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TIME AND VOLUME CONTROL FOR GAS INTERMITTERS

Filed May 25, 1940

3 Sheets-Sheet 1

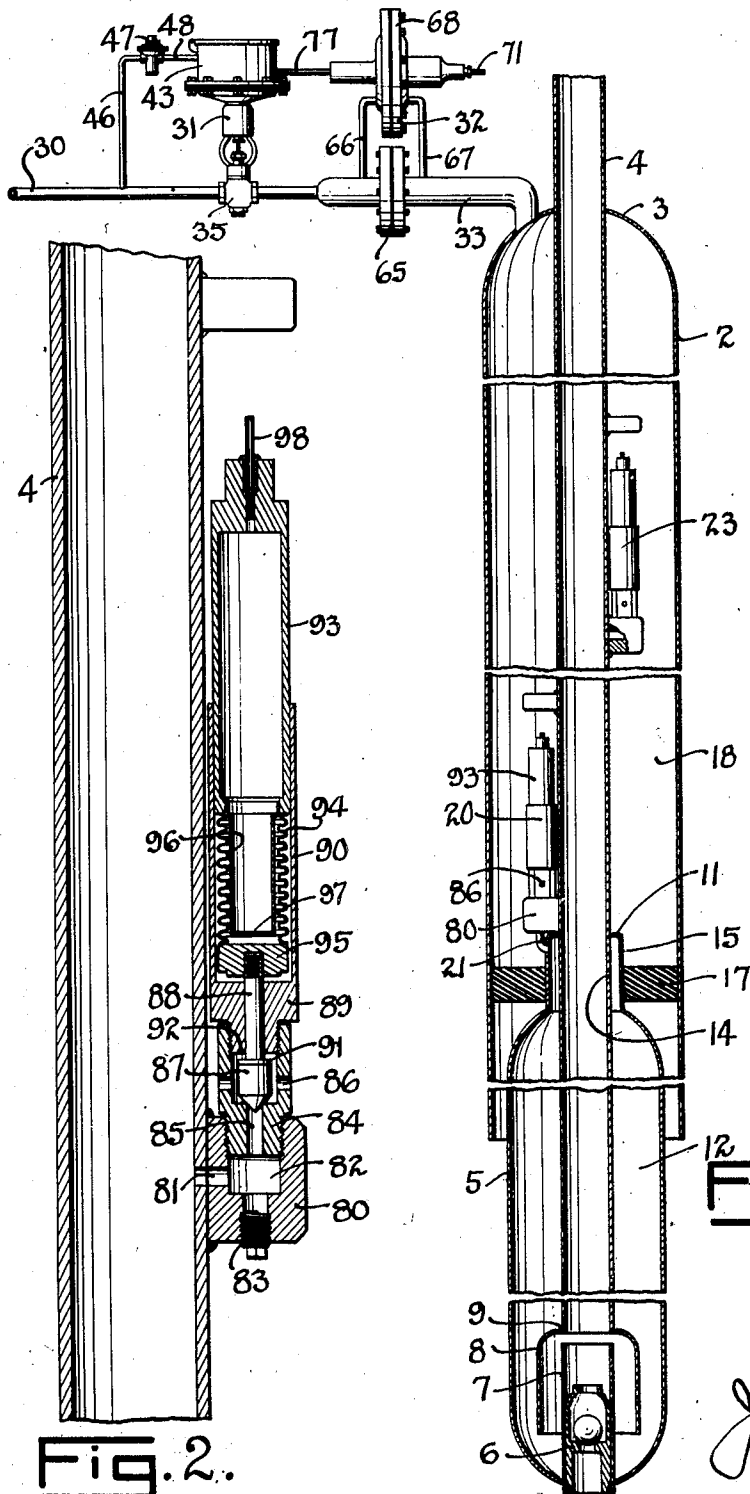


Fig. 1.

Fig. 2.

