June 6, 1944. C. M. O'LEARY 2,350,472

INTERMITTER

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Fig. 1.

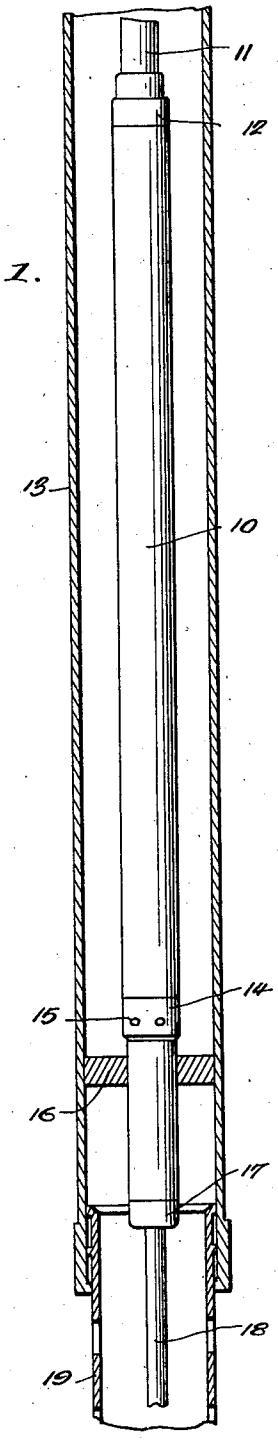


Fig. 4.

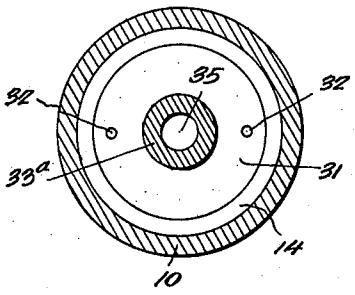


Fig. 5.

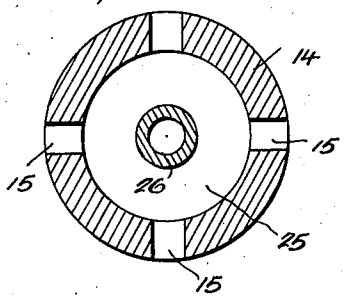
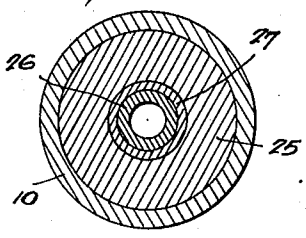


Fig. 6.



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INTERMITTER

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Fig. 2.

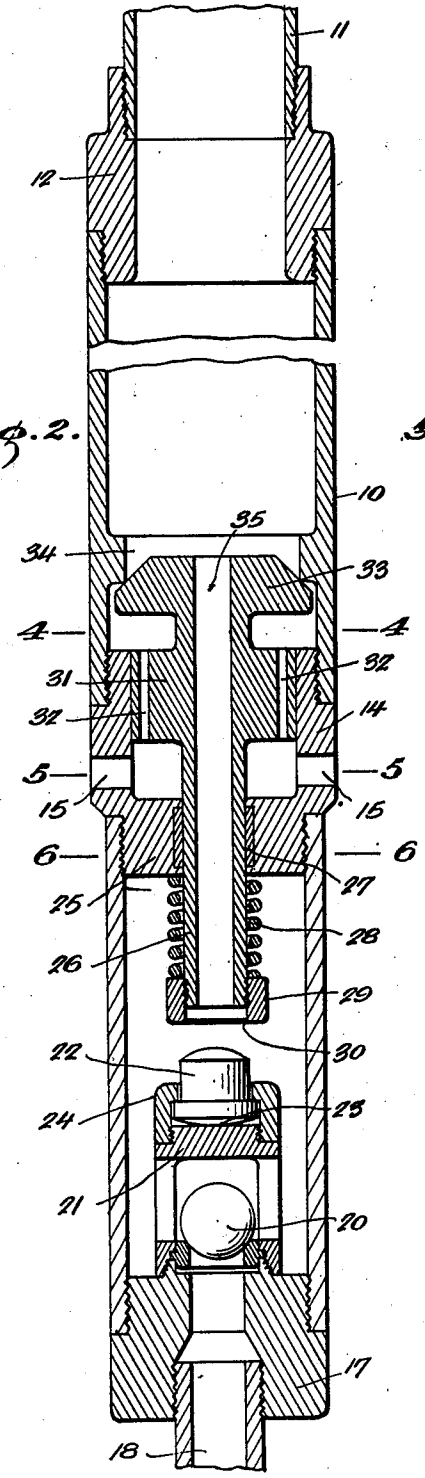
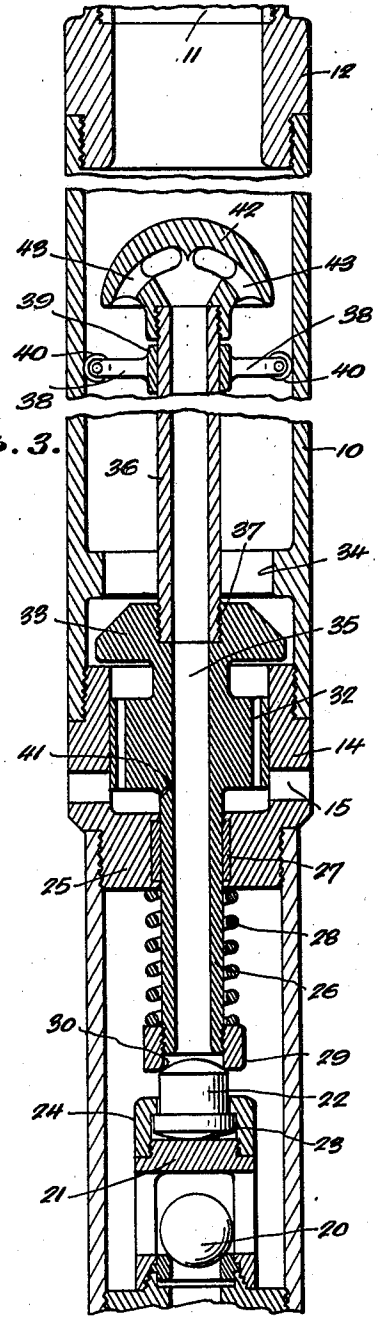


