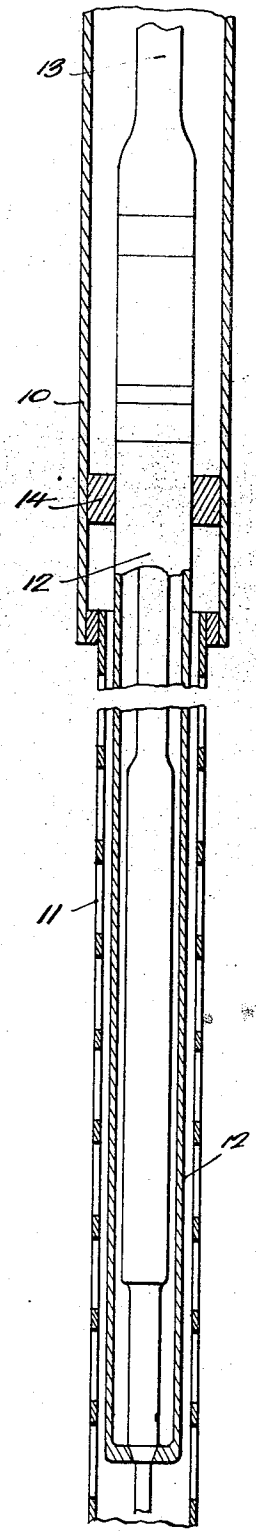
Aug. 22, 1944. C. M. O'LEARY 2,356,423

BOTTOM HOLE INTERMITTER

Filed Feb. 7, 1942 2 Sheets-Sheet 1

Fig. 1.



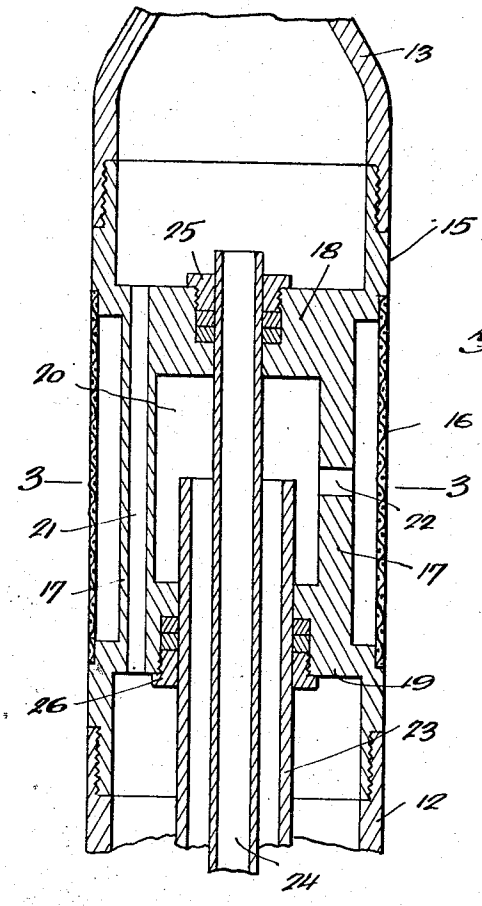
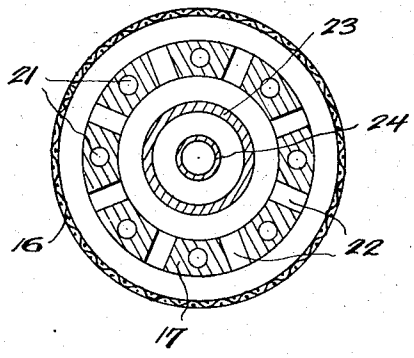


Fig. 2.

Fig. 3.



