Sept. 8, 1964 J. H. McCARVELL ETAL 3,147,808

APPARATUS AND ARRANGEMENT FOR INTERMITTENTLY PRODUCING A WELL AND SIMULTANEOUSLY SCRAPING THE WELL PIPE

Filed Feb. 17, 1961

2 Sheets-Sheet 1

Fig. 1

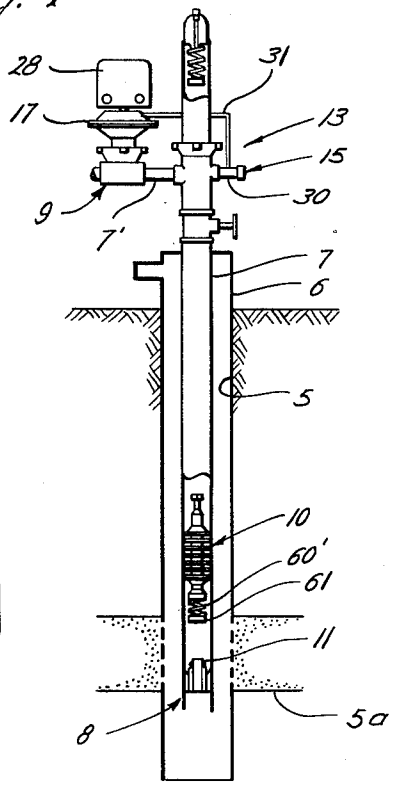
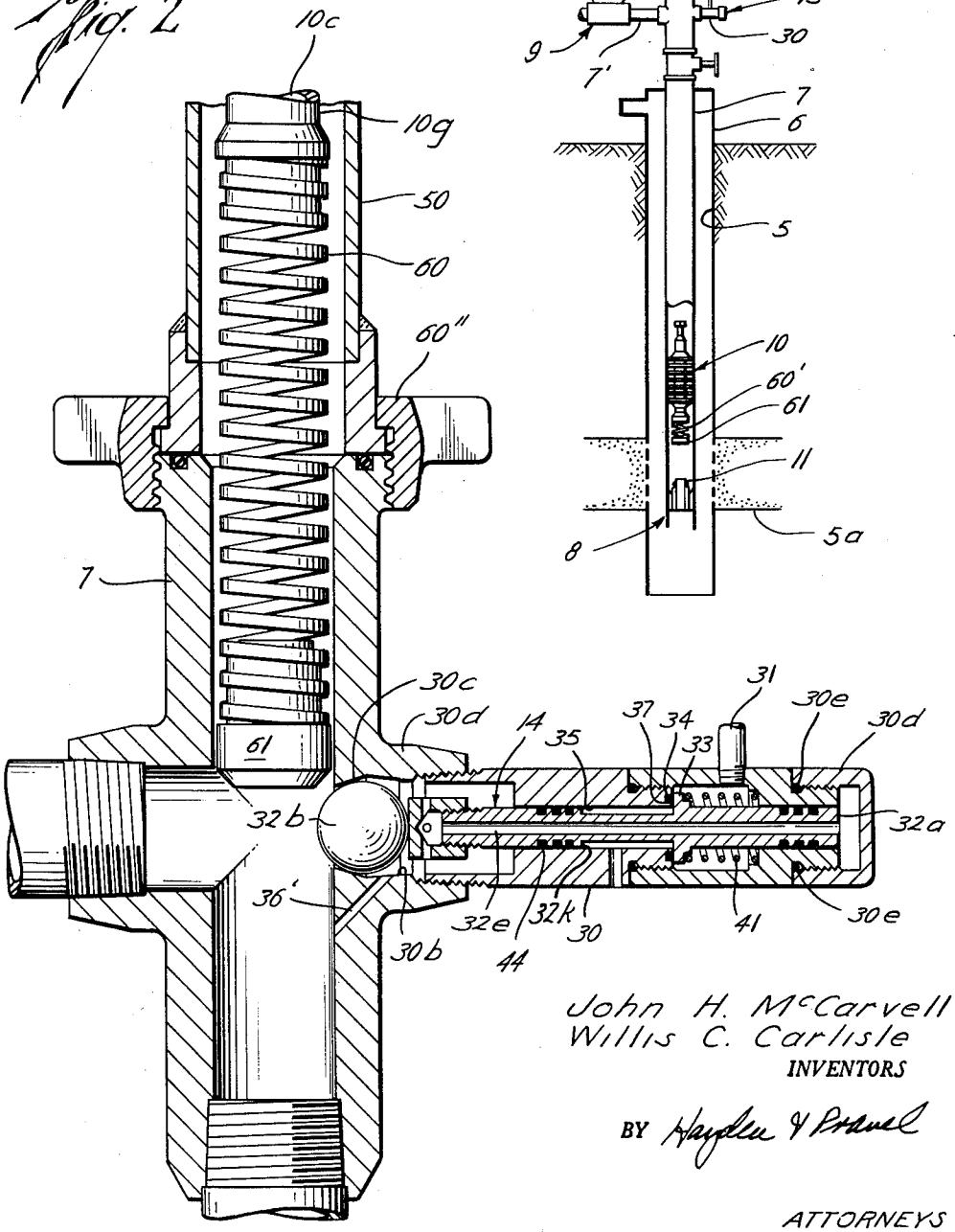