Fig. 3.



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UNITED STATES PATENT OFFICE

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INTERMITTER

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Application February 7, 1942, Serial No. 429,937

8 Claims. (Cl. 103—232)

The present invention relates generally to intermitters, or in other words fluid pressure actuated devices for intermittently causing upflow of liquid in a well, and has to do, more particularly, with what are commonly known in the oil well industry as bottom hole intermitters, wherein oil is permitted to rise to a head above the intermitter valve during the filling period or cycle, until it has reached a predetermined weight value, whereupon a change of the valve cuts off the entry of further oil, and admits casing pressure for the purpose of blowing to the surface, in the second or production cycle, the previously accumulated head of oil.

In all such intermitters it is common practise to pack off the casing pressure for the prevention of back pressure on the producing zone, since any such back pressure would have a tendency to prevent rise of well liquid under existing formation pressure during the filling cycle. This is particularly important in wells of low formation pressure, in many of which the formation pressure is normally such that the filling cycle is slow and slugs of oil can be blown out only at widely spaced intervals.

With the above in mind it is one of the objects of the present invention to provide an intermitter having a valve structure along somewhat the same line as that included in my former application, entitled "Timed intermitter," and filed January 21, 1941, under Serial Number 375,158, patented September 7, 1943, No. 2,328,841, improved, however, in certain respects which render the present device more positive in action, and more certainly proof against back pressure on the producing formation under all circumstances.

According to another phase of the present invention, it is an object to provide an intermitter in which the arrangement is not only such as to avoid danger of back pressure against the producing formation, but in which means are included for the purpose of substantially assisting formation pressure during filling cycles, for shortening such cycles as well as promoting increased oil production, the arrangement preferably being such that material assistance is afforded the oil during the filling periods, to the extent of reducing to a minimum the back pressure held on the producing formation.

A still further object of the present invention is the provision of an intermitter valve which will steadily maintain positive, effective action, and will be proof against fluttering in its use in formations of sufficient pressure to build up what are known as "false filling heads," or in other words build up pressure below the intermitter valve, during a production cycle, sufficient to cause an uprush of oil during the initial portion of the succeeding filling cycle.

With the foregoing general statements and objects, further features, objects and advantages of the invention may be better understood and more thoroughly appreciated, in the course of the following description in detail, and by reference to the accompanying drawings, illustrating the same, and forming a part of this specification. In these drawings;

Figure 1 is a vertical, sectional view through a portion of a well casing and liner, illustrating the manner of installing the intermitter.

Figure 2 is a detail vertical, sectional view through the intermitter, showing the parts in position during a filling cycle.

Figure 3 is a similar view, showing the parts in position during a blowing or production cycle, and also illustrating the use of means for assisting the filling operation in wells of low formation pressure, and,

Figures 4, 5 and 6 are detail, transverse sectional views, taken respectively on lines 4—4, 5—5 and 6—6 of Figure 2.

