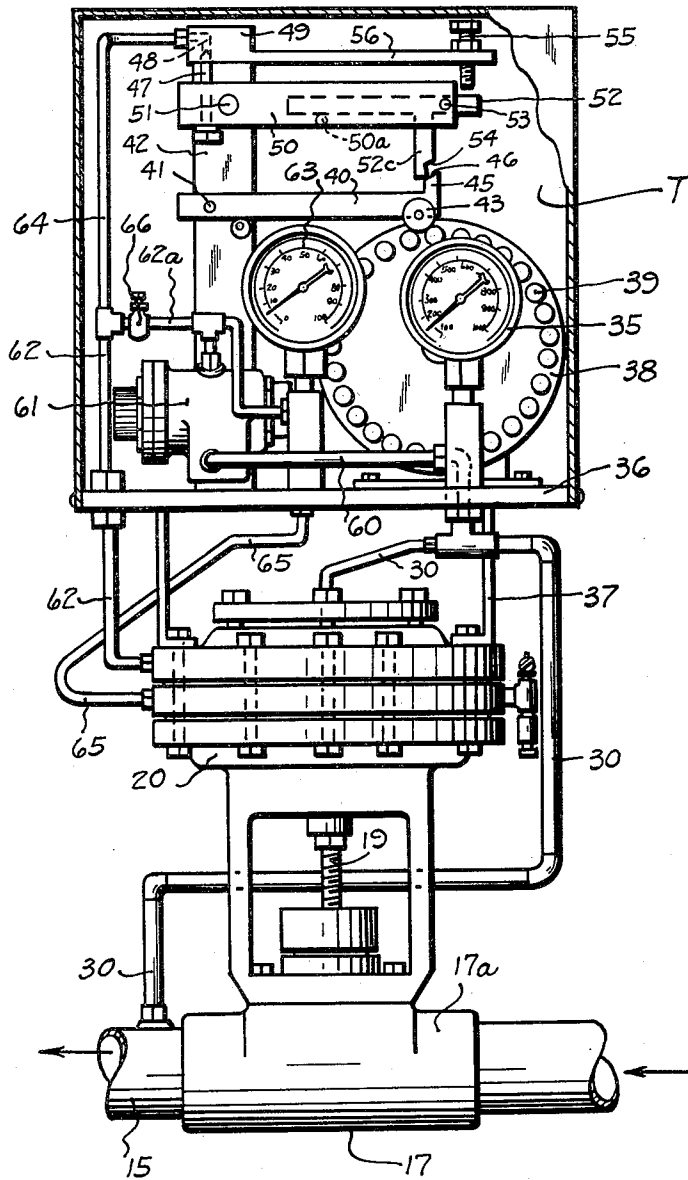


Fig. 1

Asbury S. Parks
INVENTOR.

BY *Joe E. Edwards*
ATTORNEY

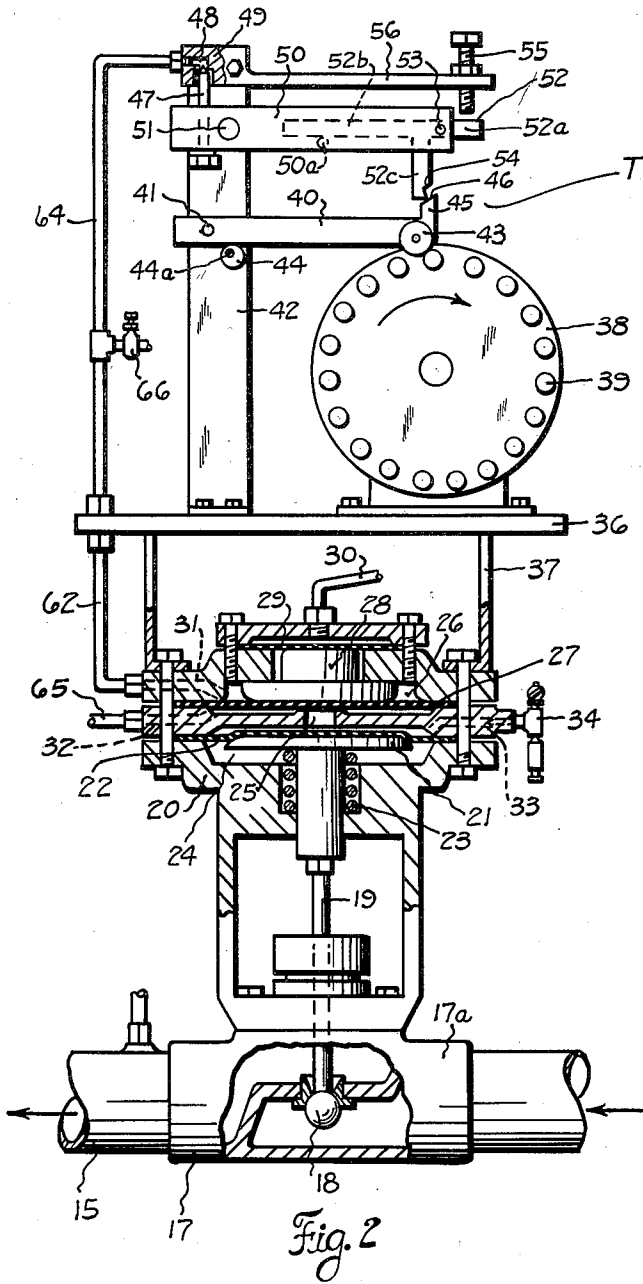
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4 Sheets-Sheet 2



Asbury S. Parks
INVENTOR.