INVENTOR
Charles M. O'Leary,
BY Myron G. Clear
ATTORNEY

Aug. 22, 1944. C. M. O'LEARY 2,356,423

BOTTOM HOLE INTERMITTER

Filed Feb. 7, 1942 2 Sheets-Sheet 2

Fig. 4

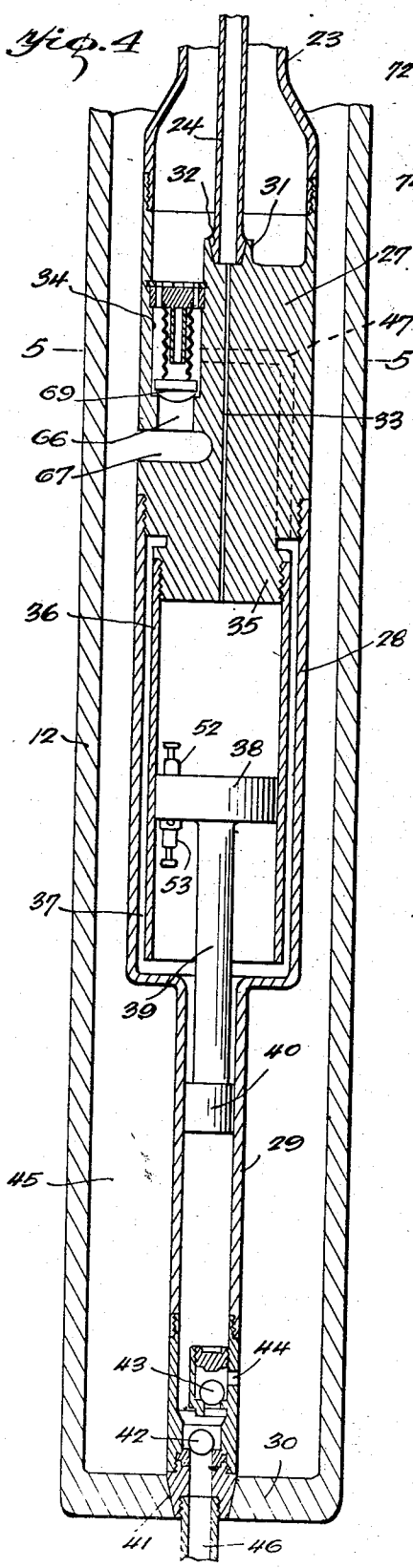


Fig. 6.

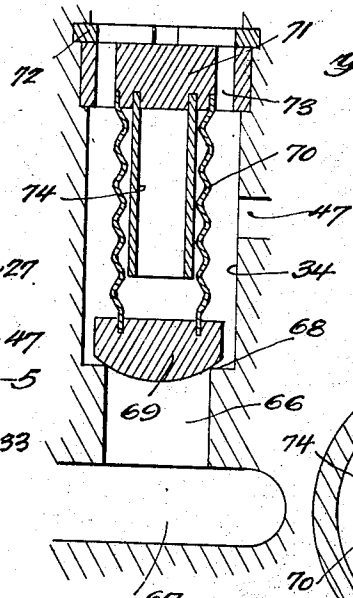


Fig. 5.