Referring now to the above figures of the drawings, there is shown in Figure 1, a vertically elongated casing 10, carried on the lower end of well tubing 11 by virtue of a coupling at 12, and depending within the well casing 13. This casing 10 serves as a filling chamber above the intermitter valve arrangement which is housed therein, in connection with a valve body 14 having wall apertures 15, to permit fluid under pressure in the casing 13 to enter the valve body 14. Below the apertures 15, packing 16, around the casing 10, and between the same and the well casing 13, serves to prevent the passage of fluid pressure downwardly to the producing formation.

The lower end of casing 10 is connected, by a coupling 17, to the upper end of macaroni tubing 18 which extends downwardly to a desired point within the liner 19, pendent from the well casing 13, to thus provide for upflow of oil into the lower end of the intermitter casing 10.

As seen in Figures 2 and 3, the bottom coupling 17 preferably supports a foot valve 20 at the upper end of the macaroni tubing 18, and in the present construction, the cage 21 of this foot valve serves as a support for a self-centering valve pin 22, which rises axially of the lower portion of casing 10. The lower end of this valve pin 22 has a convexly curved head 23, held in movable relation on a flat supporting surface,

by means of a flanged sleeve 24, spaced from, and around the base portion of the pin, so that slight yielding movements of the valve pin are thus permitted.

The valve body 14, seen as threadedly connected between sections of the intermitter casing 10, has a bottom portion 25 below the fluid pressure inlet openings 15, which portion is solid except for an axial opening through which the hollow or tubular valve stem 26 of the intermitter valve depends. Thus the bottom portion 25 of the valve body may have packing 27 therein, around the stem 26, to prevent downward flow of fluid pressure, and may also serve as an abutment for the upper end of a valve controlling coil spring 28. This spring is disposed around that portion of stem 26, below the valve body, in a compressed condition to exert a predetermined downward pressure at its lower end against a valve seat collar 29.

The collar 29, it will be noted, is threaded on the lower end of stem 26, and presents a downwardly facing valve seat 30 around the lower end of the stem channel, for effective engagement with the upper rounded end of the valve pin 22, when the intermitter valve is in its lower position, to cut off the upflow of well liquid through the stem and is located below the closed bottom 25 of the valve body and isolated thereby from the interior of the valve body.

The upper portion of valve body 14 forms therein a piston chamber slidably interfitted by a piston 31, intermediate the ends of the intermitter valve, and provided with one or more flow channels 32 for the upflow of fluid under pressure which enters the chamber below the piston through openings 15. Spaced above said piston, the intermitter valve has an upwardly facing valve member or head 33 which, in the upper position of the valve, seats against an annular seat ring 34 within the casing 10.

In its closed position, at the start of a filling cycle, the intermitter valve as a whole is held in its upper position, with fluid pressure valve 33 in seated position by reason of the action of fluid pressure from the casing 13, through openings 15 and the flow reducing channels, this action of the fluid pressure being the lower larger surface of said valve. In this position of the parts, shown in Figure 2, the liquid or well fluid valve is open by reason of the spacing of the valve seat 30 vertically away from the valve pin 22. Thus the way is free for rise of oil under formation pressure, through the standing valve 20, and through the axial flow channel 35 of the intermitter valve and its stem 26, to form a slug above the valve during the filling cycle.

Opening of the fluid pressure valve 33 of this invention, normally held tightly seated by direct action of casing pressure as above, is accomplished by the combined pressures exerted by the controlling spring 28 and the liquid load within casing 10 and tubing 11 on the upper effective area of the valve which is exposed to such load. In this way it is only necessary to vary the effective tension of the spring 28 in order to adapt the valve in any instance to the available casing pressure.

When the rise of liquid in the tubing above the valve 33 produces such a pressure that, combined with the tension of spring 28, casing pressure is overcome and the valve thus forced downwardly to unseated position, this movement is quick, positive and steady, and the arrangement is such that when the valve has been opened, it will remain steadily open without danger of fluttering or false movements at any time, due to the following:

The effective area of valve 33 is its seating area, and this area, it will be noted, is made slightly larger than the effective area of the piston 31, so that when the valve is seated, casing pressure acting against the lower effective area of the valve tends to hold it tightly on its seat against the fluid head building up in the tubing on the valve and tending to unseat the latter.

When, however, the weight of the tubing load increases to the point where, in opposition to casing pressure acting as above, it is capable, with the assistance of spring 28, of overcoming such opposition, it forces the valve downwardly to unseated position.