BY Joe E. Edwards
ATTORNEY

ATTORNEY

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4 Sheets-Sheet 3

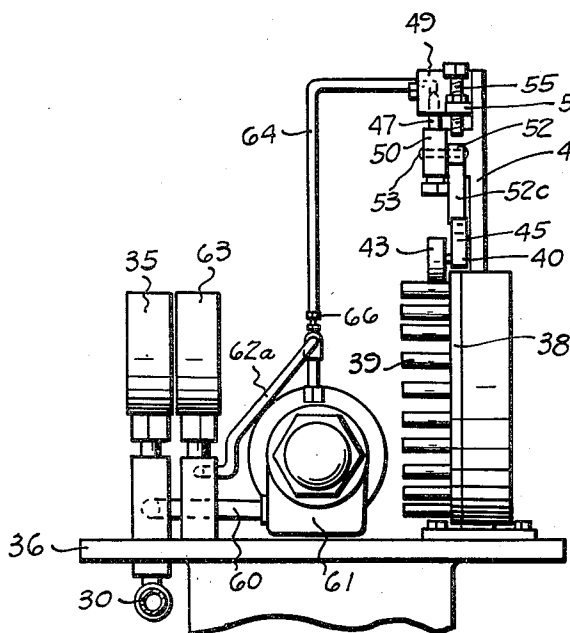


Fig. 3

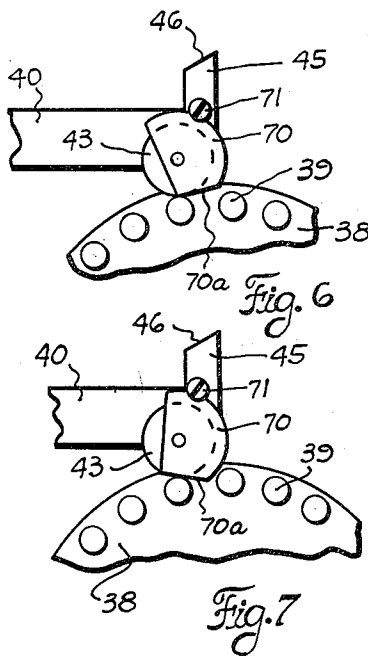


Fig. 7

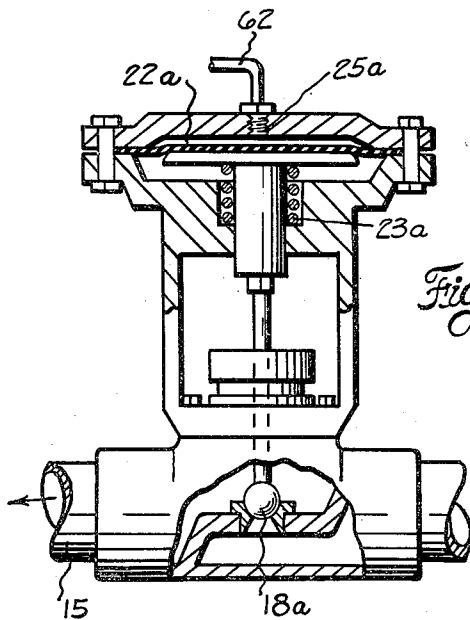


Fig. 8

Asbury S. Parks
INVENTOR.

BY *Joe E. Cowan*
ATTORNEY

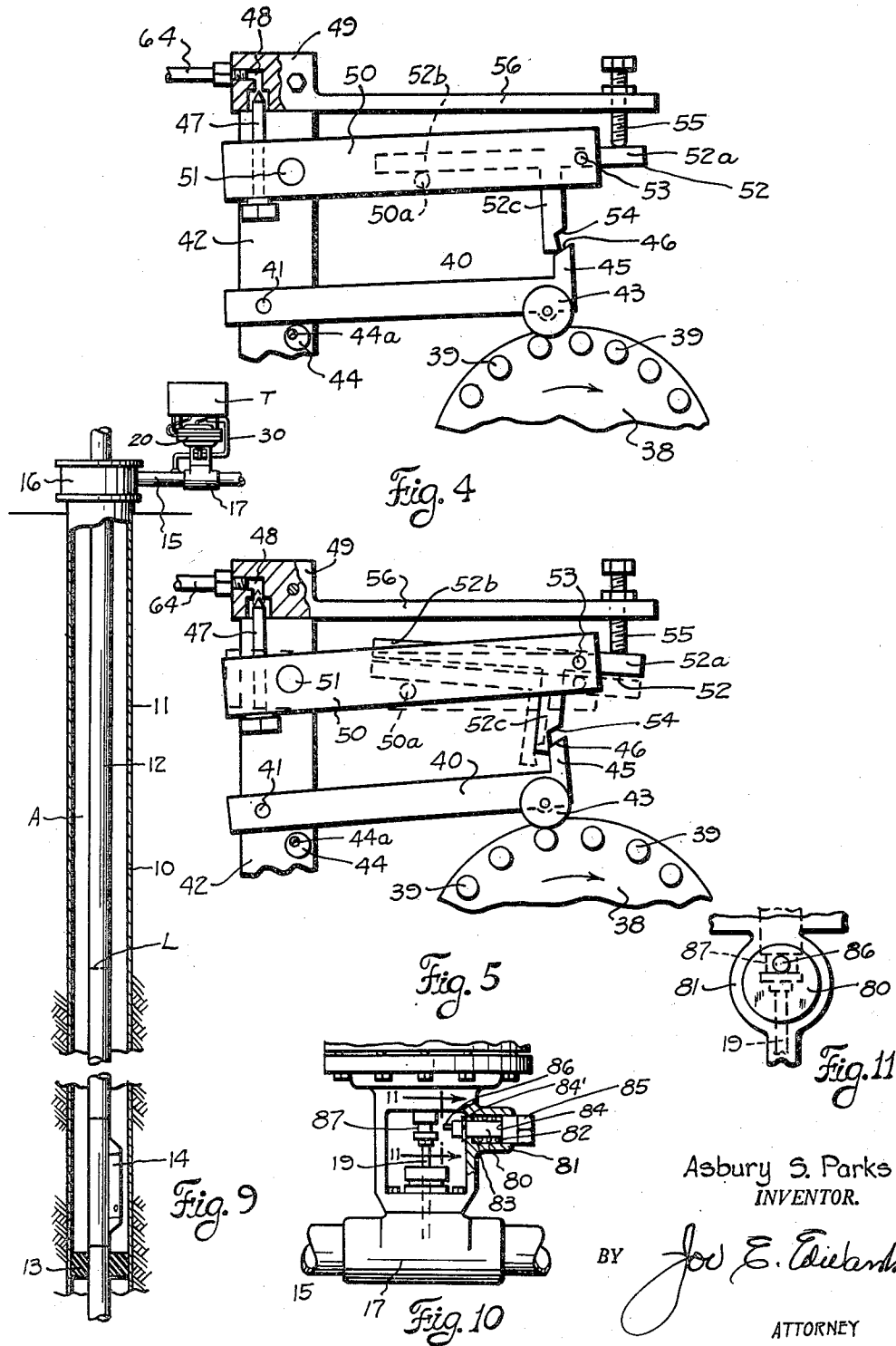
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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,551,334

