May 12, 1953 A. S. PARKS 2,638,110

VALVE CONTROL APPARATUS

Filed Oct. 16, 1947 2 Sheets-Sheet 1

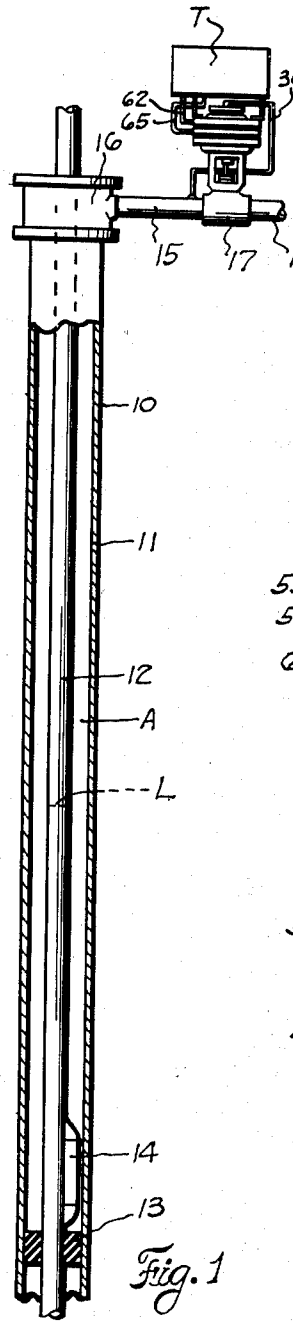


Fig. 1

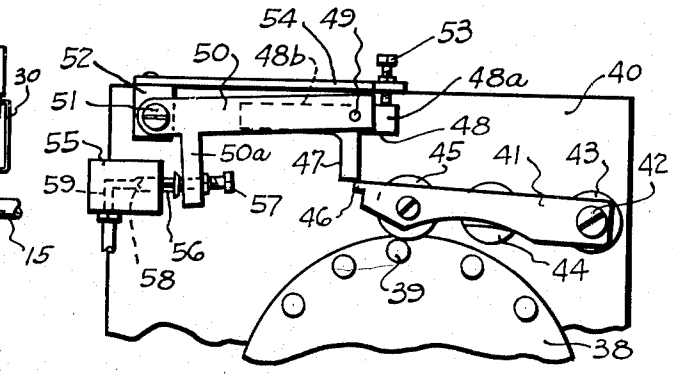


Fig. 4

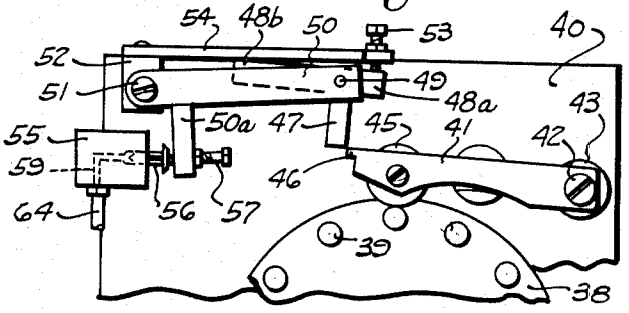


Fig. 5

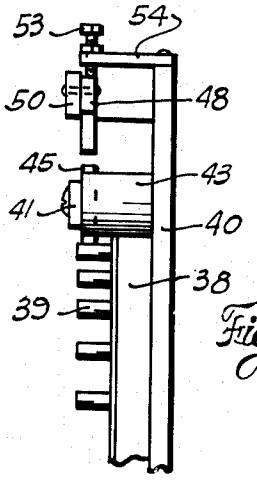


Fig. 3

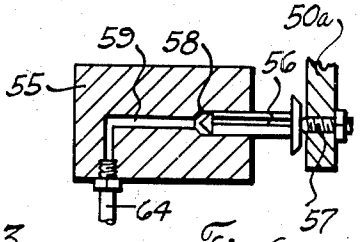


Fig. 6

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VALVE CONTROL APPARATUS

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2 Sheets-Sheet 2

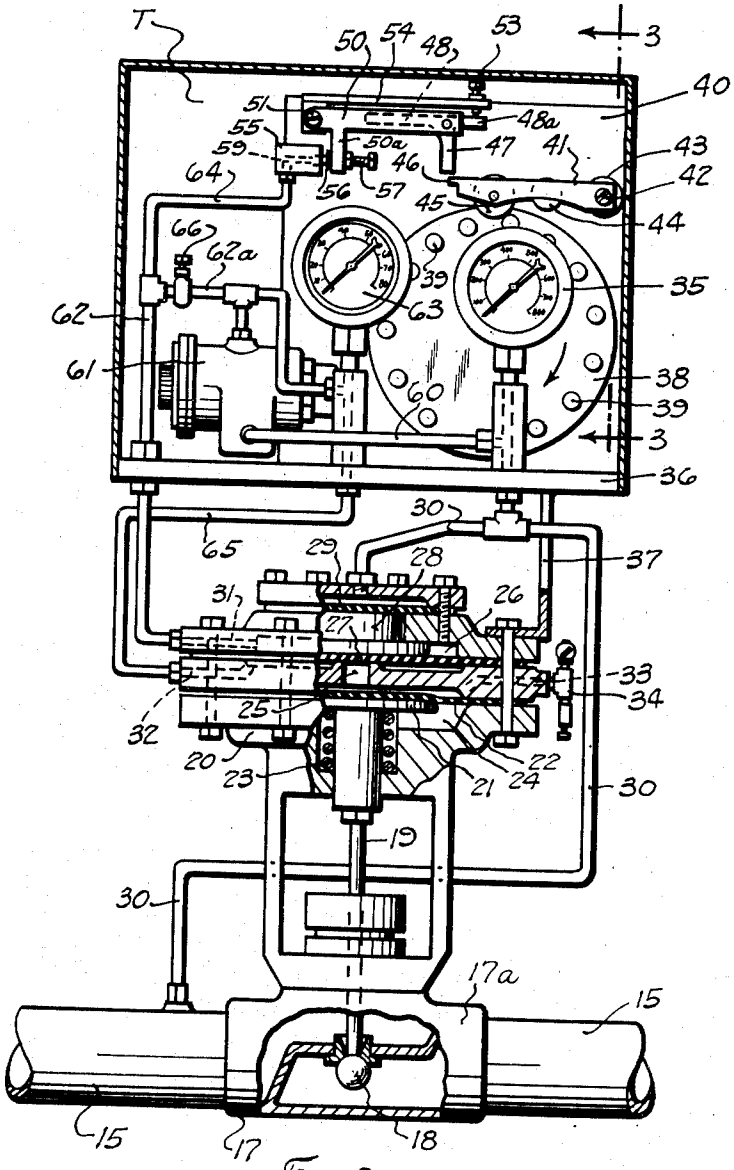


Fig. 2

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UNITED STATES PATENT OFFICE

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VALVE CONTROL APPARATUS

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Application October 16, 1947, Serial No. 780,177

7 Claims. (Cl. 137—155)

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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 provide a surface control apparatus for admitting a lifting medium to a well conductor and having

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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 particular object of the invention is to provide an improved surface controller wherein the timing mechanism for controlling the timing cycle includes a pivotally mounted arm adapted to be actuated by a clock controlled element and being arranged to be moved into engagement with the outer end of a pivoted control member to start the timing cycle; the control member having means pivoted thereto and arranged to co-act with a fixed stop member for disengaging the control member at any desired time to end the timing cycle, said control member and its co-acting means being entirely independent of the clock controlled element, whereby the length of the timing cycle is controlled solely by the adjustment of the co-acting means.

Another object of the invention is to provide an improved apparatus of the character described wherein a pivoted arm is movable by a clock controlled element and wherein a second arm is pivoted above and opposite to the first arm so that the outer end of the second arm overhangs said first arm; the second arm having a pivoted actuator connected to its outer end so that when the first arm is moved upwardly, it will engage said actuator to swing the second arm, whereby a valve means connected with said second arm is operated to control the operation of a main valve device.

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 a 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 2 is a view partly in section and partly