Fig. 2



John H. McCarvell
Willis C. Carlisle
INVENTORS

BY Hayden & Brandt

ATTORNEYS

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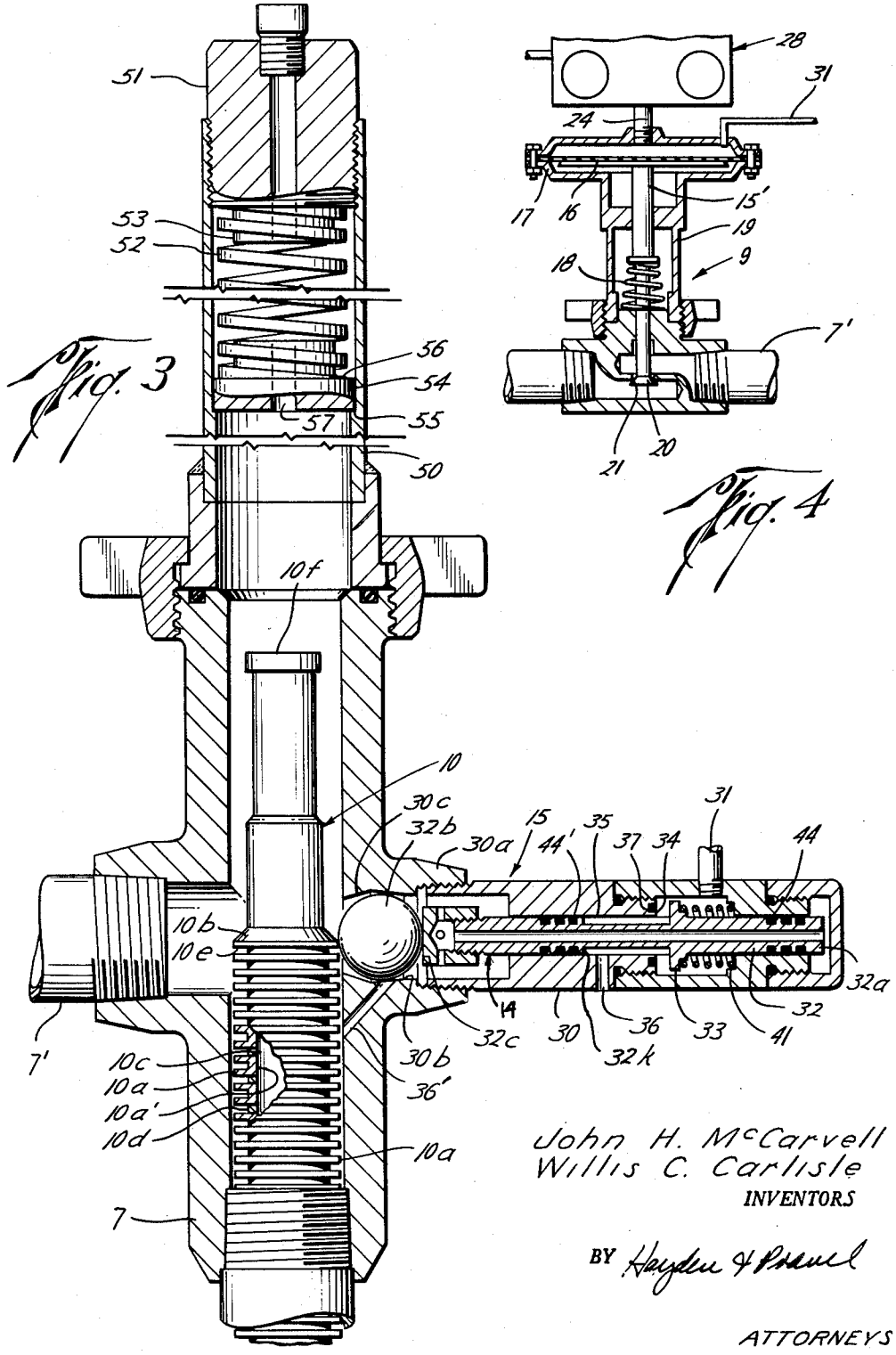