CONTROL APPARATUS

Asbury S. Parks, Houston, Tex.

Application May 24, 1947, Serial No. 750,322

12 Claims. (Cl. 161—7)

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This invention relates to new and useful improvements in control apparatus.

As is well known, the use of auxiliary lifting mediums, such as gas or air, for lifting well fluids to the surface has become general practice in the petroleum industry. Usually the admission of the lifting medium into the well liquid column is controlled by a "flow valve" which is actuated by the differential in pressures acting on opposite sides thereof, or by an "intermitter" valve which is operated at predetermined intervals, in accordance with the entrance of the well liquids into the well tubing or flow string. Ordinarily, the intermitter type of valve is actuated solely by an increase in pressure of the lifting medium in the annular space outside the well tubing or flow string and this pressure is controlled by a timing mechanism at the surface. The timing mechanism must necessarily be capable of properly timing the pressure increase required to actuate the intermitter valve and to accurately control said pressure under all conditions.

It is one object of the present invention to provide an improved surface control apparatus which is particularly adapted for use in controlling the pressure of a lifting medium, such as gas or air, which is utilized for lifting well fluids to the surface through a well tubing or flow string.

An important object of the invention is to provide an improved surface control apparatus which is constructed so as to accurately control the timing cycle of operation of an intermitter valve unit; said apparatus also having means for controlling the pressure of the lifting medium which is normally present in the annular space outside the flow string and which is utilized to actuate said valve unit, whereby efficient operation of the unit under all conditions is assured.

Another object of the invention is to provide an improved surface control apparatus, of the character described, which combines a timing mechanism with a pressure regulating device, with the timing mechanism functioning to operate the main inlet valve in accordance with a desired time cycle; the arrangement being such that the regulating device is inactive when the timing mechanism is holding the main valve closed and being rendered operative to control the pressure when the main valve is opened by actuation of said mechanism, whereby accurate timing of operation, together with control of pressure, is had.

Still another object of the invention is to pro-

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vide a surface control apparatus for admitting a lifting medium to a well conductor and having an improved timing mechanism for controlling the timing cycle, wherein said mechanism is first actuated by a clock-controlled element to begin the timing cycle and is rendered inactive to end the timing cycle by means entirely independent of the clock-controlled element, whereby the timing cycle may be accurately controlled separately of said element; the means which ends the timing cycle being either a manually adjustable element forming part of the timing mechanism or being a pressure-actuated member operated by the lifting medium pressure.

A further object of the invention is to provide an improved surface controller wherein the timing mechanism for controlling the timing cycle comprises a movable actuator adapted to be operated by a clock-controlled element to engage a control member to start the timing cycle, together with means arranged to co-act with the control member to dis-engage the same from the actuator at any desired time to end the timing cycle; said control member and its co-acting means being entirely independent of the actuator and clock-controlled element, whereby the length of the timing cycle is controlled solely by the adjustment of said co-acting means.

Still another object of the invention is to provide an improved apparatus, of the character described, which has a simple, accurate adjustable means for controlling the length of the timing cycle; said apparatus being adapted to actuate a pilot valve arrangement which, in turn, controls the operation of a main valve device.

A particular object of the invention is to provide an improved surface control apparatus which may be utilized to control operation of a main valve in a flow line or which is adaptable for use in combination with a regulating device, whereby the operation of the main valve is controlled and the pressure in the flow line is simultaneously regulated.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of a control apparatus, constructed in accordance with the invention and showing the upper portion of the housing

broken away to clearly illustrate the timing mechanism,

Figure 2 is a view of the control apparatus showing the regulating device and main valve in cross-section and having portions of the timing mechanism removed to more clearly illustrate the operating parts of said mechanism,

Figure 3 is an elevation of the timing mechanism and viewing the parts from a right angle to the position shown in Figure 1,

Figure 4 is a view of the operating elements of the timing mechanism and illustrating their position at the start of the timing cycle,

Figure 5 is a similar view illustrating the position of the parts at the end of the timing cycle,

Figure 6 is an enlarged partial view of the clock-controlled element and the actuator and illustrating an adjustable section which mounts on the actuator,

Figure 7 is a similar view illustrating the section in another adjusted position,

Figure 8 is a transverse, sectional view of a pressure-actuated main valve with which the timing mechanism may be combined,

Figure 9 is a more or less schematic view of a well bore having a fluid conductor and an intermitter valve therein and showing a control apparatus, constructed in accordance with the invention connected thereto,

Figure 10 is a partial detail of the valve, illustrating a locking means for opening the main valve independently of the pressure-actuated apparatus, and

Figure 11 is an enlarged vertical, sectional view of the locking means, taken on the line 11-11 of Figure 10.