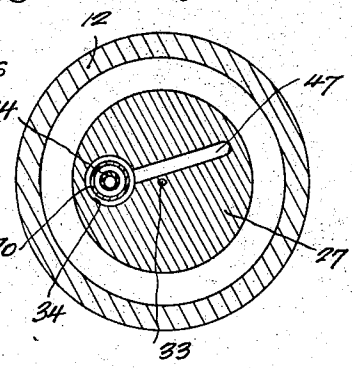
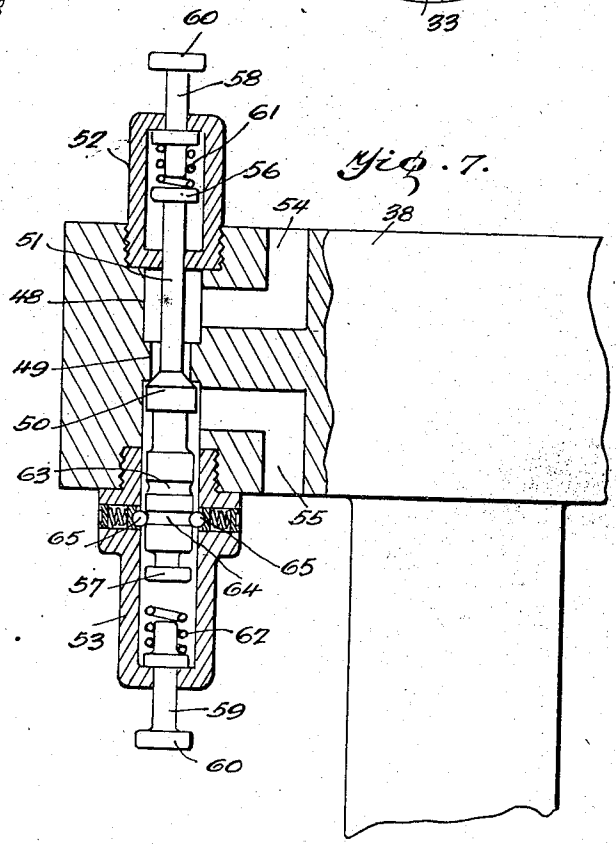


Fig. 7.



INVENTOR
Charles M. O'Leary,
BY
Myron S. Olear
ATTORNEY

Patented Aug. 22, 1944

2,356,423

UNITED STATES PATENT OFFICE

2,356,423

BOTTOM HOLE INTERMITTER

Charles M. O'Leary, Houston, Tex.

Application February 7, 1942, Serial No. 429,939

5 Claims. (Cl. 103—10)

The present invention relates generally to a method and means for causing outflow of oil from oil wells of small productive index, and is more particularly suitable for use in wells where, in the interest of steady maximum flow of oil from the producing formation, it is of primary importance to not only eliminate any back pressure on the formation but to be able to create a low pressure area adjacent to the formation, and to keep the fluid level down.

There are many wells capable of producing oil steadily in relatively small quantities providing that the oil is removed as it accumulates in the bottom of the hole. In a great many instances the oil flows from the producing formation either without gas pressure or with so little gas as not to constitute a practically useable factor in the upflow of the oil to discharge. The lack of gas in such instances means a condition wherein it is extremely important that no back pressure be created against the formation which might interfere with the free flow of oil therefrom. Also in many instances the creation of a low pressure area adjacent to the formation is of material help in maintaining a steady flow of oil.

The problem of economically causing upflow and discharge of oil from wells of the above type is generally considered to be answered by the use of an intermitter, since the first cost and upkeep of a rod pump with a surface pumping unit is prohibitive. Various types of intermitters may be used with good results provided there is a high liquid level in the well and fluid-actuated plunger pumps may also be economically employed, but in deep wells of the small productive character set forth, and particularly those having a low liquid level therein, both intermitters and fluid-actuated pumps have been found lacking. The intermitters known at the present time fail because the well liquid flows into the same at a rate controlled by well pressure which thus makes it difficult to accumulate uniform proper heads of oil; because of slow filling operation due to the low levels of liquid, and because of the resulting waste of gas pressure. The fluid-actuated plunger pumps fail mainly because of the great pressure required to lift a long solid column of oil to the surface.

It is, for the above reasons, the primary object of the present invention to provide a method and apparatus which combines the advantages, and eliminates the disadvantages, of both of the above systems, and is economically useable in deep wells of low productivity index and low liquid level without waste of gas pressure; without danger of retarding free flow of oil from the formation, and without requiring high operating pressures.

It is a further purpose to provide a method for causing outflow from deep wells of low productivity, and low formation pressure, and especially those having normally a low level of liquid therein, which includes positively and intermittently forming, under fluid pressure from the surface, heads or slugs of well liquid in a filling chamber isolated from and without regard to, or influenced by, the formation pressure or liquid level in a well, so that such heads or slugs may be uniformly of economical intermitting weight, and to further, by fluid pressure, cause upflow of each head when it reaches a predetermined economically intermitting weight, in a manner permitting immediate resumption of measured accumulation of the next head or slug following each outflow operation.