Fig. 3

Fig. 4

John H. McCarvell
Willis C. Carlisle
INVENTORS

BY Hayden & Russell

ATTORNEYS

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APPARATUS AND ARRANGEMENT FOR INTERMITTENTLY PRODUCING A WELL AND SIMULTANEOUSLY SCRAPING THE WELL PIPE

John H. McCarvell and Willis C. Carlisle, both of 1521 Prince St., Houston, Tex.

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The present invention relates to an arrangement and apparatus whereby a well, such as an oil or gas well, may be periodically produced and simultaneously the well pipe through which the production occurs scraped to remove paraffin and other deposits therefrom.

In some wells, the deposition of paraffin, or other similar materials within the well pipe, occurs frequently thereby restricting the flow through the pipe. It therefore becomes necessary to continually remove the paraffin deposits, such removal in most instances at the present time requiring that normal flowing of the well be interfered with while the paraffin is removed.

The present invention provides an arrangement whereby well pipes may be periodically scraped to remove paraffin and other deposits therefrom in a manner so as to not interfere with normal well flowing operations.

Also, where wells are produced by means of a gas lift, or even by means of the natural pressure in the formation, present production methods and apparatus may waste substantial volumes of gas by leaving the flow conduit open longer than necessary to flow collected liquids from the well pipe.

The present invention provides an apparatus and method whereby a well pipe may be closed at a predetermined time when liquids collected in the well pipe have been discharged therefrom.

Still a further object of the present invention is to provide an arrangement for scraping a well pipe and to utilize the movement of the scraper through a well pipe to aid in closing off flow through the well pipe when the scraper has reached the end of its travel.

Yet a further object of the present invention is to provide an arrangement for simultaneously scraping a well pipe and periodically effecting flow through the pipe including a valve responsive to pressure means to open and close the well pipe for flow therethrough, means for controlling the valve means and operable by fluid pressure to open the valve means, means mounted in the well pipe upstream of said valve means and operatively connected with control means, said last named means being operable by engagement with a scraper means moving through the pipe to actuate said control means for closing the valve means to close off flow through the well pipe.

