Sept. 7, 1943. C. M. O'LEARY 2,328,841

TIMED INTERMITTER

Filed Jan. 21, 1941

Fig. 1.

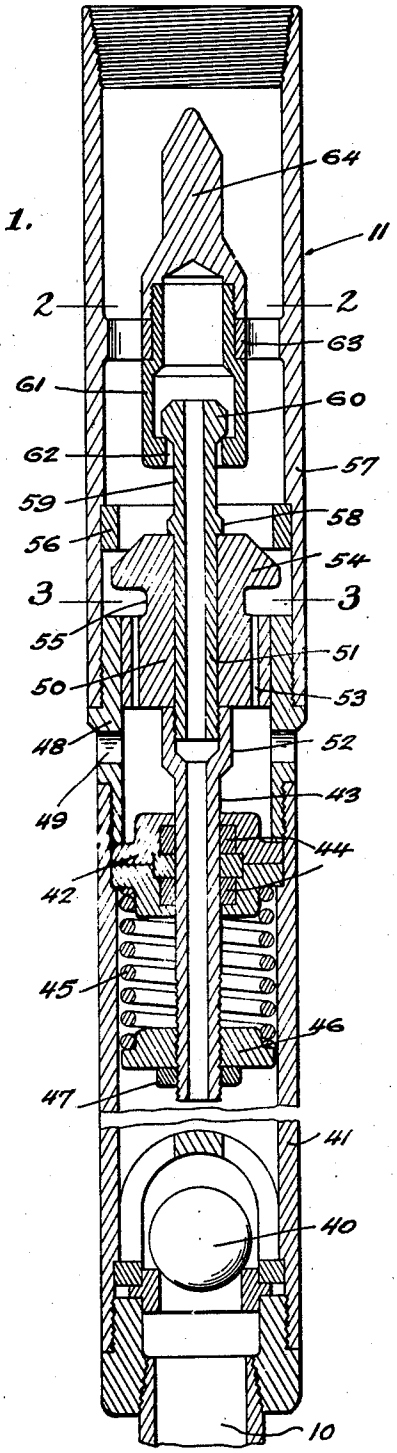


Fig. 2.

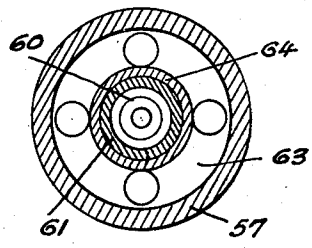
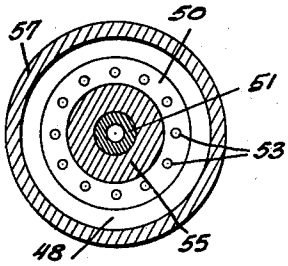


Fig. 3.



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TIMED INTERMITTER

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16 Claims. (Cl. 103—232)

The present invention relates generally to devices and apparatus for intermittently flowing oil from oil wells, and more particularly to what are known as bottom hole intermitters by means of which oil is intermittently forced to the surface by casing pressure through tubing within the casing in cycles during a portion of each of which cycles oil is permitted to rise to a head in the tubing above an intermitter valve while casing pressure is cut off, and during the other portion of which flow of oil above the valve is cut off and casing pressure is admitted through the valve to blow the head or slug of oil, previously admitted thereabove, to the surface.

The primary object of the present invention is the provision of an intermitter valve unit of the above type, which will be effective and unfailing in action; which will be positive under low differentials of pressure, and which will readily lend itself to disposition in a well either upon the lower end of outflow tubing or upon an adjustable means of anchoring the same within such tubing so as to open at its upper end therein.

In the accompanying drawing a preferred form of the invention is shown, and will now be described in detail with the understanding that such modifications and changes may be made therein, as fall within the terms of the following claims. In the drawing, which forms a part of this specification,

Figure 1 is an enlarged detail view in vertical longitudinal section, of the intermitter valve unit of the present invention, and

Figures 2 and 3 are enlarged detail transverse sectional views, taken respectively on lines 2—2 and 3—3 of Figure 1.

By reference to the accompanying drawing, it will be noted that a cylindrical casing 11 houses the intermitter valve assembly of the present invention. As best seen in Figure 1, this casing 11 is open at its upper end where it is adapted for connection in any suitable manner to the outflow tubing of an oil well, and is in communication at its lower end, through a foot valve 40, with a tubing extension 10 connected to, and depending from, the lower end of the casing. It is to be understood that, in practice, the casing 11 will open at its upper end into the outflow tubing, and that the depending tubing extension 10 will open at its lower end into the production zone of the well, below the normal surface or level of oil.