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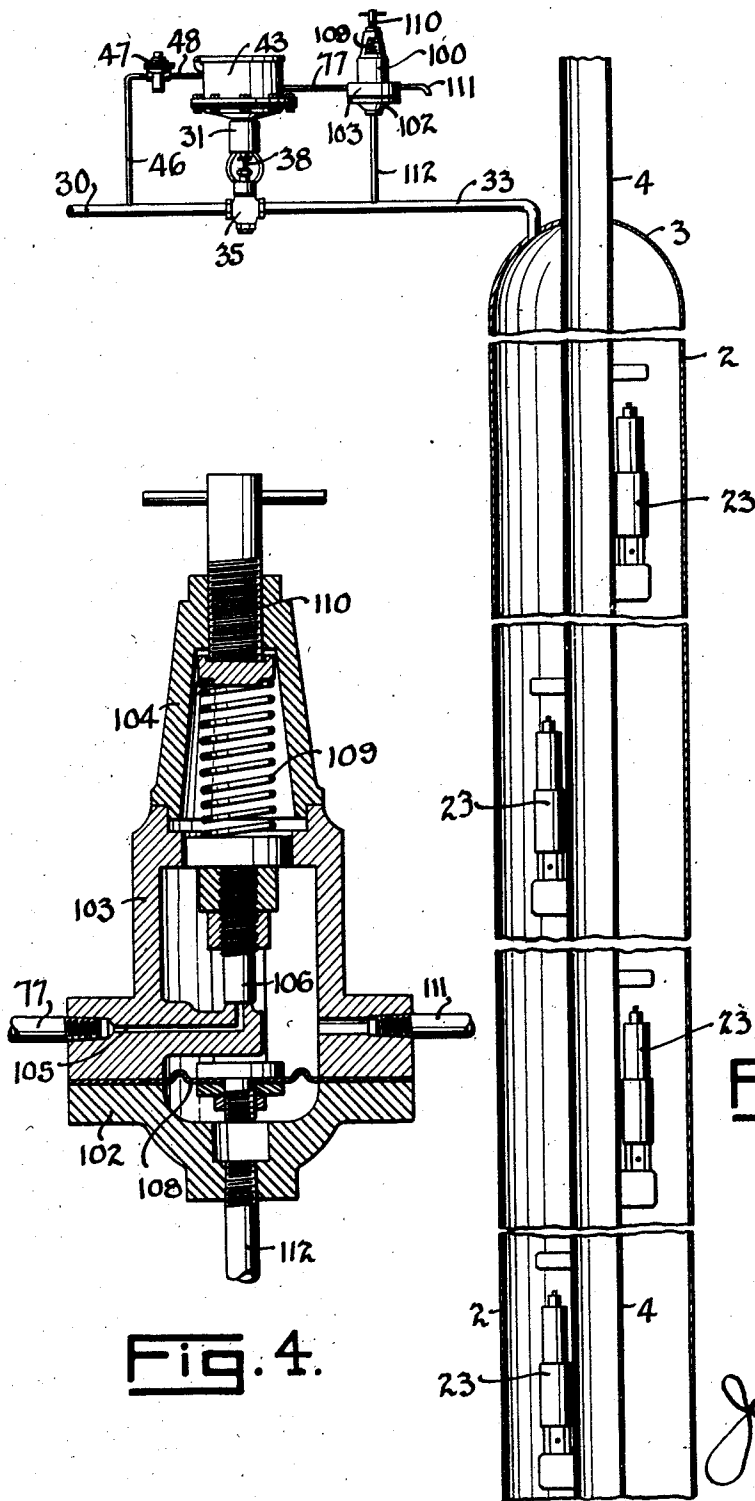
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