in elevation of a control aparatus constructed in accordance with the invention,

Figure 3 is a partial sectional view taken on the line 3—3 of Figure 2,

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

Figure 5 is a view similar to Figure 4 showing the parts in position at the end of the timing cycle.

Figure 6 is an enlarged sectional detail of the pilot valve.

In the drawings (Figure 1), 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 predetermined intervals, the main control valve 17 is opened 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. The regulated pressure may be referred to as the pilot pressure and is always less than the pressure being controlled in the main supply pipe 15. Under such a condition with pressures equalized across the diaphragm 27 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 because as stated, the control pressure in the main line is always greater than the pilot or regulated pressure in passages 31 and 32. Thus, even though the regulated pressure is acting against the under side of the upper diaphragm 29 the controlled pressure in line 30 overcomes the same to hold upper diaphragm 29 and the intermediate diaphragm 27 in a lowered position. 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. This is possible because the area of intermediate diaphragm 27 is greater than the area of the upper diaphragm 29 and a lesser pressure will function to move both diaphragms upwardly. The bleeder valve 34 is adjusted so that the pressure enter-

ing 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 regulated 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 upright supporting plate 40 is secured to the base 36 and extends upwardly behind the timing element or wheel 38. An actuating arm 41 has one end pivoted at 42 to the upright supporting plate 40 and a suitable spacer 43 which is interposed between the arm and the plate locates the arm in a position overhanging the outwardly extending timing pins 39. Downward movement of the arm is limited by an outwardly extending stop member 44 which is secured to the upright plate 40. The outer end of the actuator arm 41 has a freely rotatable bearing roller 45 pivoted thereto and as is clearly shown in Figure 3 the roller overlies the timing pins 39 and is adapted to be engaged thereby. The timing wheel rotates in a clockwise direction in Figure 2 and obviously as each timing pin moves beneath the roller 45 the actuator arm 41 is lifted upwardly; as the timing pin moves from beneath said roller, the actuator arm returns to its normal or substantially horizontal position, with the downward movement of said arm being arrested by the stop 44.

