May 30, 1933. H. C. OTIS 1,911,323

APPARATUS FOR CONTROLLING OIL WELLS

Filed Nov. 26, 1932 2 Sheets-Sheet 1

Fig. 1.

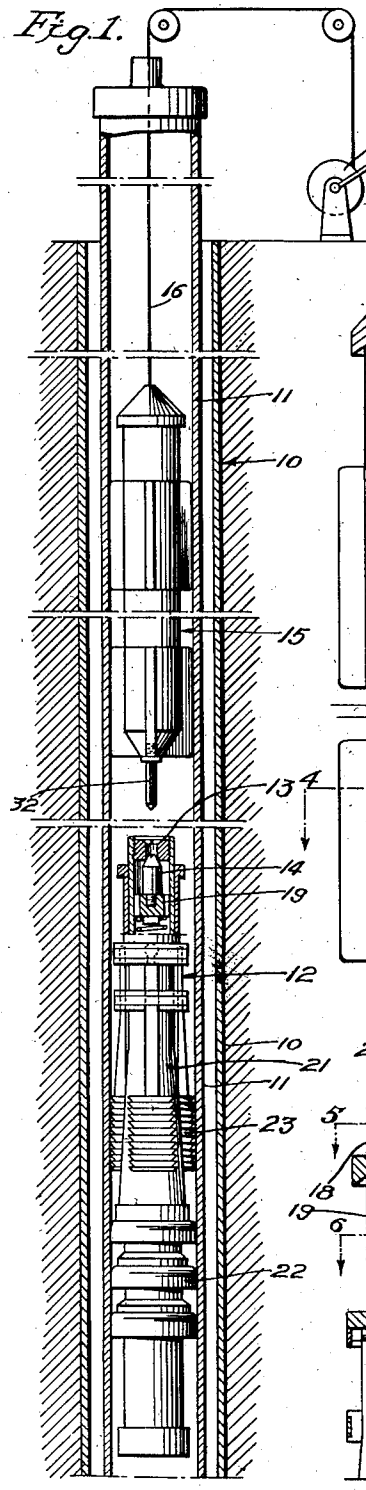


Fig. 2

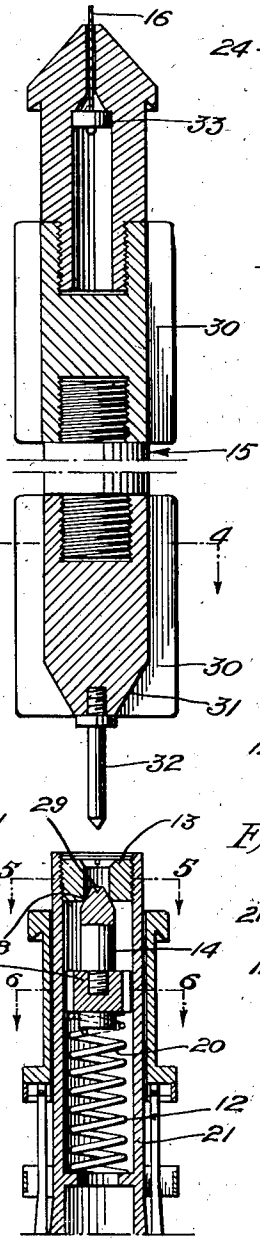


Fig. 3.

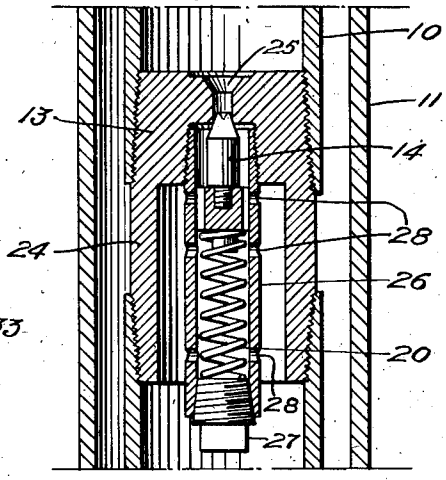


Fig. 4.

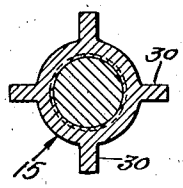


Fig. 7.

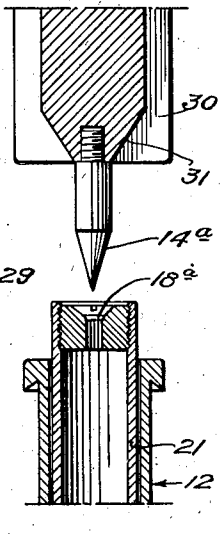


Fig. 5.