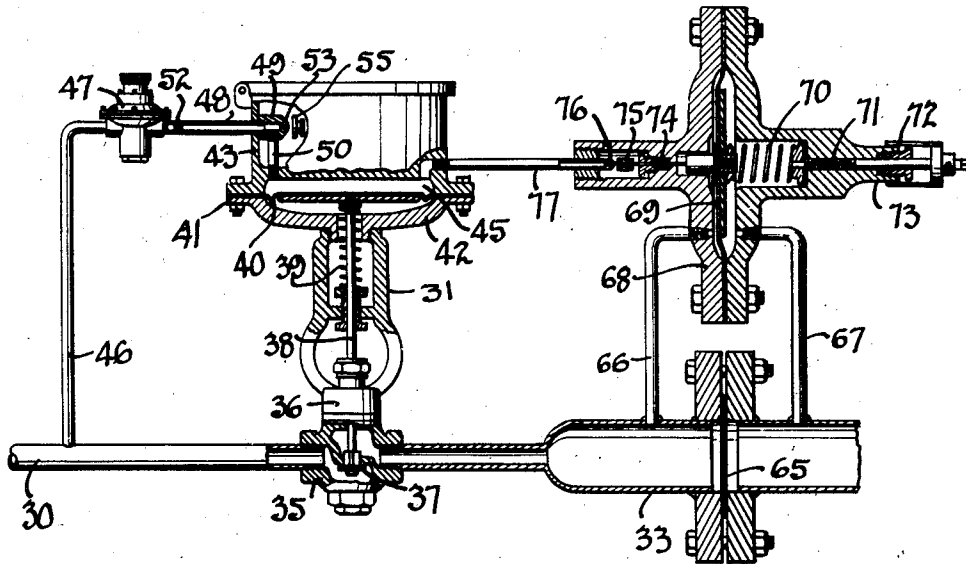


Fig. 5.

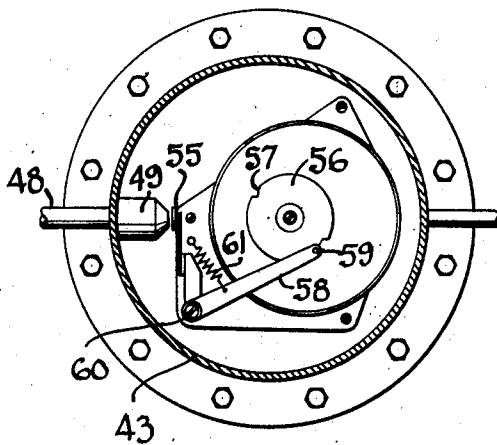


Fig. 6.

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TIME AND VOLUME CONTROL FOR GAS INTERMITTERS

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13 Claims. (Cl. 103—231)

The invention relates to an intermitter for wells wherein the well is to be produced intermittently and is of a particular type where the fluid pressure is controlled both as to time and as to volume, so that adjustment thereof may be had to produce from the well a predetermined amount of fluid which will vary with the characteristics and requirements of the particular well.

In the flowing of wells the procedure has evolved to an arrangement wherein a predetermined flow from each well is permitted and the present invention contemplates a mechanism which can be adjusted so as to produce the predetermined allowable from the well and which will not produce more than this allowable and, at the same time, conserve the pressure fluid being used to flow the well.

With present devices used for flowing wells it is not uncommon to have a great waste of fluid pressure so that the gas-oil ratio of the well is very high, but with the present invention the gas-oil ratio can be reduced materially and positively controlled to produce the desired volume of liquid.

It is one of the objects of the invention to provide a time and volume control for gas intermitters.

Another object of the invention is to provide one or more unloading valves on a string of tubing in a well which valves are charged to operate at a predetermined gas pressure introduced into the well and controlled from the surface.

Another object of the invention is to flow a well by introducing a predetermined volume of pressure fluid so that a predetermined volume of liquid will be produced from the well thereby.

Another object of the invention is to control a timing mechanism for introducing pressure fluid in the flowing of the well, so as to control not only the volume of the gas introduced but the rate of introduction as well.

Still another object of the invention is to provide a mechanism for applying a constant source of pressure to a flowing device which will control the rate of admission of the pressure fluid so as to produce from the well a predetermined volume which is governed by the rate of the flow.

Another object of the invention is to provide a timer mechanism to admit pressure fluid in the flowing of a well for a predetermined period while controlling the maximum pressure which is applied to the well as a function of the volume which is to be produced.

Another object of the invention is to provide a differential control mechanism for well inter-

mitters wherein the differential pressure set up across an orifice plate will control the power valve for admitting pressure fluid.