Other objects and advantages of the present invention will become more readily apparent from a consideration of the following description and drawings wherein:

FIG. 1 is a schematic side elevation, partly in section, showing the arrangement of the present invention on a well pipe;

FIG. 2 is an enlarged sectional view of the upper end of a portion of the arrangement shown in FIG. 1, and illustrates the scraper means after it has actuated the means to close the valve for shutting off flow through the well pipe, and then moved to its uppermost position in the well pipe;

FIG. 3 is an enlarged sectional view similar to FIG. 2 and showing the scraper means at the time it contacts the plunger means mounted in the well pipe to effect closing of the valve means in the flow line; and

FIG. 4 is an enlarged view of the valve means and pressure sensitive means for opening the valve in response to fluid pressure.

Attention is first directed to FIG. 1 of the drawings

wherein a well bore is illustrated at 5. The well bore is provided with suitable casing 6 extending inwardly thereinto. The tubing 7 through which the well is flowed is positioned in the casing 6 and extends longitudinally thereof to a position adjaecnt the lower end of the well bore as represented schematically at 8. A valve means as shown generally at 9 is connected in the upper end of the tubing or flow pipe 7' for opening and closing the flow pipe 7 to flow of fluids therethrough. The scraper or piston means shown generally at 10 is initially inserted in the flow pipe 7 in the upper end of the tubing 7 and its weight causes it to initially sink in the well fluids, to rest on the tubing stop 11 in the lower end of the tubing. The tubing stop 11 has a hole therethrough to communicate the lower end of the tubing 7 with the producing formation in the well, such formation being represented by the numeral 5a.

When the valve means 9 at the earth's surface is opened, in a manner as will be described hereinafter, well fluids from the formation and those collected in the tubing 7 flow up the tubing 7 to be discharged from the tubing into a suitable collection means, such as a tank or the like, not shown. When fluid flows upwardly, the pressure thereof moves scraper 10 upwardly also thereby scraping the inner walls of the tubing 7. The movement of the scraper 10 and the scraping action on the well pipe 7 continues until the scraper 10 reaches the wellhead arrangement designated generally at 13 in FIG. 1 whereupon the scraper means 10 contacts a portion of the plunger means represented generally at 14 in FIG. 2 of the drawings which forms part of the releasing means designated generally as 15 in FIG. 1 of the drawings. When the plunger means 14 is moved to the right, as viewed in FIG. 3 of the drawings, the pressure acting on the valve means 9 is released whereby the valve means 9 may move to closed position. When this occurs, flow through the tubing 7 is shut off, and the scraper means 10 may then fall by gravity back down the tubing 7 to rest on the tubing stop 11 until the valve 9 has been again opened and flow occurs through the tubing 7.

The valve means 9 is shown in greater detail in FIG. 4, such valve means being positioned in the line 7' which forms a part of the tubing 7, but extends laterally therefrom. The valve means 9 is operatively connected by means of the rod 15' to the diaphragm 16 mounted in the housing 17 by means well known in the art. A spring 18 is mounted within the valve body 19 as shown in FIG. 4 and normally urges the rod 15' and the valve element 20 on the lower end thereof to seated position to close off the port 21 in the line 7' whereby flow through the well pipe or tubing 7 is prevented. The diaphragm 16 has one side thereof communicated or connected by means of the conduit 24 to a source of fluid pressure whereby the diaphragm may be moved, such movement being in opposition to the spring 18 to unseat the valve element 20 whereby the port 21 is opened to flow fluid through the well pipe 7.

Thus, the diaphragm 16 is sensitive to fluid pressure from the pressure source (not shown) through the conduit 24 to open the valve means 21 at periodic intervals as desired. Suitable means as illustrated generally at 28 are provided for controlling flow through the line 24, such means comprising a time cycle controller, which is adapted to open conduit 24 to the source of pressure fluid at timed intervals as desired. Such means 28 may be of any conventional type such as illustrated in U.S. Patent 3,002,526. From the foregoing description, it can be appreciated that the valve means 9 is normally in closed position as shown in FIG. 4 of the drawings; however, at periodic intervals a charge of fluid pressure is conducted to act on the diaphragm 16 so as to open the valve means 9 whereby fluid flow may occur through the well pipe 7.