In the drawings (Figure 9), the numeral 10 designates a well bore having a well casing 11 extending therethrough. A well fluid conductor or tubing 12 extends axially through the well casing in the usual manner and the annular space A between said tubing and the casing is packed off nearer the lower end of the well bore by a suitable well packer 13. The well fluids entering the extreme lower end of the well bore enter the well tubing or conductor 12 and flow upwardly therein to a predetermined level, in accordance with the particular well conditions, the level being presumed to be at the dotted line L. An intermitter or control device 14 is mounted in the conductor 12 and is arranged to control the admission of a lifting medium, which is in the annular space between the casing and the tubing, into the well tubing, whereby the well liquid within the tubing above the device 14 is lifted to the surface.

The lifting medium, such as gas or air, is admitted to the annular space through an inlet conductor or pipe 15 which connects to a casing head 16 mounted on the upper end of the well casing 10. The conductor or pipe 15 has a main valve 17 mounted therein and the control apparatus, constructed in accordance with the present invention, is utilized to control operation of the valve 17, whereby the lifting medium under pressure is admitted to the annular space at the proper and predetermined intervals. It might be noted that the pressure of the lifting medium which will be presumed to be gas, is maintained at a predetermined amount within the annular space. The particular predetermined pressure of the normally present lifting medium is dependent upon the particular adjustment of the intermitter device 14 and said pressure is just insufficient to actuate the intermitter and admit the lifting gas to the well tubing. At predeter-

mined intervals, the main control valve 17 is open to admit additional lifting gas under pressure to the annular space and this admission of additional gas raises the pressure in the annular space to actuate the intermitter device 14 and thereby inject the lifting gas into the well liquid column within said tubing. The main control valve 17 remains open for a predetermined time and then closes so that the intermitter device 14 is again shut off upon the reduction of pressure in the annular space to a predetermined point. The apparatus remains inactive until such time as the well liquids have again entered the well tubing to approximately the level L, at which time the main valve 17 is again opened to repeat the operation. This particular method of lifting well liquids to the surface is in general use and the present invention relates primarily to the control mechanism which is associated with the main valve 17.

Referring to Figures 1 and 2, the main valve 17 which controls flow through the conductor or line 15 comprises a valve housing 17a having a downwardly opening valve member 18 therein. The valve member is carried by a stem 19 which extends upwardly into a diaphragm housing 20. An enlarged disk 21 is secured to the upper end of the valve stem and engages the underside of a diaphragm 22, being held in engagement therewith by a coil spring 23. It will be evident that the spring normally urges the valve stem and valve member 18 to a raised or closed position.

The diaphragm 22 is disposed within a diaphragm chamber 24 which has communication through a port 25 with a second diaphragm chamber 26. A second diaphragm 27 is mounted within the chamber 26 and has its upper end engaged by a follower 28. A third or smaller diaphragm 29 normally engages the upper end of the follower 28 and it might be noted that the relationship in the area between the smaller diaphragm 29 and the intermediate diaphragm 27 may be of any desired ratio. The upper surface of the smaller diaphragm 29 is exposed through a conductor or line 30 to the pressure on the downstream side of the valve element 18, said conductor being suitably connected into the main supply pipe 15. A suitable pressure gauge 35 is connected to the conductor 30, said gauge being supported upon a base or supporting plate 36 which is mounted on suitable brackets 37 extending upwardly from the diaphragm housing 20. The intermediate diaphragm has its opposite sides exposed through passages 31 and 32, respectively, to a regulated pressure which is normally exactly the same, whereby the diaphragm 27 is in balance. Under such a condition the pressure acting through the line 30 on the upper diaphragm 29 forces the intermediate diaphragm 27 over the communicating opening 25 to seal said opening. Any pressure above the lowermost diaphragm 22 which co-acts with the valve stem may escape through a bleeder port or passage 33 which is adjustably regulated by a suitable bleeder valve 34.

It will be evident that when the pressures across the intermediate diaphragm 27 are balanced or equal, the pressure from the downstream side of the supply pipe 15 will move the upper and intermediate diaphragms downwardly to close the communicating opening or port 25. When this condition exists, the coil spring 23 maintains the valve member 18 in a closed position. If the pressure acting on the upper surface of the intermediate diaphragm 27 is relieved,

the pressure normally present and acting against the underside of the intermediate diaphragm will lift said diaphragm and uncover the communicating port 25, whereby this pressure may act against the lowermost or actuating diaphragm 22. The bleeder valve 34 is adjusted so that the pressure entering the intermediate port is admitted more rapidly than it can escape through said bleeder valve with the result that said pressure acting on the diaphragm 22 moves the valve stem and valve member 18 downwardly against the tension of the spring 23 to thereby open the main valve and admit the lifting gas into the supply pipe 15 and thence into the annular space between the well casing and the well tubing.