Immediately upon unseating of the valve 33, casing pressure is then active upon only the smaller effective area of piston 31, so that during the flow period in which the accumulated slug of oil is being raised, there is substantially less closing force against the valve than there previously existed when the valve was seated, and hence there is less tendency for the valve to seat until there is a pressure drop in the tubing.

Due to the foregoing it is plain that more pressure is necessary in the tubing to bring about downward or unseating movement of the valve 33, than is thereafter necessary to hold the valve in unseated position during the flow period. Hence it follows that before the valve can be returned to its seat the pressure in the tubing must drop considerably below that pressure which was required therein to unseat the valve.

During unseating of the valve 33 under tubing load, the effective areas of both the valve and the piston 31 are high pressure areas, and continue so while the load is lifted in the tubing and until there is a pressure drop therein. When there is a pressure drop in the tubing, incident to discharge of the slug, the area around the valve head 33 and the upper end of the piston 31 is converted into a low pressure area, to which casing pressure can communicate only through the flow reducing channels 32, so that such casing pressure will thus act against the high pressure lower end of the piston to quickly and positively shift the valve member upwardly so that the valve will be seated.

During the above described operation, and immediately upon movement of the pressure control valve 33 to unseated or lower position, liquid valve seat 30 engages valve pin 22 and thus cuts off further rise of well liquid through the intermitter valve channel. It will be noted that the effective area of the stem 26 is not greater, and is preferably less, than the effective area of valve pin 22, so that when the liquid valve is closed, the valve collar 29 is either balanced in the pressure of the well liquid or subjected to downward pressure thereby, thus aiding the spring 28 and the fluid pressure around valve 33 to defeat any tendency toward pumping movement of the intermitter valve which might otherwise occur in the changing pressures of the well liquid.

The arrangement of the present invention is thus effective for the purposes stated, with very little differential as regards the weight of the liquid of the slug over and above the casing pressure, and admits of ready variation of the precise differential requirement by the adjustment of the effective tension of spring 28. Being positive in its action, effectively guided in its movements, and free of danger of hammering in

its operation under low pressure differentials, the described intermitter will be efficient over long periods without attention or the necessity of repairs or substitution of parts, and in all such respects, is a substantial improvement upon known devices for the same purpose.

One very important feature, briefly referred to as one of the objects, is the fact that the intermitter valve as above described, provides a well liquid flow channel **35** which is substantially continuous and entirely free of any part or parts capable of developing a back pressure tending to unseat the gas control valve and in this way causing a fluttering or unstable action of the valve.

Not infrequently wells are encountered which build up considerable pressure below the intermitter valve during the blow of a slug in the production cycle, so that when the blow-down is reached and the gas control valve seats and the liquid valve opens, there is a very sudden uprush of well liquid in what is known as a "false filling head." With the present valve structure such a situation is well taken care of because the force of the uprush of liquid can only operate to hold the gas control valve tightly against its seat.

In the various features thus far described, the construction shown in Figure 3 is precisely that of Figure 2, but, recognizing the advantage of the use of such an intermitter in many wells which produce oil in substantial quantity, though under low formation pressure, there is shown in Figure 3 an additional arrangement whereby to facilitate the rise of well liquid into the filling chamber in a manner which reduces the back pressure on the producing formation by aerating and lightening the incoming well liquid, and insures rapid filling of the chamber during each filling cycle.

To the above end it is proposed that to the valve head **33** be added a pipe or stem **36** rising to the upper portion of the filling chamber within casing **10**. The lower end of this pipe or stem **36** may be threaded in connection with the valve head at **37** so that its bore forms a continuation of the intermitter valve channel **35**. A guide may be used on this stem, since it rises and falls with the intermitter valve, and such guide may take the form of radiating arms **38** extending from a collar **39** around the stem, with anti-friction rollers **40** at the ends of such arms to engage the inner surface of the casing **10**.

With such an arrangement, a minute pressure inlet port **41** is formed through the depending stem **26** of the intermitter valve below the piston **31**, and thus in communication with the channel **35**, the port being inclined to direct the fluid pressure upwardly at all times for injection into the rising liquid, whereby to aerate and lighten the liquid and thus assist the liquid in its flow upwardly into the filling chamber. This will tend to reduce back pressure on the producing formation and offset any lack of formation pressure which may have to be met with.

To prevent blowing the oil upwardly into the production line, a mushroom deflecting head or cowl **42** may be used on the upper end of the rising stem or pipe **36**, with downwardly directed discharge openings **43** insuring delivery of oil downwardly into the filling chamber, and permitting separation of gas therefrom as well as unobstructed rise of such gas into the production line.