The invention, for this purpose, proposes a method and apparatus which combine an intermitter and a pressure actuated pump so that the pump will lift oil only so far as is necessary to form a predetermined head or slug of oil within a filling chamber isolated from pressure communication with the oil producing formation, and the intermitting arrangement will automatically cause upflow of the accumulated head or slug of oil whenever it reaches a predetermined weight value.

It is a further object to provide such a method and apparatus whereby both the pumping means for thus forming the head or slug, and the intermitting means for discharging the accumulated head or slug, will be controlled by a single pressure or gas supply line wherein the gas may be fed to the working parts under a constant pressure from the surface, and wherein provision is made for cessation of the pumping action during intermitting and for immediate resumption of pumping operation to form the succeeding head or slug.

The manner in which the method is carried out and the apparatus for so doing may be better understood and more thoroughly appreciated in the course of the following detailed description thereof and by reference to the accompanying drawings, the latter forming a part of this specification and including several figures illustrative of the invention, of which,

Figure 1 is a general side view, partly in elevation and partly in section, showing the manner in which the apparatus is installed in a well.

Figure 2 is an enlarged detail vertical sectional view through the upper portion of the housing of the apparatus, showing the construction adjacent to the crossover.

Figure 3 is a detail horizontal sectional view taken substantially on line 3—3 of Figure 2.

Figure 4 is an enlarged vertical sectional view through the lower portion of the housing and the casing enclosing the pump and intermitter valve.

Figure 5 is a horizontal sectional view taken substantially on line 5—5 of Figure 4.

Figure 6 is an enlarged detail vertical sectional view through the intermitter valve, and,

Figure 7 is a similar view through the valve arrangement of the motor piston.

Referring now to the above described figures and particularly to Figure 1, there is shown a well casing 10 from which a perforate liner 11 depends within the production zone of a well in practice. An elongated, cylindrical housing 12 is, according to the present invention, lowered into the casing 10, on production tubing 13, so that the lower portion of housing 12 may suitably depend within the liner 11, and the upper portion of the housing may be suitably packed off, as by means of packing 14, within the lower portion of casing 10 to thus cut off the space within the casing above the packing, from the space within the liner 11 and also with respect to the producing formation.

The upper portion of housing 12 which, it will be noted is of substantially greater diameter than the tubing 13, includes, above the packing 14, a crossover section 15 around which there is shown a cylindrical filtering screen 16. This section 15, as shown in Figure 2, has a cylindrical wall 17, spaced from screen 16, and upper and lower end walls 18 and 19, enclosing a central chamber 20. Through the wall 17 are vertical outflow channels 21 which extend through the end walls 18 and 19 and open at their upper ends into the interior of housing 12 above and below the crossover.

The channels 21 are spaced apart in a series circumferentially of wall 17 and alternate with radial openings 22 through said wall, as plainly seen by a comparison of Figures 2 and 3, the latter openings placing the central chamber 20 in communication with the interior of the well casing above the packing 14.

Through a central opening in the lower end wall 19 is fixed the upper end of a pressure flow tube 23, the upper end of which is open within the chamber 20. Through this flow tube there extends a much smaller macaroni tube 24, which extends through chamber 20 and has its upper end portion fixed through an opening centrally of the upper end wall 18 so that it opens into the production tubing 13. Packing glands 25 and 26 respectively in the end walls 18 and 19 around macaroni tube 24 and pressure flow tube 23 serve to prevent leakage therearound.

In order to better understand what follows, let it be understood that channels 21 provide for upflow of oil or well liquid only during the continuous lift of a slug of accumulated oil upwardly from the housing 12; flow tube 23 never receives liquid, and provides only for downflow of fluid pressure or gas from chamber 20 of the crossover 15 to the intermitter valve and to the fluid actuated pump, and macaroni tube 24 provides for upward exhaust of pressure into the production tube 13 above the crossover 15 only during operation of the pump, when the space within said production tube is at low pressure.