So long as the pressure on the downstream side of the valve 18 does not exceed a pressure which would be sufficient to overcome the normal pressure acting below the intermediate diaphragm, the valve will remain open. It is obvious that by maintaining the pressure which acts against the underside of the intermediate diaphragm at a predetermined point, the pressure which must be reached in line 30 in order to close the valve is accurately controlled. As the pressure on the down stream side of the valve member 18 exceeds a predetermined amount in accordance with the ratio between the upper diaphragm 29 and the intermediate diaphragm 27, and also in accordance with the controlled pressure acting on said diaphragm 27, then in that event this excessive pressure acting on the upper diaphragm forces the intermediate diaphragm to close the communicating port or opening 25. When this occurs the pressure above the actuating diaphragm 22 escapes through the bleeder passage 33 and allows the spring to close the main valve. Closing of the main valve may also be accomplished if the pressures acting on opposite sides of the intermediate diaphragm are again equal so as to balance said diaphragm. In such case it is evident that the pressure acting on the upper diaphragm 29 would move the intermediate diaphragm downwardly to close the opening or port 25.

It thus becomes obvious that the particular device illustrated may be opened by reducing the pressure which is normally acting above the intermediate diaphragm 27. Closing of the main valve may be accomplished either by again equalizing pressures across the intermediate diaphragm 27 or by an excessive increase in the pressure on the downstream side in the supply pipe 15, the particular increase in pressure at this point necessary to close the valve being in accordance with the particular construction of the device and the ratio between the areas of the diaphragms 29 and 27. It is pointed out that the regulating device and main valve shown and described herein is fully disclosed and claimed in applicant's co-pending application, Serial No. 637,272 filed December 26, 1945. It is described herein to more fully explain the specific operation of applicant's improved timing mechanism and also to disclose the combination of the regulation device and valve, with a timing mechanism which combination is not shown in said co-pending application.

The timing mechanism which is generally indicated at T is arranged to control the pressure which is acting on the upper end of the intermediate diaphragm 27. This timing mechanism is mounted upon the supporting or base plate 36 and includes a clock-controlled timing wheel 38. The timing wheel is rotatable and is provided

with a plurality of outwardly extending timing pins 39 which may be properly placed in the openings in the wheel to control the timing cycles. As is the usual case with timing wheels, said wheel is rotated at a predetermined speed by a clock mechanism (not shown).

An actuator bar 40 has one end pivoted at 41 to a vertically extending standard or support 42, the latter being bolted or otherwise secured to the base plate 36. The outer end of the actuator bar 40 has a freely rotatable bearing roller 43 pivoted thereto and said roller overlies the outwardly extending timing pins 39 of the timing wheel. The timing wheel rotates in a clock wise direction in Figures 1 and 2 and obviously as each timing pin moves beneath the roller 43, the actuator bar 40 is lifted upwardly. As the timing pin moves from beneath said roller, the actuator bar returns to its normal or substantially horizontal position, with the downward movement of said bar being limited by a stop pin 44 mounted in the standard 42. The stop pin is eccentrically mounted on a screw 44a whereby it may be adjusted to provide an adjustable limiting means. The actuator bar has its extreme outer end formed with an upstanding lug or projection 45 which has its upper surface bevelled or inclined as shown at 46.

The movement of the actuator bar 40 is adapted to control the opening and closing of a pilot valve 47 which valve controls flow through an angular port 48 which is formed in a valve housing 49. The valve housing is secured to the extreme upper end of the vertical standard or support 42. The pilot valve 47 has the lower portion of its stem secured in one end of an operating arm 50, which arm is pivoted on a pin 51 to the vertical support or standard. When the arm 50 is swung, the valve 47 is moved to an open or closed position, depending upon the movement of the arm.

The valve operating arm 50 extends outwardly from the standard and has a T-shaped connecting member 52 pivoted to its extreme outer end on a pivot pin 53. As is clearly shown in Figure 2 the member 51 includes substantially horizontally extending arms 52a and 52b, as well as a vertically extending leg 52c. The arm 52b is considerably longer than the arm 52a and is of such weight with respect to the pivot point that normally the member 52 assumes the position shown in Figure 2 with the arm 52b engaging a stop pin 50a in the arm 50 and with its leg 52c hanging in a substantially vertical position. The lower end of said leg overlies the inclined upper surface of the upstanding projection of lug 45 of the actuator 40 and said lower end is formed with a suitable angular offset 54.

An adjustable limiting or stop screw 55 is threaded through a fixed supporting bracket 56 which extends outwardly from the valve housing 49 and which overlies the connecting member 52. Due to the overhanging disposition of the limiting screw, any upward movement of the connecting member 52 will cause its shorter arm 52a to engage said screw, whereby said member will be swung on its pivot with respect to the operating arm 50.

In the operation of the timing mechanism, the parts are normally in the position shown in Figure 2, in which position the roller 43 of the actuator has just disengaged one of the timing pins. At this time the operating bar 50 is substantially horizontal and the pilot valve 47 is closed. The connecting member 52 has swung on its pivot 53

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to a position with its leg 52c substantially vertical and overlying the upstanding projection or lug 45. As the clock mechanism continues to impart rotation to the timing wheel 38, one of the timing pins 39 engages the roller 43 of the actuator 40 and swings said actuator upwardly to a position shown in Figure 4. Upward movement of the outer end of the actuator 40 results in the upstanding projection or lug 45 engaging the lower end of the vertical leg 52c of the connecting element 52. The weight of the elongate arm 52b of the element 52 is sufficient to maintain the element 52 in its same relative position with respect to the operating arm 50, whereby upward movement of the leg 52c by the lug 45 results in swinging the outer end of the operating arm upwardly. Such upward movement of the outer end of said arm results in a downward movement of the pilot valve 47, whereby the angular port 48 in the valve housing is opened.