When the fluid flows through the well pipe 7, the scraper means 10 is moved off the tubing stop 11 and upwardly through the well pipe 7 so as to scrape the well pipe as previously described. Upward movement of the scraper means continues and as illustrated in FIG. 3 of the drawings, the scraper means 10 will actuate the release means designated generally at 15, whereby the fluid pressure acting on the diaphragm 16 is released so that the spring 18 can move valve element 20 of valve means 9 to closed position.

The release means 15 is positioned upstream of the valve means 9 in the tubing 7 and includes the housing 30 which is secured in the upper end of the tubing 7 as shown in FIG. 3 of the drawings. The release means 15 is communicated to the pressure side of the diaphragm 16 by means of the line or conduit 31 as shown in FIG. 4 of the drawing, such line being connected into the housing 30, as shown in FIG. 3 of the drawings. In order to prevent escape of the fluid pressure from the pressure side of the diaphragm 16 through line 31, plunger means 14 includes an elongated rod 32 which has the annular enlargement 33 thereon. The enlargement 33 seats against the annular vertical face 34 in the housing 30 as shown in FIG. 2 of the drawings, and this normally closes off communication between pipe 31 and discharge port 36 of housing 30.

The face 34 surrounds and is formed on the end of the bore 35. The rod 32 is reduced in size from the enlargement 33 to a position 32*k* on the rod 32 whereby the bore 35 may communicate with the discharge port means 36 of the housing 30 when the plunger means 14 is moved to the right as viewed in FIG. 3 of the drawings. A seal 37 is provided in the face 34 to aid in preventing fluid communication between the conduit means 31 and discharge port means 36 when the enlargement 33 is seated against face 34. In order to retain the rod 32 normally in the position shown in FIG. 2, the spring 41 is positioned within the housing 30 as shown in the drawings and urges the rod 32 laterally of the housing 30 and towards the interior of the tubing 7. In order to further seal off the escape of fluid pressure from within the housing 30, until a predetermined time, suitable seal means as illustrated at 44 and 44′ are provided at spaced intervals along the rod 32. It will be noted that seal means 44 is provided adjacent the outer end 32*a* of the rod 32, and another seal means 44′ is provided on the plunger within the bore 35, but positioned or spaced on the rod 32 so that when the rod 32 is moved to the position shown in FIG. 3 of the drawings, such seals will not interfere with the flow of fluid pressure from the conduit 31 and through discharge port 36, but will seal off the pressure fluid in the well pipe 7 from the valve actuating fluid pressure communicated to the housing 30 through the conduit 31.

As previously noted, the housing 30 is positioned laterally relative to the well pipe 7, and it will be particularly noted that such housing is mounted in the fitting 30*a* which fitting is provided with a bore 30*b* therethrough which communicates with the interior of the well pipe 7. The bore 30*b* is reduced in cross section as illustrated at 30*c* to provide a seat for the ball 32*b* which abuts against the end 32*c* of the elongated rod 32. Thus, in effect, the ball 32*b* forms a part of the plunger means 14 along the rod 32, but such ball is rotatable and movable within the bore 30*b* for a purpose as will be described in greater detail hereinafter.

It will be noted that the interior of the well pipe 7 communicates with the bore 30*b* by means of the passage 36′ whereby the fluid pressure from tubing 7 surrounds the ball 32*b* and equalizes the pressure on each side of the ball. Normally, the plunger means 14 including ball 32*b* and rod 32 is seated in the position as illustrated in FIG. 2 of the drawings since the spring 41 tends to move the rod 32 against its ball 32*b* and urge it against seat 30*c*. In this position, fluid pressure is equalized on each side of the ball 32*b*, but is sealed off from passing along the plunger 32 or the surface of bore 35 by reason of the seal means 44′. Thus, the well pressure fluid in tubing 7 is sealed off from the valve actuating pressure fluid communicated to housing 30 through conduit 31. A bore 32*e* extends longitudinally of the rod 32 so as to equalize pressure on both ends thereof and a cap 30*d* is threadedly secured on the end of the housing 30 and is provided with suitable seal means as shown at 30*e* for inhibiting the leakage of well fluids therefrom.