As best seen in Figure 1, foot valve 40 is disposed in a lower section 41 of casing 11, which section 41 also houses at its upper end a horizontal cross wall or barrier 42. Centrally through this wall or barrier 42, the tubular liquid stem 43 depends with its lower open end below the wall, the latter being otherwise imperforate to effectively prevent upflow of liquid except through said stem. Preferably the cross wall 42 is of two-part construction, with packing 44 between said parts around the stem 43.

The cross wall 42 also forms a stationary abutment for the upper end of a controlling spring 45, whose function will presently appear. The lower end of this spring engages a movable abutment disc 46, adjustably threaded on the lower end portion of stem 43 and normally held in adjusted position by a lock nut 47.

The cross wall 42 is securely held between the upper internally shouldered end of the lower section 41 of casing 11 and the threadedly connected lower end of an intermediate valve section 48 of said casing, the latter forming therein a valve cylinder and having radial gas or pressure receiving openings through the lower portion of its wall, as seen at 49.

Within the valve or cylinder section 48 is a slidably interfitting piston 50, situated above the openings 49, and clamped on an axial tube 51 whose lower threaded end is engaged by a threaded box on the upper end of the liquid stem 43 with which the tube 51 is communicatingly alined.

The piston 50, which has an annular series of openings 53 therethrough parallel to its axis for the upward passage of casing pressure entering the openings 49, has an upper head 54, connected thereto by a reduced neck portion 55. The head 54 is in the form of an upwardly tapering frustum of a cone, and forms the main or pressure valve, being adapted, when the piston 50 is in uppermost position, to seat upwardly against a valve seat ring 56. This ring is fixed in the upper section 57 of the casing 11, the lower end of which section is threadedly connected to the upper end of valve section 48.

The axial tube 51 has an external shoulder 58 above the valve head 54 and an upward extension 59 terminating at its upper end in a valve head 60 within a vertically tubular valve housing 61. This housing 61 has at its lower end an internal flange 62 forming a valve seat on which the valve head 60 seats in a downward direction when the piston 50 is in its lowermost position, as in Figure 1, to thus prevent outflow of liquid rising through the stem 43 and tube 51.

The housing 60 is clamped axially of, and spaced from, the upper casing section 57, through a cross wall 63, by means of a cap member 64,

which closes the upper end of the housing so that the latter thus forms a chamber around the upper end of the liquid inlet channel through stem 43 and tube 57.

The cross wall 63 has an annular series of openings therethrough around the housing 61, to permit of upflow of liquid from the well when the valve 60 is unseated, and upflow of gas pressure when the valve 54 is unseated. These valves plainly move as a unit, with the tube 51 and stem 43, one being seated when the other is unseated.

It is obvious from the foregoing that when the intermitter valve unit in its casing 11 is lowered and anchored within a well, it may be positioned at a point where the extension tubing 10 depends into the liquid of the well, with the controling pressure inlet openings 49 above the liquid level. As thus positioned, casing gas pressure above the liquid level enters the said openings 49, such pressure acting on the liquid in the well and in connection with the intermittent valve, since it is commonly prevented, by the use of a suitable packer (not shown) from passing directly into the well tubing or casing.

In Figure 1 the parts of the intermitter valve unit are shown with the gas or pressure valve 54 lowered from its seat to the position it assumes during the upflow of gas pressure for the blowing of a column or slug of oil upwardly in the well tubing to discharge, the parts being held in this position by liquid pressure on valve 60 plus the tension of controling spring 45 as well as the back pressure, caused by the rising liquid head, on valve 54 and the upper surface of piston 50. When, however, the column or slug of oil in the tubing has been discharged, and there is a consequent pressure drop above the intermitter, casing pressure against the lower surface of the piston 50 immediately starts upward movement of the intermitter valve unit.

The initial upward movement of the piston 50 unseats the liquid control valve 60 against the closing pressure of liquid thereon, and against the tension of spring 45, and since valve 60 is thus relieved of closing pressure when unseated, the piston then quickly completes its upward movement until pressure control valve 54 is seated upwardly against seat ring 56 with substantially a snap action.