Upward movement of the arm 50 which continues to hold the pilot valve 47 open continues until the connecting member 52 engages the limiting or stop screw 55. After the short arm 52a of the connecting member 52 engages the screw 55 any continued upward movement imparted to the member 52 results in said member being swung on its pivot 53, as indicated in full lines in Figure 5. As soon as the member 52 has been swung sufficiently to cause its lower end to clear the upstanding lug 45, the operating arm 50 and the member 52 connected therewith may fall downwardly to its original position which is indicated in dotted lines in Figure 5. This results in an immediate closing of the pilot valve 47 to shut off the flow through the angular port 48. It will be obvious that the pilot valve is closed as soon as the connecting member 52 is swung and irrespective of whether or not the actuator 40 is still moving upwardly because of its contact with the timing pin 39.

From the foregoing it will be seen that the timing cycle is started when the timing pin 39 moves the actuator to lift the operating arm 50 through the connecting member 52. It is at this time that the pilot valve 47 is opened. The timing cycle is completed and the pilot valve closed in accordance with the adjustment of the limiting or stop screw 55 for obviously as soon as the connecting element 52 is swung through its engagement with this pin, the valve is closed. For this reason, the length of time that the pilot valve remains open is controlled solely by the adjustment of the limiting screw and this length of time is independent of the clock-controlled timing wheel 38 and the actuator 40. The provision of the adjusting screw 55 makes it possible to accurately, with the single adjustment, control the length of time that the pilot remains open.

In order to control the opening and closing of the main valve element 18 which controls flow through the supply pipe 15, a pressure fluid is supplied to opposite sides of the intermediate diaphragm 27 of the valve actuating device. This pressure is supplied through a pipe 60 which extends from the conductor 30. The pressure passes through a regulator 61, of standard construction, which is mounted on the base plate 36 in any suitable manner. The regulator reduces the pressure to the desired amount in accordance with the construction of the diaphragms 27 and 29 and is conducted to the upper surface of the intermediate diaphragm 27 through lines 62 and branch 62a. A suitable pressure gauge 63 is connected between the pipe 60 and branch 62a to

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indicate the pressure of the fluid present in these lines as well as in line 62. The line 62 is also connected through a line 64 with the angular passage 48 of the valve housing 49 and with this arrangement it will be evident that when the pilot valve 47 is opened through actuation of the timing mechanism T, as above explained, the pressure from line 62 will be vented to atmosphere whereby a pressure reduction above the intermediate diaphragm 27 occurs. A conductor 65 extends from the pressure regulator to the passage 32, whereby the pressure flowing from the regulator may also act on the underside of the intermediate diaphragm 27. A suitable needle valve 66 is mounted in the line 62a which conducts pressure fluid to the upper end of the intermediate diaphragm 27 and said valve functions to meter or control the flow through said line.

In the operation of the apparatus, the main valve element 18 is closed, as shown in Figure 2. The pressure on the downstream side of said valve in the supply pipe 15 is acting upon the uppermost diaphragm 29. At this time the pressure flowing from the regulator 61 is conducted to both sides of the intermediate diaphragm 27 whereby the pressures across this diaphragm are equalized. It is noted that the regulated pressure to the underside of the diaphragm 27 is unrestricted while flow to the upper side of said diaphragm is throttled by the needle valve 66 in the line 62a. The provision of this needle valve assures that pressure can be built up in the line 62 leading to the upper side of the diaphragm 27 only when the pilot valve 47 is closed.

When pressures across the diaphragm 27 are equal, the downstream pressure acting against the upper diaphragm 29 has urged the intermediate diaphragm 27 downwardly to close the communicating port 25 to the actuating diaphragm 22. This allows the coil spring 23 to hold the valve 18 closed. Any variation in the pressure on the downstream side of the valve 18 in the supply line 15 will not affect opening of the valve because since the pressures across the intermediate diaphragm are balanced, any pressure at all acting on the diaphragm 29 will maintain the main valve closed. Therefore, it might be said that the regulating portion of the mechanism connected with the main valve is rendered inactive when the main valve 18 is closed by the timing mechanism and its associated parts.

As the timing wheel rotates, it swings the actuator 40 upwardly and as explained imparts an upward movement to the outer end of the operating arm 50, whereby the pilot valve 47 is opened. When this occurs the pressure within the lines 62 and 64 which communicate with the upper surface of the intermediate diaphragm, are vented or opened to atmosphere, with the result that a pressure reduction above the intermediate diaphragm 27 occurs. This unbalances the intermediate diaphragm 27 and allows the pressure beneath said diaphragm which is acting through the line 65 to lift the intermediate diaphragm and permit said pressure to act against the actuating diaphragm 22 and thereby open the valve 18. Opening of the valve 18 allows a flow of the lifting gas through the supply pipe and to the annular space in the well casing.

As soon as the main valve 18 opens, the regulating mechanism which is associated with the main valve is rendered operative and, therefore, as the pressure on the downstream side of the valve 18 exceeds a predetermined amount, in ac-

cordance with the ratio between the diaphragm 29 and the diaphragm 27, as well as in accordance with the pressure acting against the underside of said diaphragm 27 as controlled by the regulator 61, the diaphragm 29 will move downwardly to again seat the intermediate diaphragm over the opening 25 which as explained, will permit closing of the valve. Thus, it is possible for the mechanism to open or begin the time cycle in accordance with the clock mechanism or rather, the clock controlled timing wheel and to close the main valve in accordance with the pressure which occurs on the downstream side in the supply pipe 15.