Another object of the invention is to provide a charged valve for well intermitters which will seal off to exclude pressures exceeding a predetermined amount so as to protect the valve against excessive pressure.

Still another object of the invention is to provide a means and method of intermitting wells wherein the flow of a predetermined volume is controlled by a time and volume control of the introduction of pressure fluid.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view illustrative of a well construction and the timing and volume control mechanism as applied for operation.

Fig. 2 is a vertical section of one of the unloading valves and illustrating the detailed construction thereof.

Fig. 3 is a vertical sectional view of the arrangement of the time and volume control wherein pressure is admitted for a predetermined time with a regulator for the maximum pressure to be applied.

Fig. 4 is a vertical sectional view of the maximum pressure regulator of Fig. 3.

Fig. 5 is an enlarged side elevation with certain parts in section of the timing and differential control mechanism of Fig. 1.

Fig. 6 is a top plan view of the timer mechanism with the top removed to illustrate the internal construction thereof.

In Fig. 1 a well casing is illustrated generally at 2 and has its upper end 3 closed about a tubing 4. A well of this sort may be of any desired depth and the tubing and casing may be of any desired diameter. This tubing or flow string extends down into the well to the lower reaches thereof and, as seen in Fig. 1, supports a drum 5, which is in the form of an accumulation chamber for the oil discharging from the formation into the well bore. A standing valve 6 which opens upwardly is carried by the lower end of the drum so that fluid under pressure may enter the flowing assembly but may not discharge therefrom through the valve 8. A sleeve 7 projects above the standing valve and is enclosed by a skirt or apron 8, which is mounted on the lower end 9 of the tubing string 4. The drum 5 is closed about the standing valve 6 and about the tubing at the elevation 11. In this manner it seems obvious

that fluid entering the standing valve 6 may either move upwardly in the tubing 4 or it may circulate through the skirt 8 into the chamber 12 inside of the drum 5. A leak port 14 is provided in the tubing adjacent the head 15 of the drum so that any gas present in the drum may escape into the tubing with a view of allowing the oil or other liquid to flow into the drum.

A packer 17 may be provided in the well casing about the drum or the tubing so as to form a seal and provide a fluid pressure reservoir 18 in the casing above the packer.

An intermitter valve 20 is shown as being connected to the head 15 of the drum so that pressure fluid admitted from the reservoir 18 may pass through the connection 21 into the drum. This pressure would be exerted on the upper surface of the liquid in the drum and if it were a predominant pressure it would force the liquid level downwardly and compel such liquid to flow upwardly through the tubing string 4 to be elevated from the well.

Any desired number of unloading valves 23 can be arranged at spaced intervals along the tubing and these valves may be set to open at slightly greater pressures than that at which the intermitter valve 20 unloads. Thus, if the tubing 4 should contain liquid the pressure applied to the reservoir 18 would first cause opening of the intermitter valve 20 but if the applied pressure were insufficient to unload the well the intermitter valve 20 would stay open but little or no pressure fluid would enter the drum 5. If the pressure in the reservoir 18 were then increased the next succeeding higher valve would open and this operation would continue until a valve would open at a pressure which was sufficient to unload the column of oil in the tubing 4 above that valve. When the column of oil in the tubing is unloaded down to that valve it would reduce the back pressure on the next succeeding lower valve which then, being open due to the increased pressure, would begin to admit fluid pressure fluid so that the valves would unload in sequence downwardly along the tubing until the load on the well was reduced to such an extent that there would be a flow through the intermitter valve 20.

The valves 20 and 23 are of a particular construction which is best seen in Fig. 2 and will be later described. They are of a type which will open when a predetermined gas or fluid pressure is applied thereto, depending upon the pressure at which the valve is charged or set to operate.

In order to control the flow of fluid pressure into the reservoir 18 from a source of pressure in the pipe 30, a timing mechanism 31 and a differential pressure mechanism 32 are attached to the inlet line 33.