The pressure control valve 54 being thus closed and liquid control valve 60 being open, liquid from the well flows upwardly from the extension tubing 10 under casing pressure, lifting foot valve 40, and passes through stem 43 and tube 51, valve housing 61, past valve 60, into the casing of the intermitter above pressure valve 54.

The rising liquid thus passes through the intermitter unit and continues upwardly into the well tubing into which the unit opens until a hydrostatic head or column of oil is formed in the said tubing. The ultimate height of this liquid column in the well tubing is, of course, dependent upon casing pressure, that is, gas pressure in the casing on the surface of the liquid in the well. This same pressure is also acting against the lower surface of valve 54 and the lower surface of the piston 50 so as to hold the pressure valve 54 closed. Thus during the first portion of each cycle of operation, the gas control or pressure valve 54 is closed, and the liquid valve 60 is open, with liquid flowing upwardly into the well tubing 13.

As the column of liquid above the intermitter valve unit increases, the pressure of such liquid on valve 54 gradually increases until this pressure, plus the adjusted tension of spring 45, reaches a point where the valve 54 is forced downwardly against the seating pressure of the gas acting upwardly against the same and its piston 50. Thus we commence the second portion of the cycle of operation with the unseating of the gas control valve followed by the seating of the liquid control valve 60, so that further upflow of liquid into the well tubing is cut off, and the rise of casing pressure is provided for.

It is plain that with the valves positioned as just above described, the second portion of each cycle of operation continues until the previously formed column or slug of oil in the well tubing has been raised therein, and finally discharged, bringing about a pressure drop in the tubing above valve 54 as first above set forth.

In the above operation, the adjusted or set tension of spring 45 controls the volume of oil, or in other words the height of the column of oil, which rises above the intermitter valve unit, since it cooperates with the hydrostatic head or weight of the column in forcing the closing of the liquid valve and the opening of the gas pressure valve.

The lower seat area of valve 60 is somewhat larger than the area of stem 43 but less than the total upper area of said valve and stem, and the upper seat area of valve 54 is somewhat larger than the area of piston 50 but less than the combined area of its lower surface and the lower surface of the piston 50. Thus the closing force on each valve, when seated, is greater than the force tending to close the same when open, so that a snap action results during each movement of the connected valves from one position to another.

As an example of the operation, let us assume that at an adjusted position of the intermitter valve assembly with respect to the normal level of liquid in the well, the casing pressure would raise a column of oil 400 feet in the tubing, the pressure of which column increases from zero at the top thereof to a maximum at the level of liquid in the well. If it is desired to permit only a 150 foot column to rise, the spring 45 can be adjusted and set to add to the pressure of a 150 foot column sufficient tension to cause shifting movement of the valve unit downwardly when a column of that height is above the unit. Thus a column of oil of a desired height may be formed during the first portion of each cycle, and blown out during the second portion of each cycle.

Since casing pressure on the surface of the oil in the well brings about rise of the column of oil in the well tubing during the first portion of each cycle, it is obvious that the time of completing the column above the intermitter valve unit may be effectively controled vertically adjusting the intermitter valve unit toward and away from the normal level of oil in the well. The closer the intermitter valve unit is to the level of well liquid, the greater the pressure of the rising column of oil in the tubing and the faster the oil will rise therein to the point where, with the cooperation of the tension of spring 45, it will shift the intermitter valve unit for the start of the second portion of each cycle of operation.

It is a well known fact that in intermitter valves operated by a head of fluid in the outflow tubing or eduction passage there is a tendency for velocity flow during the filling period to

create a false pressure head in the eduction passage, which tends to open the gas valve prematurely. This is particularly true when flowing wells which have high bottom hole pressures, or when the submergence of the tubing extension 10 or tail piece is great, as when the well is put on production after being idle for a time. In the present invention the extension of the gas valve body in the liquid flow chamber, and the restricted opening through the body, causes a pressure drop across the body when fluid flows therethrough so as to thus counteract the above mentioned disadvantage.

Having fully described the present invention, what is claimed is,

1. In a well flowing device, a body adapted for insertion in a well pipe, having an eduction passage, a liquid passage, and a passage for the entrance of gas to force elevation of liquid through the eduction passage, combined gas pressure and liquid pressure flow control means movable as a unit within said body and forming a part of the liquid passage, spring means associated therewith for urging the control means to gas flowing position, and a pressure surface on said control means responsive to gas pressure for urging the control means to liquid flowing position.