In the event that the pressure on the downstream side of the valve in pipe 15 does not exceed the predetermined pressure for which the mechanism is adjusted, then the valve 18 will remain open until the pivoted connecting member 52 engages the limiting screw 55. When this occurs, the member 52 is swung to disengage the upstanding projection 45 of the actuator so that the pivoted operating arm may drop to its original position to close the pilot 47. When the pilot 47 closes, the pressure in the lines 62 and 64 will again be built up to the same pressure as that in the line 65 and this will result in an equalization of pressures across the intermediate diaphragm, whereby the upper diaphragm 29 may again function to lower the intermediate diaphragm and close the communicating opening or port 25. As explained, this results in permitting the coil spring 23 to again close the valve. In this instance, the time cycle or the period during which the valve remains open is controlled solely by the timing mechanism T and in accordance with the adjustment of the limiting screw 55.

With the arrangement illustrated in Figures 1 and 2 the provision of the intermediate diaphragm 27 makes it possible for the main valve to be closed in accordance with pressure which may develop in the supply pipe 15. However, in some instances it may not be desirable to employ this pressure regulating mechanism and in such case an ordinary motor valve, such as illustrated in Figure 8, may be controlled in its operation by the timing mechanism. In this instance an actuating diaphragm 22a is associated with a main valve element 18a which valve element is a downwardly closing, rather than an upwardly closing valve as is the valve 18. A communicating port 25a establishes communication between the upper end of the actuating diaphragm 22a and has the line 62 connected thereto. A spring 23a acts against the underside of the diaphragm 22a and normally urges the diaphragm upwardly to tend to open the main valve 18a.

In the operation so long as the pilot valve 47 is closed, the pressure in line 62 acting above the diaphragm 22a is greater than the pressure of the spring 23a and the diaphragm is in the lowered position shown in Figure 8, holding the valve element 18a closed. When the pilot valve 47 is opened by means of the timing mechanism, the pressure in line 62 acting above said diaphragm is reduced, allowing the coil spring 23a to lift the valve from its seat. When the timing mechanism again closes the pilot valve 47, the pressure in line 62 again builds up to lower the diaphragm 22a to again close the valve 18a.

It may be desirable to provide an additional adjustment to control the length of time during which the actuating bar 40 is engaged with the timing wheel 38 and in Figures 6 and 7 such an arrangement is illustrated. In this instance

an arcuate segment 70 is pivotally mounted on the roller 43 and is adapted to be locked in various adjusted positions by a set screw 71. One surface or edge 70a of the segment is tangential to the periphery of the roller and it will be evident by observing Figures 6 and 7 that said segment may be adjusted so that this surface will remain in engagement with the timing pin 39 a greater or lesser period of time. This adjustment is not essential to the invention but provides an additional means for controlling the timing cycle when said cycle is determined solely by the clock operated timing wheel.

There may be instances where it is desirable to hold the main valve 18 open, as for example, at the start of operations at which time there is no pressure present in the annular space between the tubing and the well casing. In Figures 10 and 11, an arrangement is illustrated for manually opening the valve 18 and maintaining it in an open position until the desired pressure is reached on the downstream side of said valve to permit automatic operation of the unit. As is shown in Figure 10, a stub shaft 80 is rotatably mounted within a suitable collar 81, preferably formed integral with the frame of the main valve and this shaft is disposed radially of the valve stem 19 of said main valve. A coiled spring 82 which is confined between a shoulder 83 within the collar and an external shoulder 84 on said shaft urges the shaft toward an outward position. Outward displacement of the shaft from the collar is prevented by a snap ring 84' which is engaged within an annular groove in the shaft and which normally abuts the inner end of the supporting collar and valve frame. The outer end of the shaft is formed with suitable wrench flats 85.

The inner surface of the stub shaft is provided with a pin 86 which is mounted eccentrically of the shaft and which projects inwardly toward the valve stem. When the shaft 80 is moved inwardly under tension of the spring 82, the pin 86 is adapted to engage within an annular groove 87 which is formed in the valve stem 19 and obviously, when so engaged a rotation of the shaft will impart a downward movement to the stem and main valve 18 to open said main valve, such downward movement being accomplished because of the eccentric mounting of the pin 86. Since the downward movement is against tension of the valve spring 23, a sufficient frictional engagement between the wall of the groove 87 and the pin 86 is set up to prevent retraction of the stub shaft 80 by the relatively weaker spring 82 and thus the main valve is held open.

The main valve 18 will remain open until the stub shaft is manually rotated to lift the stem and valve or until the downstream pressure is built up sufficiently to hold said valve open. When the latter condition occurs the tension on the valve stem is relieved to relieve the frictional engagement of the wall of the groove 87 with the pin 86, whereby the spring 82 may retract or move the stub shaft outwardly to disengage the pin entirely from said groove. Thus, a simple and effective means is provided for holding the main valve 18 open separately from the timing mechanism which normally controls the automatic operation of said valve.

From the foregoing it will be seen that a very simple and accurate timing mechanism, capable of use either with a simple motor valve or with a valve and regulating device, is provided. Where

a regulating device is employed, the main valve may be opened on time and closed either by pressure or by time. When used with a simple control valve the timing cycle is, of course, controlled solely by the timing mechanism. The mechanism is exceptionally simple and provides the single limiting or stop screw which may be adjusted to control the period of time of the cycle. In other words, the timing wheel begins the timing cycle but has nothing to do with the ending of said cycle, provided, of course, that the adjusting screw 55 engages the connecting element 52 prior to the time that the pin 39 moves completely from beneath the actuator.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A control apparatus for controlling the admission of fluid into a conductor including, a conductor, a fluid supply connected to said conductor, a main control valve in the conductor for controlling the admission of fluid to said conductor, pressure-operated means for opening and closing said valve, a clock-controlled timing mechanism for actuating the pressure-operated means of said valve to open said valve and admit fluid to the conductor during a predetermined time cycle, a pressure regulator associated with the pressure-operated means for the valve and operated in accordance with the pressure of the fluid on the downstream side of said valve for regulating said pressure, and means actuated by the timing mechanism and connected with the regulator for rendering the regulator inactive when the main valve is closed, whereby the regulator cannot function until said main valve is opened by the timing mechanism.