The timing and differential pressure mechanisms are best seen in Fig. 5 and include a power valve 35, which includes a housing 36 carrying a valve member 37 operated by the valve stem 38. This valve is shown as an upwardly closing valve which is normally held closed by a spring 39 and which is arranged for operation by means of a diaphragm 40 arranged in the housing 41. This housing is made up of a base 42 and a timer head 43. In order to apply fluid pressure in the operating chamber 45 to open the valve a connection 46 has been arranged from the supply line 30. A suitable reducer valve 47 may be provided on this connection so that pressure fluid to actuate the power valve will not exceed a predetermined value. A connection 48 from the reducer valve

leads through the fitting 49 and the pipe 50 into the chamber 45. A choke 52 is provided in the pipe 48 so as to restrict the flow of fluid there-through. Normally the flow will be through the pipe 46, the reducer valve 47, and the pipe 48 into the fitting 49. A discharge port 53 in the fitting 49 is seen as open in Fig. 5, so that the flow ordinarily would be through this port into the atmosphere and there would be no flow into the chamber 45.

In order to direct the pressure through this connection into the chamber 45 a closure 55 is arranged to be operated by the timing mechanism as best seen in Fig. 6. This timing mechanism includes a rotatable cam 56, which carries the notches 57. A lever 58 is arranged to have the pin 59 thereof engage in the notches so as to allow pivoting of the lever about the shaft 60. A spring 61 normally urges this lever against the cam 56. When the pin 59 moves into one of the notches 57 the closure 55 is forced against the fitting 49 to close the port 53. The pressure through the pipe 48 will then accumulate in the chamber 45 to depress the diaphragm 40 and open the main power valve.

By arranging the speed of rotation of the timer and the size and configuration of the notches 57 it seems obvious that the opening and the closing of the valve 35 can be accurately controlled.

In order to control the rate of flow into the well an orifice plate 65 is provided in the entry pipe 33 and the connections 66 and 67 lead off from the opposite sides of this orifice plate to a housing 68 which carries a diaphragm 69. This diaphragm will, therefore, move in accordance with the differential pressure across the orifice plate but is normally urged to the left, as seen in Fig. 5, by a loading spring 70. This loading spring is adjustable by means of the screw 71 which carries a cylinder 72 which moves relative to indicia 73 on the periphery of the housing 68. By observing this construction the adjustment of the spring 70 may be determined.

A rod 74 projects into the lefthand side of the housing 68 and carries a plug 75 which is adapted to close the port 76 in the pipe 77 which leads from the timer head 43 and from the chamber 45. This port 76 is relatively small so as to allow a gradual leakage of pressure fluid from the chamber 45.

The pressure fluid admitted from the main valve 35 flows into the entry pipe 33 and if the rate of flow exceeds the rate at which the fluid will pass the diaphragm 65 it seems obvious that a differential pressure will be set up across the diaphragm. As this differential pressure increases the diaphragm 69 will be moved to the right to uncover the port 76 and allow the escape of pressure fluid from the chamber 45 so that the spring 39 will close the valve member 37. On the other hand, if the differential pressure decreases across the plate 65 the opposite action will occur to close the port 76, allowing the pressure to increase in the chamber 45 and open the valve member 37.

It seems obvious from the foregoing construction that there will be somewhat of a hunting action on the part of the main valve 35 during the period it is to be opened by the timing mechanism so as to admit the volume of fluid during that period at a predetermined rate, so that in combination the timing and the differential pressure mechanism control not only the volume but the rate of flow as well. By adjustment of the spring 70 the differential pres-

sure at which the valve 35 will be operated can be readily controlled.

The adjustment of the screw 71 determines the volume which will flow into the well during the time interval set upon the timer 31.

Fig. 2 shows the construction of the valve 20 or 23 wherein a base 89 is affixed to the tubing 4 over an inlet opening 81. A chamber 82 in the base is closed at the bottom by the plug 83 and at the top by a valve seat 84. This seat has a passage 85 therethrough for the flow of pressure fluid and has the inlet openings 86 in the side thereof. Inside of this seat is the valve member 87 carried by a stem 88 which is arranged for sliding movement in the base 89 of the protector sleeve 90. A gasket 91 is positioned about the stem 88 on top of the valve member 87 so as to form a seal with the lower end 92 of the base 89. A pressure chamber 93 is affixed at the upper end of the protector sleeve 90 and carries a bellows 94, which is arranged for movement in the protector sleeve 90. The valve stem 88 is connected to the lower collar 95 of the bellows and the upper end is affixed to the bottom of the pressure chamber. A safety baffle 96 is affixed in the lower end of the pressure chamber 93 and extends into the bellows having a small opening 97 in the bottom thereof so as to control the flow in and out of the pressure container 93 to and from the bellows 94.