Referring to Figure 4, it will be seen that the lower end of pressure flow tube 23 enlarges for connection with the upper end of a combined intermitter and pump casing, and that said tube is directly connected to the upper end of a cylindrical valve block 27 constituting the upper section of this casing. To the lower end of this valve block 27 is connected the upper end of a cylindrical barrel 28, from the lower end of which a substantially reduced plunger barrel 29 depends to the lower end 30 of the housing 12.

The valve block 27 has an axially disposed tapering seat 31 at its upper end receiving the lower tapering end 32 of the macaroni tube 24. The block 27 also has a small axial pressure exhaust channel 33 therethrough opening at its upper end into the macaroni tube 24 and opening at its lower end through the lower end of the block. In addition, block 27 has an enlarged upwardly opening bore 34 at one side of its axial channel 33, for a purpose which will presently appear, and is provided at its lower end with a reduced portion 35. To this portion 35 is connected the upper end of a piston cylinder 36, spaced from the wall of barrel 28 to form an annular pressure feed channel 37. The lower end of cylinder 36 terminates short of the lower end of barrel 28 so that channel 37 is thus in open communication at its lower end with the lower end of the piston chamber.

Within piston cylinder 36 is a vertically slidable valved piston 38 on the upper end of a rod 39 which depends within the smaller plunger barrel 29 and carries at its lower end a plunger 40 slidable in said barrel 29. It will be understood that both piston 38 and plunger 40 will be provided with leak-proof rings, cups and the like.

The lower end of plunger barrel 29 is tapered at 41 to seat within a conformably tapering opening axially of the lower end 30 of housing 12. An intake or standing valve 42 seats within the lower end of said barrel 29, and an outlet valve 43 is provided therein above the standing valve to control a side opening 44 which outlets into the filling chamber 45 thus formed within the housing 12. An intake pipe 46 may depend from the lower end of barrel 29 below the lower end of the housing, to extend into the well liquid substantially below its normal level in the well, however low that level may be.

When the piston 38 is moved up and down by pressure against its lower and upper surfaces in a manner to be presently described, the relatively smaller plunger 40 follows such movements, and liquid is alternately drawn upwardly into the barrel around the standing valve 42, and discharged from the barrel around the outlet valve 43 and through outlet opening 44 into the filling chamber 45 to fill the latter in substantially measured quantities to a predetermined point above the valve block 27 for the formation of an economically dischargeable head or slug as we shall hereinafter see.

Referring to Figures 4 and 5, it will be seen that the valve block 27 has an angular pressure flow channel 47 of substantial size whose upper end opens into the bore 34 to receive pressure fed downwardly therein from the pressure flow tube 23, and whose lower end opens into the upper end of the feed channel 37 between piston cylinder 26 and barrel 28. In this way fluid pressure is fed into the lower portion of the piston chamber and is active against the relatively greater effective area of the piston 38 as compared to plunger 40.

As best seen in Figure 7, the piston 38 has therethrough a valve bore 48, intermediate the ends of which is an annular internal rib 49 forming a valve seat. A valve member 50, intermediate the ends of a valve stem 51, is adapted to seat upwardly against seat 49. The opposite ends

of the bore 48 are closed by upper and lower cages 52 and 53. Upper and lower angular channels 54 and 55, have their inner ends opening into the bore 48 respectively above and below valve seat 49, and have their outer ends opening, respectively, through the upper and lower surfaces of the piston 38.