2. A control apparatus for controlling the admission of fluid into a conductor including, a conductor, a fluid supply connected to said conductor, a main control valve for controlling the admission of fluid to said conductor, a clock-controlled timing mechanism associated with said main valve for operating said valve to admit fluid to the conductor during a predetermined time cycle, a pressure regulator connected to the main valve and actuated by the pressure of the fluid on the downstream side of the valve for regulating said pressure, means controlled by the timing mechanism and having connection with the regulator for preventing actuation of said regulator when the timing mechanism is holding the main valve closed, said last-named means permitting the regulator to function in a normal regulating manner when the timing mechanism has opened the main valve, whereby said regulator may close said main valve independently of the timing mechanism and upon the attainment of a predetermined fluid pressure on the downstream side of said main valve.

3. A control apparatus for controlling the admission of fluid to a conductor including, a conductor, a fluid supply connected to the conductor, a main valve in the conductor for controlling the admission of fluid to the conductor, a pressure-operated means for operating the main valve, a pilot valve associated with the pressure operated means for actuating the same to thereby operate the valve, a timing mechanism for controlling the pilot valve, whereby the main valve may be opened

and closed on predetermined time cycles by said timing mechanism, a pressure regulator associated with the main valve and actuated by the pressure in the conductor on the downstream side of the main valve, said regulator functioning to close the main valve in the event the downstream pressure exceeds a predetermined amount during the timing cycle and prior to the time that the timing mechanism closes said valve, and means for conducting a balancing pressure to the regulator to render said regulator inoperative when the main valve is closed by the timing mechanism, said last named means being controlled by the pilot valve.

4. The combination with a pressure-actuated main control valve in a fluid conductor, of a timing mechanism including, a pilot valve associated with the pressure-actuated main valve and adapted to control the operation of said valve, a clock-controlled element, an actuator connected with the pilot valve for controlling said pilot valve to thereby control opening and closing of the main valve, said actuator being adapted to be engaged by the timing element to operate the pilot and thereby open the main valve, and means forming part of the actuator and movable therewith in a direction to open the valve but movable independently of said actuator and clock-controlled element for operating the pilot to close the main valve, whereby the length of the period during which the main valve is held open is controlled separately of the clock-controlled element.

5. The combination as set forth in claim 4, wherein the last named means is adjustable to permit variation of the period during which the main valve remains open.

6. The combination with a fluid conductor having a pressure-actuated main valve and also having a pressure regulator for controlling the main valve to regulate the pressure of the fluid on the downstream side of said main valve, of a timing mechanism including, a pilot valve associated with the pressure-actuated main valve and so arranged that opening of the pilot causes opening of the main valve and closing of said pilot causes closing thereof, a clock-controlled means for actuating the pilot at predetermined time intervals to open and close the main valve on predetermined time cycles, means for conducting a balancing pressure to the pressure regulator to render the same inactive, said pilot valve controlling the application of the balancing pressure to the pressure regulator to render said regulator inactive when the pilot and main valve are closed, whereby said regulator may function to operate the main valve only after the pilot has operated to open the main valve.

7. A timing mechanism including, a clock-controlled element, a movable control arm for controlling actuation of a valve means, an actuator adapted to be engaged and moved by the clock-controlled element and arranged to operate the control arm to start the timing cycle, and means independent of said actuator and clock-controlled element for disengaging said control arm from said actuator, whereby the valve means may be actuated to end the timing cycle.

8. A timing mechanism including, a clock-controlled element, a movable control arm for controlling actuation of a valve means, an actuator adapted to be engaged and moved by the clock-controlled element and arranged to operate the control arm to start the timing cycle, means independent of said actuator and clock-controlled

element for disengaging said control arm from said actuator, whereby the valve means may be actuated to end the timing cycle, and manually adjustable means for controlling the disengaging means, whereby the timing cycle may be readily varied.

9. A timing mechanism including, a clock-controlled element, a movable control arm for controlling actuation of a valve means, an actuator adapted to be engaged and moved by the clock-controlled element and arranged to operate the control arm to start the timing cycle, and a pivoted connecting element mounted on the control arm and normally in a position to be engaged by the actuator so that movement of the actuator is imparted to the control arm, and a stop arranged to be engaged by the element to swing the same and thereby disengage it from the actuator, whereby the control arm may return to its original position to actuate the valve means and thereby end the timing cycle.

10. A timing mechanism as set forth in claim 9, wherein the stop is manually adjustable to permit the timing cycle to be varied.

11. A control mechanism as set forth in claim 2, together with manually actuated means for holding the main valve open.

12. A control apparatus for controlling the ad-

mission of a fluid to a conductor including, a conductor, a fluid supply connected to the conductor, a main control valve for controlling the admission of the fluid to said conductor, a clock-controlled timing mechanism associated with the main valve for opening said valve at a predetermined time interval and for holding said main valve open for a predetermined desired time, pressure-actuated means independent of the timing mechanism for closing said valve in the event that the pressure on the downstream side of the main valve exceeds a predetermined amount, and manually actuated means for locking the main valve in an open position, said locking means being automatically released when the pressure on the downstream side of the main valve reaches a predetermined point.

ASBURY S. PARKS.

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