The extreme outer or free end of the pivoted arm 41 is provided with a lug 46 and this lug is arranged to engage the vertical depending leg 47 of a generally T-shaped element 48. The element 48 is also formed with a relatively short horizontal arm 48*a* and a longer horizontal arm 48*b* and said element is pivoted on a pin 49 to the outer end of a valve operating bar 50. The bar 50 is pivoted on a screw 51 which is secured to the upright plate 40 and a suitable spacer 52 properly locates the bar 50 and its pivoted hanger 48 in a position overlying the lug 46 at the free end of the actuating arm.

An adjusting screw 53 is threaded downwardly through a supporting bracket 54 which has one end secured to the upright supporting plate 40 with its opposite end overhanging the element 48 so that the arm 48*a* of said element may engage the screw. The arms 48*a* and 48*b* are of such weight with respect to the pivot point 49 that normally the member 48 assumes the position shown in Figure 2 and in such position, the leg 47 depends vertically in a position overlying the lug 46 of the actuating arm 41.

In the operation of the timing mechanism, the parts are normally in the position shown in Figure 2, in which position the roller 45 of the actuating arm 41 has just disengaged one of the timing pins 39. At this time the valve operating bar 50 is substantially horizontal and has a vertical extension or leg 50*a* which is adapted to co-act with the fluted valve stem or member 56 of a pilot valve 55. The pilot valve 55 is suitably mounted on the upright supporting plate 40 and when the operating bar 50 is substantially horizontal with its leg 50*a* vertical, the valve member 56 is in a seated or closed position. A suitable adjustable screw 57 is threaded through the leg 50*a* and engages the end of the valve member 56 to normally hold said valve against a seat 58 formed in an angular passage 59 in the valve body. With the operating bar in a horizontal position, the hanger member 48 is in a position with its leg 47 substantially vertical and overlying the lug 46 of the actuating arm 41.

As the clock mechanism operates to rotate the timing wheel 38, the next timing pin 39 engages the roller 45 of the actuator 41 and swings said actuator upwardly to the position shown in Figure 4. Upward movement of the outer end of the actuator 41 results in the lug 46 of said actuator engaging the lower end of the vertical leg 47 of the hanger element 48. The weight of the

elongate arm 48b is sufficient to maintain the element 48 in its same relative position with respect to the operating bar 50 whereby upward movement of the leg 47 results in a swinging of the outer end of said operating bar 50. Such upward movement of the outer end of said arm results in swinging or moving of the vertical leg 50a outwardly of the valve stem or member 56 whereby the valve may move off its seat 58 and thereby open the angular passage 59 of the pilot valve body to atmosphere.

Upward movement of the bar 50 which permits the valve 56 to remain open continues until the screw 53 mounted in the bracket 54 is engaged by the short arm 49a of the hanger element 49. After this engagement of the arm 49a with the screw 53, any continued upward movement which is imparted to the member 49 results in said member being swung on its pivot, as shown in Figure 5. As soon as the member 49 has been swung sufficiently to cause its lower end to clear the engaging lug 46, the operating bar 50 and the member 49 connected therewith may fall downwardly to their original position, as shown in Figure 2. This results in the leg 50a of the operating bar 50 moving the valve member 56 inwardly to effect an immediate seating or closing of said valve member 56 to shut off the flow through the angular port 59. Thus, it is obvious that the pilot valve 56 is closed as soon as the hanger element 49 is swung and irrespective of whether or not the actuator 41 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 bar 50 through the hanger element 49. It is at this time that the pilot valve 56 is permitted to open. The timing cycle is completed and the pilot valve closed in accordance with the adjustment of the limiting or stop screw 53 for obviously as soon as the hanger element 49 is swung through its engagement with this screw, 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 36 and the actuator 41. The provision of the adjusting screw 53 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 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 59 of the valve housing 55 and with this arrangement it will be evident that when the pilot valve 56 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 61 to the passage 22, 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 56 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 41 upwardly and as explained imparts an upward movement to the outer end of the operating bar 50, whereby the pilot valve element 56 is permitted to open, such opening being caused by the pressure in the line 64 acting against the valve element. 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 thereby permit said pressure to act against the actuating diaphragm 22 to open the main 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 accordance 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 arm 48a of the pivoted connecting element 48 engages the stop screw 53. When this occurs, the element 48 is swung to disengage the lug 46 of the actuator so that the pivoted operating bar may drop to its original position to cause the leg 50a to move the valve element 56 inwardly to close the pilot valve. When the pilot valve 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 main valve. In this instance, the time cycle or the period during which the main valve remains open is controlled solely by the timing mechanism T and in accordance with the adjustment of the limiting screw 53.