A connection 98 provides for charging the pressure chamber 93 and the bellows with gas at a predetermined pressure. This pressure determines the pressure at which the valve will operate.

In operation this valve will be positioned as shown in Fig. 2 and will be charged with such a pressure in the pressure chamber 93 as will permit the valve member 87 to rise from its seat at a predetermined pressure, say, three hundred pounds.

The pressure applied to the valve enters the ports 86, passes around the valve stem 88 upwardly through the base 89 and into the bellows chamber inside of the protector sleeve 90 and about the bellows. As this applied pressure increases and moves above the predetermined pressure at which the valve is set to operate, the fluid inside of the chamber 93 is compressed and the bellows begins to collapse. As the bellows collapses the stem 88 and valve 87 will be raised so as to open the passage 85 and allow pressure fluid to enter the tubing 4. As the applied pressure at the opening 86 is reduced due to the flow into the tubing it seems obvious that there will be a corresponding reduction inside of the protective sleeve 90. The bellows will expand as the pressure reduces. It has been found in operation that a construction of this sort actually snaps open and snaps closed so that the valve is opened and closed sharply. In fact, the baffle 96 is provided with the damping openings 97 so as to prevent too violent an action of the device by permitting the gradual leakage into or out of the baffle through this small orifice 97. This baffle also serves to reduce the volume of gas required to fill the inside of the housing 90 and thus causes a more accurate control and definite action.

In some instances excessive pressures may be purposely or inadvertently applied to the device and the openings 86 which might have a detrimental effect upon the bellows 94, so, with a view of protecting such bellows against excessive pressures, the protective sleeve 90 has been provided, and the gasket 91 on the valve stem above the valve member. Thus, when sufficient pressure is

exerted to collapse the bellows sufficiently to move the valve 87 upwardly a sufficient distance, then the gasket 91 engages the lower end of the base 89 and forms a seal about the stem so as to prevent any excessive pressure entering the bellows chamber. Thus any excessive pressure is sealed off and the bellows is protected against destruction. When the excessive pressure is exhausted so that the valve 87 tends to move down, then the valve may be closed and the pressure again equalized in the bellows chamber.

The apparatus of Fig. 1 can be used to obtain a constant flow if desired by either disconnecting the timer 31 or allowing it to run constantly to hold the power valve open. Under these circumstances excessive pressure would be applied to the intermitter valve 20 to keep it open at all times or it might be that the well would seek a balance in accordance with the applied pressure and one of the unloading valves 23 under these circumstances might be the valve through which the pressure fluid would enter the tubing, depending upon the pressure encountered in the well, the elevation of the static head and the back pressure applied. Under these circumstances, the differential pressure mechanism 32 would be set to admit a predetermined volume and the pressure which accumulated in the well due to that volume would seek the appropriate valve for entry, depending upon the characteristics of the well. The faster the rate of entry of the pressure fluid the faster will be the increase in the pressure applied in the well. The higher pressure will thus operate the higher valves to unload the well and in this manner the back pressure on the formation is reduced. This operation continues until the valves unload which operate at pressure which is constant for the rate of entry, so that in this manner the well automatically seeks a proper balance for operation.

In Fig. 1, the drum 5 may be omitted and the standing valve placed directly on the lower end of the tubing or the packer provided about the tubing to maintain the pressure chamber 13 without the drum 5. In either instance it may be used as an intermitter or as a constant flow device.