2. In a well flowing device, a body adapted for insertion in a well pipe and having a gas flow passage, a liquid flow passage, and an eduction passage through which liquid, entering through said liquid passage, is elevated by gas entering through said gas passage, closure members for the said gas and liquid passages, movable as a unit in said body and forming a part of the liquid passage, said members having pressure responsive areas, the gas flow closure member having less effective pressure responsive area exposed to gas pressure when the gas pressure passage is open than when said passage is closed.

3. In a well flowing device adapted for insertion in a well pipe, means forming an eduction passage, a gas flow passage and a liquid flow passage, unitary valves on the liquid flow passage means influenced in operation by pressure in the gas passage for opening and closing the gas and liquid flow passages and causing liquid, entering through the liquid passage to be elevated through the eduction passage by gas entering through the gas passage, the valve controlling gas flow being so constructed and arranged that the force holding said gas valve closed is greater than the force tending to close said gas valve when it is open.

4. In a well flowing device adapted for insertion in a well pipe, an eduction passage, a gas flow passage, and a liquid flow passage member, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering through the gas passage, unitary valves on said liquid flow passage member influenced in operation by pressure in the liquid passage for opening and closing the liquid and gas flow passages, the valve controlling liquid flow being so constructed and arranged that the force holding said liquid valve closed is greater than the force tending to close said liquid valve when it is open.

5. In a well flowing device adapted for insertion in a well pipe, an eduction passage, a gas flow passage, and a liquid flow passage member, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering through the gas passage, unitary valves on said liquid flow passage member influenced in operation by pressure in the gas and liquid passages for opening and closing the gas and liquid flow passages, the valves being so constructed and arranged that the force holding either one of said valves closed is greater than the force tending to close either one of said valves when it is open.

6. In a well flowing device adapted for insertion in a well pipe, an eduction passage, a gas flow passage, and a liquid flow passage member, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering through the gas passage, unitary valves on said liquid flow passage member influenced in operation by pressure in the eduction, gas flow and liquid flow passages for opening and closing the gas and liquid flow passages into the eduction passage, the valves being so constructed and arranged that the force holding either one of said valves closed is greater than the force tending to close either one of said valves when it is open, in order to impart snap action to the opening and closing of the valves.

7. In a well flowing device adapted for insertion in a well pipe, an eduction passage, a gas flow passage, and a liquid flow passage, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering through the gas passage, a gas control valve influenced in operation by pressure in the eduction passage for opening and closing the gas flow passage into the eduction passage, and a liquid control valve connected to the gas control valve for positively opening and closing the liquid flow passage into the eduction passage as the gas valve is respectively closed and opened, the said gas control valve and liquid flow passage being such that velocity flow through the liquid flow passage transmits a closing force to said gas valve tending to yieldably hold said gas valve closed and thereby hold the liquid valve open.

8. In a well flowing device adapted for insertion in a well pipe, means forming an eduction passage, a gas flow passage and a liquid flow passage, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering through the gas passage, a gas valve controlled by pressure in the eduction passage for opening and closing the gas flow passage into the eduction passage, yieldable means tending to unseat the gas valve, a liquid valve controlled by the gas valve for positively opening and closing the liquid flow passage into the eduction passage as the gas valve is respectively closed and opened, said valves being connected and movable as a unit to positively unseat one valve when the other valve is seated, and the said liquid flow passage being in part through the gas control valve, whereby velocity flow of liquid through the liquid passage with the liquid valve open, tends to transmit to the gas valve an influence yieldably holding the latter in closed position to thus defeat false pressure in the eduction passage resulting from velocity flow of liquid.

9. In a well flowing device adapted for insertion in a well pipe, means forming an eduction passage, a gas flow passage and a liquid flow passage, arranged to cause liquid, entering through the liquid passage, to be elevated through the eduction passage by gas entering

through the gas passage, unitary valves, one of which is effective to open and close the gas flow passage into the eduction passage, and the other of which is effective to open and close the liquid flow passage into the eduction passage under control of the gas valve as the latter is respectively closed and opened, the valve unit being controlled by pressure in the eduction passage to unseat one of said valves when the other is seated, adjustable means yieldably urging the gas valve to unseated position and the liquid valve to seated position, and means whereby velocity flow of liquid through the liquid flow passage with its valve open, tends to hold the gas valve in seated position against any false pressure in the eduction passage resulting from such velocity flow of the liquid.