With valve 50 seated, as in Figure 7, pressure fed into the lower end of the piston chamber, acts against the lower surface of the piston 38 to move the same upwardly. During this movement any pressure above the piston is relieved by exhausting through the exhaust channel 33 and exhaust or macaroni tube 24 into the production tubing 13 above the crossover 15, since the production tubing 13 is at low pressure during pump operation. With valve 50 open the pressure passes through bore 48 and channels 54 and 55 and accumulates above the piston for action against the preponderantly greater effective upper surface of the piston. This accumulation of pressure above the piston results from its upflow through the larger channels 55 and 54 of the piston substantially faster than it can possibly escape through the relatively small exhaust channel 33. The difference between the two surfaces of the piston is the diameter of piston rod 39, and it is to be noted that the effective area of valve bore 48 and channels 54 and 55 is substantially greater than the area of pressure exhaust channel 33 which forms an outlet for pressure from the chamber above the piston 38 when the latter moves upwardly.

The upper and lower portions of valve stem 51 project movably through the inner ends of the cages 52 and 53 and have end heads 56 and 57 opposed to the inner ends of plungers 58 and 59 whose function is to shift the valve stem 51 axially in the bore 48 upon contact with the valve block 27 and the bottom of barrel 28 when the piston approaches the upper and lower limits of its travel.

The plungers 58 and 59 have outer heads 60 and are provided with inner coil springs 61 and 62 disposed therearound and normally projecting inwardly therebeyond. The stem 51 also has, near its lower end, an enlarged portion provided with lengthwise spaced annular grooves 63 and 64. Spring-pressed latch balls 65 are carried within the lower cage 53 for movement into grooves 63 and 64 respectively as the valve 50 is shifted to open and closed positions.

The foregoing piston valve thus has its parts relatively arranged so that with the valve 50 closed as in Figure 7, the piston will move upwardly in cylinder 36 until plunger 58 comes into contact with the end of the lower reduced end portion 35 of valve block 27. Plunger 58 will thus be depressed until its lower or inner end engages the head 56 of the valve stem and shifts the latter downwardly with a force overcoming the springs holding balls 65 within groove 64. During this movement the spring 61 is placed under compression so that immediately upon displacement of the latch balls 65, said spring will shift the valve stem downwardly until the balls engage in the upper groove 63. This movement opens the valve 50 and permits fluid pressure to pass through the valve bore for causing downward movement of the piston due to the accumulation of pressure above the piston. A similar operation takes place when the piston reaches the lower limit of its travel and plunger 59 comes into contact with the bottom of the piston barrel 28. In this instance, however, the valve stem is shifted upwardly to restore the valve to the closed position of Figure 7 and provides for movement of the piston upwardly in its cylinder.

As best seen in Figure 6, the intermitter valve bore 34 communicates at its lower end through a reduced opening 66 with a cavity 67 in the valve block 27. This cavity 67 opens exteriorly of the block into the liquid space of the housing 12 and the shoulder at the upper end of opening 66 forms a valve seat 68 on which a valve 69 is normally seated by fluid pressure on its upper surface. Valve 69 is in sealed connection with the lower end of a bellows 70, the effective area of which is less than that of the seat 68. The upper end of bellows 70 is in sealed connection with a head block 71 which is stationarily supported in the upper portion of bore 34, as by means of a snap ring 72. This block has openings 73 permitting fluid pressure to feed downwardly into the bore 34, and is provided with a depending tubular supporting member 74 internally of the bellows 70, which latter is sealed under atmospheric pressure.

Pressure fed from the well casing 10 inwardly through crossover 15 and downwardly through pressure flow tube 23 into the bore 34 normally acts against the upper surface of intermitter valve 69 to close the same and hold the same closed until there is a force, created by the weight of that portion of the column of well liquid in the housing 12 above the level of the valve, and acting, against the lower surface of the valve within its seat, which is sufficient to overcome the seating force of the pressure.