Fig. 3 shows a slightly modified arrangement of the device in Fig. 1 where a maximum pressure regulator 100 has been applied on the inlet pipe 33 in lieu of the differential pressure device 32 of Fig. 1. This regulator is connected to the pipe 77, the same as the differential pressure device but is set to control the maximum pressure which can be applied to the entry pipe 33. With this construction the timer will open wide and admit the same pressure that is present in the pipe 30, until such time as the pressure builds up in the well, whereupon the regulator 100 will operate to bleed off the pressure from the pressure chamber 45 in the timer head. The timer thus stays open for a predetermined period but the regulator is provided to limit the maximum pressure which is to be applied.

Thus, during the time interval as the pressure drops off in the reservoir 13 to lower the pressure in the inner pipe, then the regulator will close, allowing the pressure to build up and open the power valve. This action balances itself back and forth, depending upon the setting of the regulator 100.

Fig. 4 shows the regulator 100 as being made up of a base 102, a body 103, and the bonnet 104. The pipe 77 leads through a conduit 105 which is arranged to be closed by the plug 106, which plug is supported on a diaphragm 108 and pressure load-

ed by a spring 109, which is adjustable by the spindle 110. An outlet port 111 allows the pressure fluid to escape from the regulator.

The control pipe 112 leads into the base of the regulator beneath the diaphragm 108 so that when the pressure increases in the entry pipe 33 it will raise the diaphragm 108, the plug 106, and allow the pressure fluid to escape through the pipe 77.

One of the principal features of advantage of the present invention is that the means and method by which the pressure fluid which is utilized to flow the well is also the power fluid for actuating the valves. A specific form of timing control mechanism is disclosed and claimed in my copending application Serial No. 438,891, filed April 14, 1942, for Intermittent timing device.

Broadly the invention contemplates that a charged valve is to be placed in the well and is to be thereafter operated to admit pressure fluid to flow the well by the gas pressure which is controlled from the surface.

What is claimed is:

1. An intermitter assembly for wells having a packer to close said tubing in the well, an intermitter valve, a drum on the tubing to receive a charge of fluid from the well, said valve being charged with gas under pressure so as to open at a predetermined pressure, means at the surface to admit a predetermined volume of pressure fluid into the well to exert a pressure on the charged gas in the valve to open said valve and admit such pressure fluid to said drum to flow the fluid from the well, and a series of unloader valves on the tubing above said intermitter valve which are set to open at higher pressures than said intermitter.

2. An intermitter assembly for wells having a packer to close said tubing in the well, an intermitter valve, a drum on the tubing to receive a charge of fluid from the well, said valve being charged with gas under pressure so as to open at a predetermined pressure, means at the surface to admit a predetermined volume of pressure fluid into the well to exert a pressure on the charged gas in the valve to open said valve and admit such pressure fluid to said drum to flow the fluid from the well, and a series of unloader valves on the tubing above said intermitter valve which are set to open at higher pressures than said intermitter, so that if said drum and tubing are loaded, more than one charge of pressure fluid may be admitted to accumulate a pressure capable of unloading said series of valves.

3. An unloading valve for well intermitters to admit the unloading pressure fluid including a bellows charged and sealed with gas at a predetermined pressure, a valve member carried thereby, a housing about said bellows forming a chamber, an entry for the unloading pressure fluid to said chamber to first affect said bellows to operate said valve and then be admitted to unload the well, and resilient means on said valve to seal off said bellows when the valve is open so as to prevent the application of an excessive pressure through said entry to said bellows.

4. An unloading valve for well intermitters to admit the unloading pressure fluid including a bellows charged and sealed with gas at a predetermined pressure, a valve member carried thereby, a housing about said bellows forming a chamber, an entry for the unloading pressure fluid to said chamber to first affect said bellows to operate said valve and then be admitted to unload the well, and a damping baffle in said bellows.

5. A well flowing device including a flow string, a series of unloading valves thereon set to open at successively higher pressures with the lower pressure valve at the lowest elevation, and means to introduce a predetermined amount of pressure fluid into the well as a charge to open such valve or valves as will open by the pressure occurring in the well due to the introduction of such charge.