10. In a bottom hole intermitter, a casing including a liquid compartment and a gas pressure compartment, and having a pressure receiving aperture opening into said gas compartment, an intermitter valve including a vertically channeled body slidable in the casing and having a gas valve member, and an axial liquid flow stem, one end of which has a valve head and the other end portion of which depends into the liquid compartment, spring means adjustably in connection with said valve for urging the same away from the liquid compartment, a valve seat in the casing in connection with which said gas valve member seats in an upward direction in the upper position of the valve, and means forming a liquid chamber in the casing and in which the said valve head is vertically movable, said chamber having a lower opening for communication with the casing and a valve seat around said opening in connection with which the said valve head seats in a downward direction when the valve is in its lower position.

11. In a bottom hole intermitter, a casing including a lower liquid compartment and an upper pressure compartment, and having pressure receiving apertures opening into said upper compartment, an intermitter valve including a vertically channeled body slidable in the casing above said apertures and having an upper valve member, and an axial liquid flow stem the upper end of which has a valve head and the lower portion of which depends into the lower compartment, spring means adjustably in connection with said valve for urging the same downwardly, a valve seat in the casing in connection with which said valve member seats in an upward direction in the upper position of the valve, and means forming a liquid chamber in the casing and in which the said valve head is vertically movable, said chamber having a lower opening for communication with the casing and a valve seat around said opening in connection with which the said valve head seats in a downward direction when the valve is in its lower position.

12. In a bottom hole intermitter, a casing including a lower liquid compartment and an upper pressure compartment, and having pressure receiving apertures opening into said upper compartment, an intermitter valve including a vertically channeled body slidable in the casing above said apertures and having an upper valve member, and an axial liquid flow stem fixed through said body and valve member, the upper end of which stem has a valve head and the lower portion of which depends into the lower compartment, spring means urging the valve downwardly, and valve seats in the upper compartment of the casing on which the valve member and valve head respectively seat in the upper and lower positions of the intermitter valve.

13. In a bottom hole intermitter, a casing including a lower liquid compartment and an upper pressure compartment, and having pressure receiving apertures opening into said upper compartment, an intermitter valve including a vertically channeled body slidable in the casing above said apertures and having an upper valve member, and an axial liquid flow stem fixed through said body and valve member, the upper end of which stem has a valve head and the lower portion of which depends into the lower compartment, spring means urging the valve downwardly, and valve seats in the upper compartment of the casing on which the valve member and valve head respectively seat in the upper and lower positions of the intermitter valve, the relative areas of said valve member, valve head, and seats being such that the closing force on the valve member and valve head is greater when they are seated than the closing force thereagainst when they are open.

14. In a bottom hole intermitter, an intermitter valve movable as a unit, comprising an intermediate piston member having an axial hollow stem projecting above and below the same and affording a lengthwise liquid passage, said stem having an enlarged head at its upper end provided with a downwardly facing valve surface thereabout above the piston, said piston having lengthwise fluid passages therethrough independent of said liquid passage and an upper valve member provided with an upwardly facing valve surface spaced below the valve surface of the stem head.

15. In a bottom hole intermitter, a casing having pressure receiving wall openings, an intermitter valve comprising a body slidable within said casing above said openings, an axial hollow stem fixed through said body and extending above and below the same, and vertically spaced valve members on said body and the upper portion of the said stem, valve seats within the casing arranged to be alternately engaged by said valve members, a guide member for the lower portion of the stem and closing the casing around the said stem below the pressure receiving openings, and spring means anchored on said guide member and adjustably in connection with the said lower portion of the stem, exerting a force tending to seat one of said valve members and unseat the other.

16. In a bottom hole intermitter, a casing having an intermediate partition and wall openings spaced above said partition, a hollow stem forming therethrough a liquid flow channel and movably disposed axially through the partition with portions above and below the latter, a spring adjustably in connection with the lower portion of said stem and bearing against said partition to move said stem downwardly, a piston fixed on the upper portion of the stem and slidably interfitting the casing above the said wall openings, said piston having vertical pressure channels and an upper pressure valve member, a valve seat ring within the casing against which said valve member seats in an upward direction, means forming a liquid chamber within the casing having a lower opening and a valve seat around said opening, and a valve head on the upper end of said stem within said liquid chamber to seat on said seat thereof in a downward direction when the pressure valve head moves downwardly away from said seat ring.

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