In the meantime pressure from bore 34 feeds through channels 47 and 37 to operate the plunger actuating piston 38 in the manner previously described so that the well liquid will be gradually pumped into the filling chamber 45 and a head or slug accumulated in the housing 12 above the intermitter valve definitely and precisely of a weight which may be economically raised by the available pressure. This is accomplished by the pumping of the oil into the filling chamber 45 in a positive manner which may be readily predetermined as to time and volume in accordance with the existing well conditions, that is, the natural flow of oil from the producing zone. The main purpose is to accomplish the accumulation of a head of oil which may be economically intermitted under available pressure and never reaches the height of the crossover 15; which will always be of substantially the same volume, and which may be steadily drawn from a low head of liquid in the well without regard to changing formation pressures.

It is thus assured that each head or slug approaches a predetermined weight value by measured quantities of liquid pumped into the filling chamber, thus assuring that all heads or slugs so formed will be uniformly brought to just the weight value required to force the intermitter valve 69 upwardly from its seat 68. When unseated, fluid pressure, acting against the greater exposed lower surface of the valve holds the same upwardly and passes through opening 66 and cavity 67, into the filling chamber 45, for causing upflow of the fluid head or slug above the level of cavity 67. In so doing, back pressure on the body of liquid in the filling chamber 12 below the level of cavity 67 prevents operation of the pumping means previously described.

During upflow of the head or slug of oil under the expanding gas pressure, there is a drop in pressure, known as a "blow-down," and when this

occurs relief of pressure against the lower surface of intermitter valve 69 permits the same to resume seated position under pressure from above. Pressure is at the same time relieved on the remaining liquid in the filling chamber and the pumping operation promptly becomes again active to deliver measured charges of liquid into the filling chamber since the latter and the production tubing are at low pressure. It is believed to be plain from the foregoing that the operation of the pressure-actuated pump of Figures 4 and 7, occurs only during those periods in which, after blow down, the intermitter valve 69 is closed, and fluid pressure passing inwardly from the well casing 10, through crossover 15 and downwardly through pressure flow tube 23, is used solely for pump operation through bore 34 and valve block channel 47. During these pump operating periods the interior of production tube 13 above the crossover 15 of Figure 2, is at low pressure following a previous blow down, and there is never any appreciable quantity of oil above the upper end of exhaust tube 24. Any oil draining downwardly within production tube 13, during pump operation, continues downwardly through channels 21, and joins the accumulating slug or head being formed in the housing 12.

As previously described, each measured slug or head of oil is accumulated in the housing 12 around the outside of tube 23, to a predetermined height, but never reaches the height of the crossover 15. When the intermitter valve 69 is opened by the weight of the head of oil above the level of said valve, a slug of oil is forced upwardly from the housing 12, in a continuous movement through the crossover channels 21, and up the production tubing 13 until there is a blow down. Thereupon, the intermitter valve 69 closes and pump operation starts the accumulation of another head or slug of oil in the housing 12, which will be similarly discharged when the intermitter valve again opens.

According to the present method, the intermitter head of liquid may be positively accumulated from a low head of well liquid in a manner which is not influenced by possible changing pressures in the well; which may be regulated, by the pressure used, strictly in accordance with normal flow of liquid from the formation, and which will not tend to create any change in the normal pressure, if any, existing in the well beyond its tendency to create a low pressure area adjacent to the producing formation. Further, the formation of the economically intermittable head of liquid is not left to chance according to the present method, nor does it depend in any sense upon a high level of liquid in the well or upon formation pressure as in the usual intermitter, but on the other hand assures accumulation of uniform heads of liquid, to be intermitted to the surface, by an arrangement which tends to create a low pressure area within the producing zone, and a means which steadily operates between intermitting periods to build up such heads of liquid without regard to the level of liquid in the well and entirely independent of any formation pressure or change thereof.

It will be understood that, since the accumulation of liquid in the filling chamber, is by means of a pumping operation, the flowable head is an accumulation of measured quantities of liquid, and that regulation of the pressure from the surface provides for accumulation substantially in accordance with well production, to thus avoid undesirable increase in the level of liquid in the well, as well as waste of gas pressure.