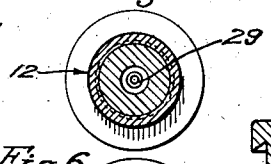
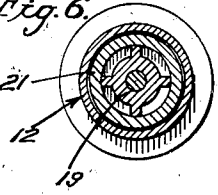


Fig. 6.



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Filed Nov. 26, 1932 2 Sheets-Sheet 2

Fig. 8.

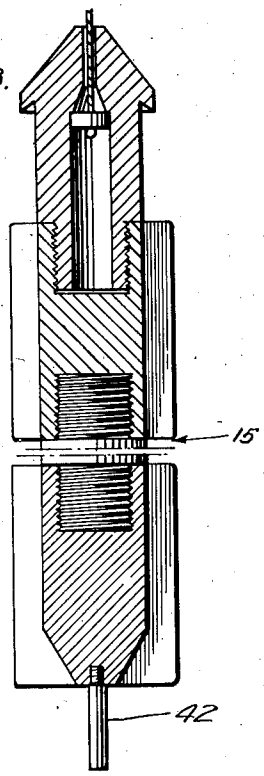


Fig. 10.

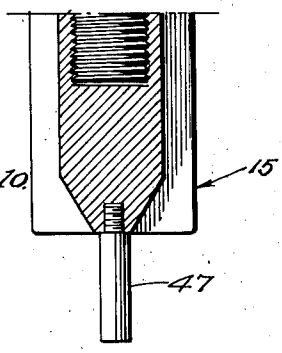
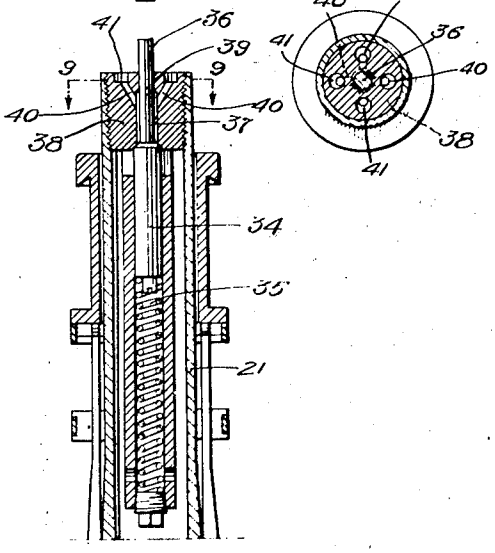
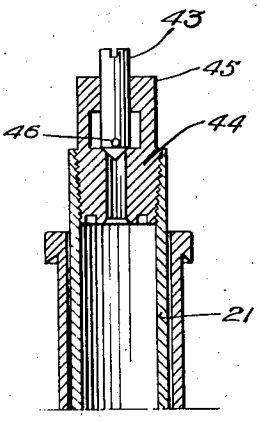


Fig. 9.





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UNITED STATES PATENT OFFICE

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APPARATUS FOR CONTROLLING OIL WELLS

Application filed November 26, 1932. Serial No. 644,515.

This invention relates to apparatus for controlling the flow of oil wells, and more particularly to an apparatus controlling wells in which the flow must be periodically terminated.

In practically all such wells a stage is reached in which, after being closed at the surface, the use of some outside agency such as swabbing or the injection of air or gas is necessary to start the flow. When the well is closed in at the surface, the fluid levels within and without the tubing of the well tend to equalize, leaving a certain volume of gas in the upper end of the tubing and of the casing under pressure. The depth and pressure of this column of gas is dependent upon the gas-oil ratio of the producing sand, the bottom hole pressure, and several other factors.

When a surface tubing valve is opened on a well of this character, the gas above the fluid level within the tubing escapes and the weight of the column of oil in the tubing is thus made less than the effective weight of the oil outside the tubing and between the tubing and casing, since the oil inside the tubing is no longer subject to the pressure of the gas formerly trapped above it, while that outside the tubing remains subject to the pressure of the trapped gas. The level of fluid in the tubing, consequently, rises to an extent dependent upon the amount and pressure of the gas which was released. This change of level may be, and in many circumstances is, sufficient to cause the well to "kick off" and commence flow. When, however, bottom hole pressures have been lowered to a certain extent, the impetus secured by this change of fluid level is not sufficient to cause the well to begin flowing, necessitating external assistance to start flow. Such a condition will, obviously, occur earlier in a well in which the gas-to-oil ratio of the producing zone is relatively low.