The scraper means or plunger means 10 includes an elongated body having a plurality of annular scraping elements 10*a* carried thereby which are H shaped with a bore 10*a*′ through each of said elements. The scraper elements 10*a* closely approximate the inner diameter of the well pipe 7 and will serve to scrape paraffin and other deposits therefrom as the scraper 10 is flowed up through the well pipe. In the preferred form, the elements 10*a* are ⅛″ smaller in diameter, than the inner diameter of the well pipe through which they move. The bores 10*a*′ of each of the elements 10*a* are slightly larger than the diameter of the body 10*c*. As a practical matter, the bore 10*a*′ may be 1/16″ larger than the body 10*c*; however, other dimensions than those given may be used without departing from the scope of the invention. Since the bore 10*a*′ of the elements 10*a* is larger than the body 10*c*, the elements may shift laterally slightly relative to the body 10*c* as the scraper means 10 moves up the well to aid in best contact of the well pipe under operating conditions. The elements 10*a* are separated by the spacers 10*d*. The spacers and rings are kept from falling off body 10*c* by the shoulder 10*e* on the enlarged end 10*f* of the body 10*c*, and by enlarged nut 10*g* threaded on the other end of the body 10*c*.

The enlarged upper end 10*f* includes the annular tapered portion 10*b* which taper portion functions to engage the ball 32*b* of plunger means 14 as the scraper 10 moves up through the well pipe 7. This moves the ball 32*b* and rod 32 against the spring 41 so as to move the ball 32*b* and plunger 32 to the right as viewed in FIG. 3 of the drawings. Thus, enlargement 33 is unseated from surface 34 whereupon conduit 31 is communicated with discharge port 36. When this occurs, fluid pressure on the pressure side of the diaphragm 16 is discharged to the atmosphere thereby permitting the spring 18 to close valve means 9.

A bumper arrangement to lessen the impact of scraper 10 against the upper end of the tubing 7 is provided as shown in FIG. 3. Such bumper arrangement is mounted in the elongated housing 50 which extends above the release means 15 on the well pipe 7. A plug 51 closes off the upper end of the housing 50 on pipe 7 and coil spring means 52 is mounted on the lower end 53 of such plug means. A piston 54 is seated on annular recess 55 in housing 50 and is urged against such annular seat 55 by reason of the spring 52 which engages the annular shoulder 56 of the piston 54. The piston 54 is provided with suitable port means 57 for equalizing pressure in the well pipe 7 on both sides thereof, the piston being slidable within the lubricator or elongated housing 50. Thus, when the upper end 10*f* of scraper means 10 bumps against the lower end of piston 55, the shock of engagement will be cushioned by reason of spring 52.

The weight of the scraper 10 is such that it will float downwardly in the fluids in well pipe 7 and again strike ball 32*b* and the rod 32 engaged therewith will move laterally to permit the scraper means to float on down into the tubing 7. The scraper means 10 includes a spring 60′ on its lower end in which is secured the annular member 61. When the annular member 61 strikes the tubing stop 11, the spring 60 serves to cushion the fall to thereby inhibit damage to the tubing stop or to the scraper means 10.

The scraper 10 is thus repositioned in the well pipe so that when the means 28 next permits pressure fluid to be discharged against the diaphragm 16 so as to open the valve means 9, the scraper 10 will move upwardly in the

well pipe 7 to scrape the pipe 7 and to close off valve means 9 when the scraper means 10 reaches the upper end of well pipe 7.