6. A well flowing device including a flow string, a series of unloading valves thereon set to open at successively higher pressures with the lower pressure valve at the lowest elevation, and means to introduce a predetermined amount of pressure fluid into the well as a charge to open such valve or valves as will open by the pressure occurring in the well due to the introduction of such charge, said means operating periodically so that if the first charge does not create a flow from the well that the second and subsequent charges will create a pressure which will overbalance the well and create a flow.

7. A well flowing device including a flow string, a series of unloading valves thereon set to open at successively higher pressures with the lower pressure valve at the lowest elevation, and means to introduce a predetermined amount of pressure fluid into the well as a charge to open such valve or valves as will open by the pressure occurring in the well due to the introduction of such charge, so that as the pressure is reduced as the well unloads, the higher valves will close and the flow occur due to the pressure fluid from the lower valve or valves.

8. A valve for well flowing devices having a flow tubing to support such valve to control the admission of pressure fluid including a housing, a valve member and valve seat therein, a bellows connected to said valve member and charged with gas at a predetermined value tending to normally retain said valve member closed, inlet ports to said housing, a chamber in the housing about said bellows to receive pressure fluid from said inlets so as to subject said bellows to the compressive force of the pressure fluid to open said valve member to admit such pressure fluid to flow the well, an enlarged reservoir forming a part of said bellows, and a damping baffle extending said reservoir into the bellows so as to reduce the volume of the bellows subject to pressure.

9. A valve for well flowing devices having a flow tubing to support such valve to control the admission of pressure fluid including a housing, a valve member and valve seat therein, a bellows connected to said valve member and charged with gas at a predetermined value tending to normally retain said valve member closed, inlet ports to said housing, a chamber in the housing about said bellows to receive pressure fluid from said inlets so as to subject said bellows to the compressive force of the pressure fluid to open said valve member to admit such pressure fluid to flow the well, an enlarged reservoir forming a part of said bellows, a damping baffle extending said reservoir into the bellows so as to reduce the volume of the bellows subject to pressure, and a leak port in said baffle to damp action of the bellows and valve member.

10. A well flowing combination including a flow string, a series of valves carried thereby and controlling communication with the interior of the string at various levels, and means for applying gas under pressure to said valves to cause the gas to enter the flow string, each of said valves having an element movable to open and close communication with the interior of the

string, a sealed bellows having one part connected to said element and another part anchored with respect to said string, and an elastic pressure fluid within the bellows under a pressure greater than atmospheric to normally tend to cause said bellows to expand and move said element to closed position, the pressure in the various bellows varying progressively from a relatively high pressure in the uppermost to a relatively low pressure in the lowermost bellows, and the bellows all having their exteriors subjected to the pressure of the gas to be admitted to the string, whereby as the pressure of said gas is increased said valves will open in turn from the lowermost to the uppermost.

11. A series of valves for use in admitting gas under pressure to a flow string and adapted to be spaced along said flow string, each valve including a hermetically sealed member expansible to close the valve and contractible to open the same and adapted to have its exterior subjected to the pressure of the gas to be admitted to the string, and an elastic pressure fluid within each of said members tending to expand the same, the pressures of said fluid in the various expansible members varying progressively from a relatively low pressure within the member on the valve adapted to occupy the lowermost position with respect to the flow string to a relatively high

pressure within the member on the valve adapted to occupy the uppermost position.

12. A valve of the character described, a bellows expansible and contractible to close and open said valve under the influence of varying pressures on its exterior surface, means enclosing said bellows and forming a chamber thereabout and having an opening therein to admit pressure fluid to act on said bellows, and means for closing said opening upon a predetermined contraction of said bellows, whereby said bellows will be protected against excessive pressures on its exterior surface.

13. In a well flowing assembly including flow tubing, a series of pressure fluid control valves mounted on said tubing to control the flow of pressure fluid thereinto, each valve including a pressure sealed bellows unit and a valve member operable thereby, each of said bellows being sealed at a different pressure to provide a sequential opening of the series upon the application of the flowing pressure fluid thereto to first open the lowest pressure valve and thereafter open the remaining valves of the series as such pressure of such fluid is increased, and means on each valve to restrict the opening movement so as to protect said bellows against the increasing pressure.

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