An important object of this invention is the provision of an arrangement whereby a relatively great fluid level change may be obtained when the well is opened, even though the bottom hole pressure be low or the gas-to-oil ratio is low.

A further object of the invention is the provision in an apparatus of this character of an arrangement whereby the flow instead of being cut off at the surface is cut off at or near the bottom of the well and the cut-off apparatus is so constructed that it may be readily manipulated from the upper end of the tubing.

A further and more specific object of the invention is the arrangement of a construction such that a valve controlling flow through the tubing may be actuated by a relatively light weight, with the result that this weight may be readily controlled from the upper end of the tubing by use of a small reel and a light wire from which the weight is suspended.

A still further object of the invention is the provision of a construction in which the controlling weight likewise serves to control the effective size of an orifice through which oil enters the lower end of the tubing.

These and other objects I attain by the construction shown in the accompanying drawings, wherein, for the purpose of illustration, I have shown a preferred embodiment of my invention and wherein:

Fig. 1 is a sectional view showing apparatus constructed in accordance with my invention in position in the well;

Fig. 2 is an enlarged detail sectional view through the apparatus;

Fig. 3 is a detail sectional view showing a modification of the choke construction;

Fig. 4 is a section on line 4—4 of Fig. 2;

Fig. 5 is a section on line 5—5 of Fig. 2;

Fig. 6 is a section on line 6—6 of Fig. 2;

Fig. 7 shows a modified arrangement in which the weight carries the valve;

Fig. 8 is a fragmentary sectional view showing a modification of the structure shown in Figs. 1 to 6, wherein the means for controlling the effective diameter of the bean is carried by the valve;

Fig. 9 is a section on line 9—9 of Fig. 8; and

Fig. 10 shows a modification of the structure shown in Fig. 7, in which the valve is

carried by the choke instead of by the weight.

Referring now more particularly to the drawings, the numeral 10 generally designates the casing of a well; 11, the tubing of the well; 12, a choke arranged adjacent the bottom of the tubing including an orificed bean 13; 14, a valve for controlling flow through the orifice of the bean; and 15, the weight for controlling the position of the valve 14. Weight 15, for reasons hereinafter appearing, is relatively light, and is supported by a piano wire or other suitable flexible support 16 leading to a reel 17 disposed at the upper end of the tubing.

In the construction shown in Figs. 1 to 6 inclusive, the lower end of the orifice of the bean terminates in a ground seat 18 for coaction with valve 14, which is arranged below the orifice. The valve 14 has a winged guide 19 co-acting with the walls of a guiding tube and the valve is constantly urged upwardly by a light spring 20 extending between a suitable stop in the guiding tube and the lower end of the valve.

In Figs. 1 and 2, the choke construction is removable and includes a tubular barrel 21 exteriorly equipped with packing means 22 and with anchoring slips 23. The orificed bean 13 is disposed at the upper end of the barrel and is, for a purpose presently to appear, arranged with its upper surface slightly below such upper end.

In Fig. 3, the choke is in the form of a nipple 24, the upper end of which is integrally constructed to form the orificed bean 13. In this construction, the upper surface of the bean is recessed as indicated at 25 for the same purpose. In the construction of Figs. 1 and 2, the barrel will, obviously, provide the necessary tubular guide for the valve 14. In the construction of Fig. 3, an inserted tube 26 performs this function. A plug 27 in the lower end of this tube forms a seat for the spring 20 and the tube wall is provided with perforations 28 to permit the passage of fluid.

In each of these constructions, valve 14 has a blunted upper end provided with a socket 29. The weight 15 comprises a bar of less diameter than the internal diameter of the tubing to afford passageway for the oil and gas, and is provided with guide vanes 30 at its upper and lower ends, these guide vanes being preferably detachably connected thereto so that the weight may be made adaptable for use in tubing of different diameters. The lower end of the vane-bearing portions is downwardly tapered, as indicated at 31, and is socketed for the reception of a pin 32. The upper end of the weight is suitably adapted as at 33 for connection with the wire line 16.