While it is believed that the operation of the present invention is apparent by reason of the foregoing description, to further amplify and describe, it will be assumed that the invention has been installed as illustrated in FIG. 1 of the drawings on a producing oil and gas well. It can be appreciated that the valve means 9, timer 28, conduit 31, and housing 30 are arranged in the wellhead 13 at the time that the well is completed, or may be inserted at a later time, if desired. The scraper means 10 may assume any suitable form, and can be inserted into the tubing 7 at the upper end thereof by removing the elongated housing 50 which forms a lubricator. To facilitate access to the upper end of the tubing 7, a union 60'' as shown in FIGS. 2 and 3 of the drawings is provided for holding the housing 50 in position on the well pipe 7 above the release means designated generally at 15. The present invention will be described as used in connection with a well which flows normally without requiring any artificial lift means. It can be adapted for use with installations where artificial lift means, such as gas lift valves, are employed without affecting the operation of the arrangement of the present invention.

The timer 28 is connected to a source of fluid pressure (not shown) and contains internal timing mechanisms which are well known in the art whereby a change of fluid pressure may be supplied to the diaphragm housing 17 for actuating the diaphragm therein. The spacing or intervals when actuating fluid pressure is discharged to act on diaphragm 16 is controlled by a clock in the means, such intervals being determined by various factors including the conditions of the well on which the apparatus is employed. If desired, the timer means 28 may be pressure controlled, that is, the intervals determined by pressure at the wellhead. The clock arrangement and pressure controlled arrangement which actuate means 28 are both well known in the art. At any event, when the timing mechanism 28 opens the line 24 to receive a charge of fluid from the outside pressure source, the diaphragm 16 is flexed so that the valve means 9 is opened to permit the flow of well fluid through the pipe 7.

When this occurs, the scraper means 10 is moved up along the flow in the well pipe, such movement serving to scrape the interior wall of the well pipe. When the upper end of the scraper means 10 moves adjacent the release means 15 so that shoulder 10*b* contacts the ball 32*b*, the ball 32*b* and rod 32 are moved laterally whereupon the conduit 31 is communicated through discharge port 36 in housing 30 to atmosphere. The timing means 28 permits only a predetermined charge of fluid pressure to be conducted to the diaphragm housing 17 to act on the diaphragm 16, so that when the conduit 31 is exposed to atmosphere, such charge or pressure fluid is dissipated, thereby permitting the spring 18 to return the valve means 9 to its normally closed position in the portion 7' of the well pipe 7. The upward momentum of the scraper means 10 may carry it above the release means 15 whereupon it will strike the bumper arrangement previously referred to herein in the upper portion 50 of the well pipe 7.

At any event, after the valve means 9 has been closed, further flow through the pipe 7 is prevented until the valve means is next opened. This is particularly advantageous in that the present device inhibits the loss of substantial quantities of gas from the well pipe 7 which might otherwise occur. However, the present invention functions to close valve 9 substantially immediately after all the collected well liquids in pipe 7 have been discharge therefrom, thereby preventing the continued flow of gas through the pipe which would otherwise occur until the valve 9 has been closed.

The scraper means 10 falls by gravity down through the well pipe and reseats on the tubing stop 11 after the valve 9 is closed, in which position it will be ready to scrape

the pipe when the timing means 28 next permits a charge of actuating pressure fluid to act upon the fluid pressure sensitive diaphragm means 16.

Thus, the arrangement of the present invention provides a means whereby the well may be intermittently flowed and each time it is flowed the flow pipe is scraped to remove deposits therefrom. Also, the scraper is utilized to trigger the release means which releases the pressure acting on the valve means 9 to permit it to move to closed position.

What is claimed is:

1. An arrangement for intermittently flowing well fluid in a well pipe including, valve means in the well pipe to open and close the well pipe to the flow of well fluids therethrough, fluid pressure sensitive means connected to said valve means and operable by fluid pressure to open said valve, a source of pressure fluid for actuating said pressure sensitive means, means associated with said fluid sensitive means for intermittently opening said fluid sensitive means to actuation by pressure fluid from said source to thereby open said valve means, releasing means operatively connected to said fluid pressure sensitive means to reduce the pressure fluid acting on said pressure sensitive means to close said valve means, piston means within the well pipe and movable longitudinally therethrough when said valve means is open to flow well fluids, said releasing means having a laterally slidable plunger means extending into the well pipe and slidable laterally by engagement with said piston means as it moves longitudinally through the well pipe to actuate said releasing means to release the pressure from said pressure sensitive means whereby said valve means in the well pipe may move to closed position, said releasing means also including means for communicating both ends of the plunger means with the well pressure whereby the plunger means is unaffected by the pressure of the well fluid.