Having thus fully disclosed the present invention, what is claimed is:

1. A bottom hole intermitter including means forming outflow tubing, means adapted to be lowered into a well on said outflow tubing and positioned above the liquid level in the well, having a filling chamber therein, a member within said chamber having channels for receiving pressure from the surface including a passage opening into said filling chamber, a suction pumping mechanism in said member actuated by pressure through said channels and positively raising well liquid into the filling chamber whereby to gradually build up a head of liquid therein independent of well pressure, and create, by its suction, an area of reduced pressure adjacent the producing formation of the well, and means actuated by weight of the head of liquid for admitting pressure from said member into the filling chamber for causing upflow of said head.

2. A bottom hole intermitter including means forming outflow tubing, means forming a filling chamber adapted to be lowered into a well on said outflow tubing, pressure-actuated suction pumping means for lifting well liquid from below the chamber into the same to positively, gradually build up a head of liquid therein of predetermined weight value independent of the level of liquid within the well and well pressure, and create, by its suction, an area of reduced pressure adjacent the producing formation of the well, means within the chamber receiving pressure from the surface for actuating said liquid lifting means and having a pressure outlet which opens into the filling chamber for pressure upflow of a head of liquid of predetermined weight value, and a pressure controlled valve in said outlet and arranged to be opened by the weight of liquid.

3. A bottom hole intermitter including means forming outflow tubing, means forming a filling chamber adapted to be lowered into a well on said outflow tubing, means in said chamber receiving pressure from the surface and having an outlet opening into the chamber, an intermitter valve normally pressure seated to close said outlet and exposed to the liquid in said chamber, to be opened by a head of liquid of predetermined weight value, and a pressure actuated suction pumping mechanism receiving its actuating pressure from said pressure receiving means, having a suction pipe depending substantially below the chamber and having its discharge opening into the chamber, whereby to gradually and positively raise liquid into the chamber for building up a head of liquid from the well within the chamber independent of the level of liquid in the well and of the well pressure and create, by its suction, an area of reduced pressure adjacent the producing formation of the well.

4. A bottom hole intermitter including means forming outflow tubing, means forming a filling chamber adapted to be lowered into a well on said outflow tubing, means in said chamber receiving pressure from the surface and having an outlet opening into the chamber, an intermitter valve normally seated by pressure from said means to close said outlet and exposed to the liquid in said chamber, to be opened by a head of liquid of predetermined weight value, and a pressure actuated pumping means receiving its actuating pressure from said pressure receiving

means, having an intake opening exteriorly of the chamber and having its discharge opening into the chamber, whereby to gradually and positively build up a head of liquid from the well within the chamber independent of the level of liquid in the well and of the well pressure, the said discharge of the pumping means being subject to back pressure, for checking operation of the pumping means, when the intermitter is open for the discharge of pressure into the filling chamber.

5. In a bottom hole intermitter, outflow tubing, means forming a filling chamber for lowering into a well on said outflow tubing, fluid pressure feeding means, a suction pumping unit in said filling chamber for raising liquid therein from the well, including an upper valve block receiving pressure from said feeding means, a piston chamber below said valve block, and a plunger barrel below said piston chamber and having a valved outlet opening into the filling chamber, a suction pipe depending below the filling chamber and communicating at its upper end with the plunger barrel, an intake valve opening into the said barrel adjacent to the upper end of the suction pipe, a fluid pressure actuated piston operating in said cylinder, a plunger operating in said barrel and connected to, and actuated by, said piston, said valve block having fluid pressure feed channels opening into the piston cylinder for actuating the piston, and a pressure flow passage opening therefrom into the filling chamber and having therein a valve seat, and an intermitter valve in said passage, exposed at its inner face to fluid pressure fed to the valve block for seating the valve on said seat, and exposed at its outer face to liquid in the filling chamber for displacement from its seat by the weight of the liquid head thereabove.

CHARLES M. O'LEARY.