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 timing mechanism for a control apparatus including, a pilot valve, a clock-controlled actuator arm having one end pivoted to a support whereby its outer end is adapted to swing in a vertical plane, an operating bar pivotally mounted at one end with its free outer end overhanging the outer movable end of said arm, means for connecting the arm to the pilot valve whereby swinging of the arm opens and closes said valve, and a connecting member pivoted to the outer end of the actuating bar and adapted to be engaged by the operating arm, whereby movement of the arm is transmitted to the actuating bar to open the valve, and means associated with the connecting member for swinging said member to disengage the same from the operating arm after said member and the bar have moved a predetermined distance, whereby said member and bar connected therewith may return to a position closing the valve even though upward movement of the operating arm is continued.

2. A timing mechanism including, a clock-controlled element, a valve means, an upright support, a control bar having one end pivoted to the support and overlying the valve means, means for connecting the bar intermediate its end with the valve means, whereby swinging of the outer free end of said bar actuates the valve, an actuating arm having one end pivoted to the support and having its outer free end located below the outer free end of the control bar and being engageable by the clock-controlled element so as to be swung thereby, a connecting member pivoted to the outer end of the control bar and having a depending leg which is normally disposed in the path of the operating arm, whereby swinging of the arm imparts a swinging movement to the bar to actuate the valve means, said connecting member having a lateral extension, and an adjustable stop on the upright support disposed in the path of the lateral extension, whereby after the bar, connecting member and control arm have moved a predetermined distance the connecting member is swung to move its depending leg out of the path of the arm, whereby the control bar may return to its original position closing the valve irrespective of whether or not the actuating arm has completed its swinging movement as controlled by the clock-controlled element.

3. A timing mechanism including, a rotatable clock-controlled element, an upright support, a pair of pivoted actuating arms mounted in opposed relation with their free ends directed toward each other, one of said arms being disposed above the other and located so that its free end overhangs the other, a valve means, means for connecting the upper arm to said valve means whereby swinging of the arm controls opening and closing of said valve means, the lower arm overlying and being operated by the clock-controlled element, a connecting member pivoted to the upper arm and adapted to be engaged by the lower arm whereby swinging of the latter imparts a movement to the upper arm, and means independent of the lower arm for disengaging the connecting member from the lower arm, whereby the upper arm may return to its original position to actuate the valve before the lower arm has completed its movement as controlled by the clock-controlled element.

4. A timing mechanism as set forth in claim 3, wherein the means for disengaging the connecting member from the lower arm is manually adjustable whereby the time of actuation of the valve may be accurately controlled.

5. A timing mechanism as set forth in claim 4, wherein the means for disengaging the connecting member from the lower arm is a fixed stop screw and a lateral extension on the member, which elements co-act to swing said member out of engagement with said lower arm after predetermined movement has been imparted thereto by the lower actuating arm.

6. A control apparatus for controlling the admission of fluid into a conductor including, a main inlet valve having a pressure-actuated operating element, means for conducting a pilot pressure to the operating element, a flexible pressure-responsive member functioning as a valve means to control the admission of pressure to the operating element of the main inlet valve and having its opposite sides normally exposed to a regulated pilot pressure whereby pressures thereacross are balanced, a second pressure-responsive member exposed to the pressure in the conductor, a force transmitting means between said second pressure-responsive member and the first pressure-responsive member, whereby the pressure acting on said second member is transmitted to said first member to move the first member in a direction shutting off pressure fluid to the operating element of the main valve to permit closing of the valve when pressures across said first pressure-responsive member are balanced, and time-controlled pilot means for unbalancing the pressures across said first pressure-

responsive member at predetermined time intervals whereby said first member is actuated to direct pressure fluid to the operating element to open the main inlet valve.

7. An apparatus as set forth in claim 6, wherein the cross-sectional area of the first pressure-responsive member bears a predetermined relationship to the cross-sectional area of the second pressure-responsive member and is of a larger area, whereby in the event that pressure acting on said second member becomes excessive, the first member may be moved into a position

shutting off pressure to the operating element of the main valve during the period that the time controlled means is maintaining the pressures across the first member unbalanced.

ASBURY S. PARKS.

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