In use of apparatus of this character, the choke assembly is either run into or set in the tubing at the desired depth. If the well has a high fluid level in the tubing, the fluid above the choke is then swabbed out and the weight 15 is lowered through the tubing to a position a few feet above the choke. When it is desired to start flow, the weight assembly is lowered the few remaining feet and pin 32 entering through the orifice of the bean and seating in the socket in the upper end of valve 14, forces the valve downwardly from its seat, permitting flow to start. When sufficient oil has been run, the weight assembly is raised a sufficient distance to insure proper seating of valve 14. Obviously, in an arrangement of this character the effective delivery of fluid through the bean orifice is controlled by the diameter of this orifice and the diameter of pin 32, so that if it is desired to vary the bean orifice, it is simply necessary to elevate weight 15 and change the size of the pin employed thereon.

In the form shown in Fig. 7, the valve seat 18—*a* of the choke is formed at the upper end thereof and the pin 32 of the weight assembly is substituted for by a valve 14—*a*. In a construction of this character, the lowering of weight 15 will, obviously, seal against flow, and raising the weight will permit the flow to begin. In this construction, the orifice of the bean is, of course, unchangeable without replacing the choke, and for this reason it is preferred that the choke be of the removable type illustrated. It will be noted that with the arrangement disclosed, there will be a very considerable pressure differential across the choke, but since the diameter of the orifice is small a very light weight will serve to balance this pressure differential and enable the valve to be unseated. For example, if the orifice be $\frac{3}{16}''$ diameter and there is a differential of a thousand pounds per square inch across the choke, a twenty-eight pound weight will suffice. It is, for this reason, possible to employ a very light rig such as a small reel and a piano wire leader for supporting the weight even though this weight be given a high safety factor.

In Fig. 8, the structure of Figs. 1 to 6 is modified to the extent that the element controlling the effective diameter of the bean is carried by the valve rather than the weight. As shown in this figure, the upwardly seating valve 34 is normally maintained in engagement with its seat by spring 35. The valve has a stem 36 extending upwardly through the aperture 37 of the bean 38. The upper end of the bean aperture is reduced to form a guide 39 for the stem and the bean aperture is connected by diverging ports 40 with sockets 41 formed in the upper face of the bean. Sockets 41, in addition to affording passage for fluids, also serve as a means whereby a spanner wrench may be employed to remove the bean. In this structure, the

stem 36 constitutes a means for determining the effective diameter of the bean orifice 37 and actuation from weight 15 is obtained by means of a pin 42 on the lower end of this weight, such pin preferably being of greater diameter than the stem 36 so that when the weight is lowered it will seat upon the upper end of bean 38 and there will, accordingly, be no strain whatever on the weight-supporting mechanism.

In Fig. 10, the structure of Fig. 7 is modified to the extent that the valve 43 which coacts with a seat at the upper end of the orifice of bean 44 is carried by the bean. As shown, the bean is extended and provided with a guide 45 for the valve, and a pin 46 prevents the force of liquid passing through the bean orifice from displacing the valve to too great an extent. In this structure, the weight 15 will, of course, be provided with a pin 47 to engage the upper end of the valve and maintain the valve against its seat.

I am aware that it has been previously proposed to control the flow of wells through use of apparatus including a choke and a vavle disposed at the bottom of the well and controlling flow through the choke. In all of such apparatuses, control depended upon either the rotation of rods or tubing, or the raising or lowering of such rods. Attempts have been made to control the effective diameter of the choke orifice by similar means; since, however, a bottom hole choke is very sensitive to small diameter changes, all of these attempts have failed for lack of practically operative equipment. With the arrangement illustrated, I may use either a choke having a fixed and relatively small bean diameter, or a choke where the bean diameter is of relatively large size as compared to the desired diameter in combination with a vertically removable element which controls the final and effectual diameter of the bean orifice during flowing of the well.

It will be obvious that, employing an apparatus of this character, a substantial difference in level can be obtained between the fluid in the tubing and that in the casing. This is due to the fact that the space within the tubing is occupied to a large extent by gas which entered the tubing in solution with the oil. If, accordingly, the bottom valve is closed while the upper end of the line is open, the gas will expand to a much larger volume leaving what oil is not ejected in the tubing. In experiments conducted with apparatus of this character in a well where the choke was disposed 1650 feet below the normal closed fluid level in the well, there was only approximately 400 feet of oil in the well above the choke following a shut-down. This provides a fluid differentiation of approximately 1250 feet to assist in starting the flow. The well in which the experiments were carried out had been in operation after drilling for five months and at that time had never made a barrel of oil without first being swabbed. With an installation as described above, the well flows its permissible production each day when the bottom hole valve is open.