The use of such an arrangement will be considerable practical advantage in many instances, and need not vary the described operation of the intermitter in any respect other than possible modification of the tension of spring **28** to compensate for the added weight imposed on the intermitter valve by the rising stem **36** and its parts.

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

1. In a well flowing device of the bottom hole intermitter type having an eduction passage, a valve housing forming a gas flow passage opening into said eduction passage and having a closed bottom, a unitary valve member having pressure responsive means for shifting said member in one direction in operation by pressure in the gas passage, and having a liquid flow passage therethrough opening into the eduction passage, valve means opening and closing said gas passage, said member also having a portion depending movably through said housing bottom, and valve means cooperating with the said depending portion of the valve member, respectively closing and opening the liquid flow passage as the gas flow passage is opened and closed, the last mentioned valve means being below the bottom of the housing and thereby isolated from the gas passage.

2. In a well flowing device of the bottom hole intermitter type having an eduction passage, means forming a gas flow passage opening into said eduction passage, a unitary valve member having pressure responsive means in said gas flow passage for shifting the member in one direction in operation by pressure in the gas passage, said valve member having a liquid flow passage therethrough opening into the eduction passage, and having valve means at its upper portion opening and closing said gas passage, and valve means cooperating with the lower portion of said member, and isolated from the gas passage, respectively closing and opening the liquid passage as the gas passage is opened and closed.

3. In a well flowing device of the bottom hole intermitter type having an eduction pipe, means forming a gas flow passage opening into the eduction pipe, a unitary axially shiftable valve member, having pressure responsive means for shifting the same in one direction in operation by pressure in said gas passage, and having an axial liquid flow passage and valve means around the upper end of said liquid passage closing and opening the gas passage as the member is shifted upwardly and downwardly, valve means cooperating with said member at the lower end of said liquid passage respectively, positively opening and closing said liquid passage as the gas passage is closed and opened, and means isolating the said liquid valve means from the gas passage.

4. In a well flowing device of the bottom hole intermitter type, having an eduction passage, a valve housing forming therein a gas flow passage opening into said eduction passage, a valve member shiftable axially in said gas passage including gas pressure responsive means for shifting the same in one direction, and having upper valve means opening and closing the gas passage, said valve member having a depending stem and an axial liquid flow passage opening at its upper end into the eduction passage, valve means cooperating with the lower end of said stem effective to open and close said liquid passage as the gas valve means respectively closes

and opens the gas passage, and said housing having a closed bottom surrounding the stem of said valve member and isolating the liquid valve means from said gas passage.

5. In a well flowing device of the bottom hole intermitter type, having an eduction passage, means forming a filling chamber in communication with said eduction passage, means forming a gas flow passage in communication with the filling chamber, a unitary valve member influenced in its movements by pressure in the gas passage, and having upper valve means opening and closing the gas passage, said valve member having an axial liquid flow passage, lower valve means cooperating therewith for closing and opening said liquid passage, and a hollow stem rising from said valve member, as a continuation of said liquid passage within, and opening into, the filling chamber.

6. The device as set forth in claim 5, with flow deflecting means at the upper outlet end of said stem.

7. In a well flowing device of the bottom hole intermitter type, having an eduction passage, means forming a filling chamber in communication with said eduction passage, means forming a gas flow passage in communication with said filling chamber, a unitary valve member, influenced in operation by pressure in said gas passage, and having upper valve means opening and closing the gas passage, said valve member having an axial liquid flow passage, lower valve means, isolated from said gas passage and cooperating with said valve member for closing and opening said liquid passage, said valve member having a gas jetting port in communication at all times with the gas passage and opening into the liquid passage in the direction of flow of liquid therein.

8. In a well flowing device of the bottom hole intermitter type, means forming an eduction passage, a valve housing open at its top into said eduction passage and having a closed bottom and a gas pressure inlet opening therein above said bottom, a vertically shiftable unitary valve member exposed at its top to the eduction passage and including a portion forming therearound a gas flow passage in said housing, valve means movable with said portion of the valve member under gas pressure in said gas passage to close off the said passage with respect to the eduction passage when the valve member is in its upper position, said valve member also including a lower portion depending movably through said housing bottom, and also having an axial liquid flow passage therethrough, and valve means cooperating with said lower portion of the valve member and positively opening and closing the lower end of the liquid flow passage when the valve member is respectively in its upper and lower positions, said last named valve means being located below the bottom of the housing and isolated thereby from the gas flow passage.

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