2. The combination recited in claim 1 wherein said releasing means includes a housing on the well pipe for receiving said laterally slidable plunger means, spring means within said housing and normally urging said plunger means laterally into the well pipe, seal means between said plunger means and housing for inhibiting leakage of well fluid from the well pipe, fluid passage means connecting said housing and said fluid pressure sensitive means, discharge port means in said housing sealed off from communication with said fluid passage means when said plunger means is seated by said opening means in said housing, said discharge port means and fluid passage means communicating when said plunger means is moved by engagement with said scraper means to release the fluid pressure off said pressure sensitive means to thereby permit said valve means to close off the well pipe, and said means for communicating the well pressure with both ends of said plunger means including a longitudinally extending passage in the plunger means communicating the end of the plunger means in said housing and outwardly of the well pipe with the pressure in the well pipe so that the well pressure is acting on both sides of the seal means.

3. The combination recited in claim 1 wherein said releasing means includes a housing on the well pipe for receiving said plunger means, conduit means connecting said pressure sensitive means and said housing, discharge port means in said housing, spring means normally urging said plunger means into the well pipe and to close off communication between said discharge port means and conduit means, said plunger being movable against said spring pressure when engaged by said scraper to communicate said discharge port means and conduit means whereby fluid pressure may be relieved from said fluid pressure sensitive means to permit said valve means to close off the well pipe, and said means for communicating the well pressure with both ends of said plunger means including a longitudinally extending passage in the plunger means communicating the end of the plunger means in

said housing and outwardly of the well pipe with the pressure in the well pipe.

4. An arrangement for periodically flowing a well comprising, valve means normally closing off flow through the well pipe, a pressure actuated operator means connected to said valve means, means to supply pressure fluid at predetermined intervals to said operator means to open said valve means to flow well fluids through the well pipe, piston means in the well pipe and movable longitudinally therethrough when well fluids flow through the well pipe, releasing means mounted on the well pipe including conduit means directly in fluid communication with said operator means for releasing the pressure fluid therefrom to permit said valve means to close, said releasing means also including a laterally movable valve means having an element thereof extending into the well pipe and engageable by said piston means for moving said valve means laterally to reduce the pressure fluid acting on said operator means to permit said valve means to close, said releasing means also including means for communicating both ends of the plunger means with the well pressure whereby the plunger means is unaffected by the pressure of the well fluid.

5. An arrangement for intermittently flowing well fluid in a well pipe including, valve means in the well pipe to open and close the well pipe to the flow of well fluids therethrough, fluid pressure sensitive means connected to said valve means and operable by fluid pressure to open said valve, a source of pressure fluid for actuating said pressure sensitive means, means associated with said fluid sensitive means for intermittently opening said fluid sensitive means to actuation by pressure fluid from said source

to thereby open said valve means, releasing means operatively connected to said fluid pressure sensitive means to reduce the pressure fluid acting on said pressure sensitive means to close said valve means, piston means within the well pipe and movable longitudinally therethrough when said valve means is open to flow well fluids, said releasing means having a housing mounted on the well pipe, a laterally movable valve mounted in said housing for lateral movement relative to the housing, a ball in contact with said slidable valve and partially extending into the well pipe for engagement with said piston means as it moves longitudinally in the well pipe to effect a lateral movement of the ball and said valve, and a conduit connected from said housing to said fluid pressure sensitive means for establishing fluid communication between said fluid pressure sensitive means and atmospheric pressure when said valve is moved laterally by said piston means, said valve having a longitudinal passage therethrough for communicating well pressure to both ends of the valve whereby the plunger is unaffected by the pressure of the well fluid.

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