As the construction illustrated is capable of considerable modification without in any manner departing from the spirit of the invention, I do not wish to be understood as limiting myself thereto except as hereinafter claimed.

I claim:

1. In apparatus for controlling the flow through the tubing of oil wells, a choke in said tubing and having an apertured bean, the aperture of which is formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve.

2. In apparatus for controlling the flow through the tubing of oil wells, a choke in said tubing and having an apertured bean, the aperture of which is formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve, the valve being carried by said weight, the valve seat being at the upper end of the aperture of the bean.

3. In apparatus for controlling the flow through the tubing of oil wells, a choke in said tubing having an apertured bean, the aperture of which is formed at its upper end with a valve seat, a weight in said tubing above the choke, means at the upper end of the tubing for supporting and vertically moving the weight, and a valve on the weight for co-action with said seat.

4. In apparatus for controlling the flow through the tubing of an oil well, a choke removably mounted in said tubing adjacent the lower end thereof, an apertured bean in said choke, said bean having a valve seat at one end of the aperture thereof, a weight in the tubing above said choke, means to vertically move the weight and a valve carried by said weight for co-action with said seat.

5. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing having an apertured bean, the apertured bean being formed at its lower end with a valve seat, a valve co-acting with said seat and normally spring-held thereagainst, a weight in the tubing above said choke, and means on the weight to ex-

tend through the aperture of the bean and unseat the valve.

6. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat and means to simultaneously displace said valve from the seat and reduce the effective diameter of the aperture of the bean.

7. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat and means to simultaneously displace said valve from the seat and reduce the effective diameter of the aperture of the bean comprising a pin insertable through the aperture to engage said valve.

8. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat, means to simultaneously displace said valve from the seat and reduce the effective diameter of the aperture of the bean comprising a pin insertable through the aperture to engage said valve, and means operable from the upper end of the tubing for controlling the operation of said pin.

9. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat, means to simultaneously displace said valve from the seat and reduce the effective diameter of the aperture of the bean comprising a pin insertable through the aperture to engage said valve, and a weight movable in and guided by the tubing upon which said pin is mounted.

10. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat, means to simultaneously displace said valve from the seat and reduce the effective diameter of the aperture of the bean comprising a pin insertable through the aperture to engage said valve, a weight movable in and guided by the tubing upon which said pin is mounted, and means at the upper end of the tubing for vertically shifting said weight.

11. In apparatus for controlling flow through the tubing of oil wells, a choke in said tubing having an apertured bean, the aperture of the bean being formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke and removable from the tubing independently of the choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve.

12. In apparatus for controlling flow through the tubing of oil wells, a choke in said tubing having an apertured bean, the aperture of the bean being formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke and removable from the tubing independently of the choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve, the valve being carried by said weight, the valve seat being at the upper end of the aperture of the bean.

13. In apparatus for controlling flow through the tubing of oil wells, a choke in said tubing having an apertured bean, the aperture of the bean being formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke and removable from the tubing independently of the choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve, the valve seat being at the upper end of the aperture of the bean.

14. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat, and means to unseat said valve including a weight in the tubing above the choke and a member extending through the aperture of the bean to thereby control the effective diameter of said aperture.

15. In apparatus for controlling the flow through the tubing of an oil well, a choke in said tubing and having an apertured bean, the aperture of said bean being formed at its lower end as a valve seat, a normally seated valve co-acting with said seat, and means to unseat said valve including a weight in the tubing above the choke and a member extending through the aperture of the bean to thereby control the effective diameter of said aperture, said weight being removable from the tubing independent of the choke.

16. In apparatus for controlling the flow

through the tubing of an oil well, a choke in said tubing having an apertured bean, the apertured bean being formed at its lower end with a valve seat, a valve co-acting with said seat and normally spring-held thereagainst, a valve stem extending through and projecting above the apertured bean, and a weight in the tubing above said choke to unseat the valve.

17. In apparatus for controlling the flow through the tubing of oil wells, a choke in said tubing and having an apertured bean, the aperture of which is formed at one end with a valve seat, a vertically movable valve to co-act with said seat, a weight in said tubing above said choke, and means at the upper end of the tubing for supporting and vertically moving the weight, vertical movement of said weight controlling seating and unseating of the valve, the valve being carried by a guide formed above the aperture, the valve seat being disposed at the upper end of the aperture of the bean.

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