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2,033,563

MEANS FOR CONTROLLING WELL FLOW

Filed Aug. 25, 1934

2 Sheets-Sheet 1

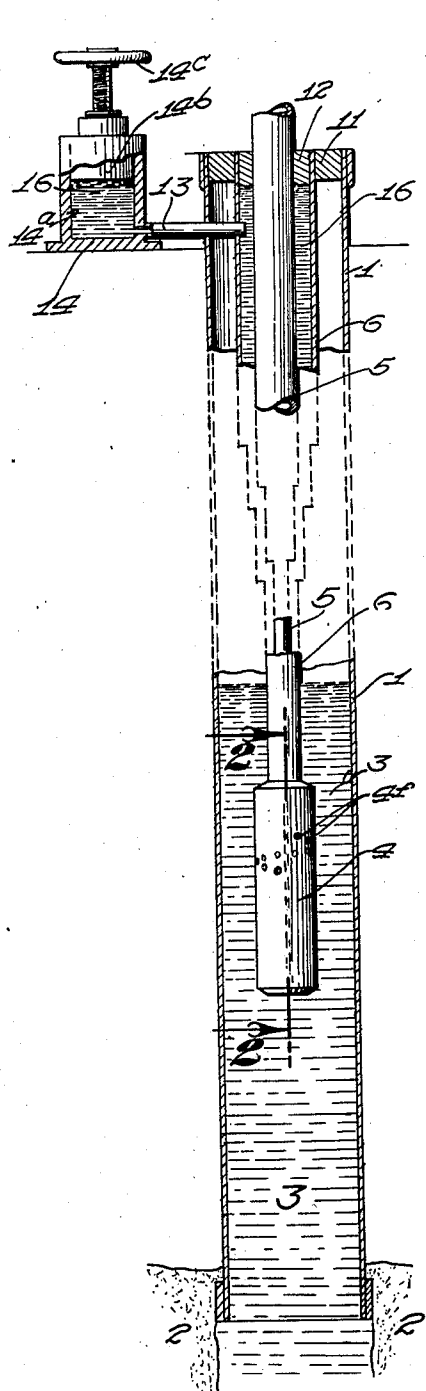


FIG. 1

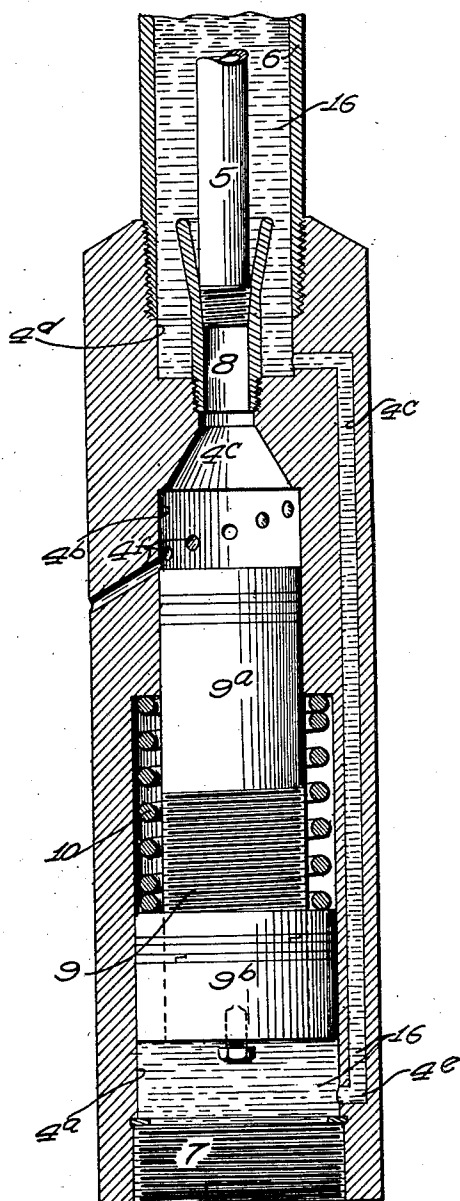


FIG. 2

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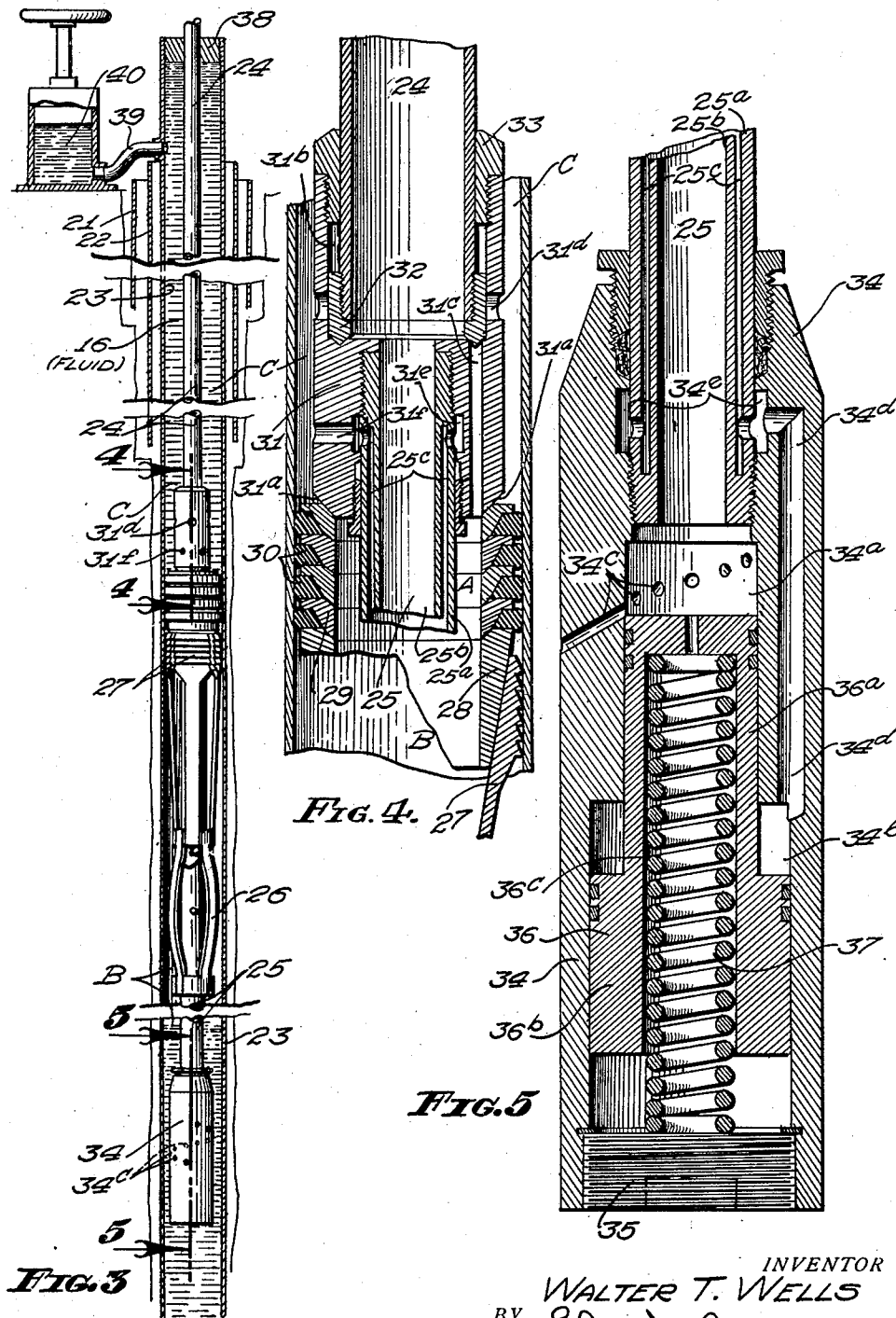
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MEANS FOR CONTROLLING WELL FLOW

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Application August 25, 1934, Serial No. 741,399

9 Claims. (Cl. 166—2)

My invention relates to a method and means for controlling well flow, and the objects of my invention are:

First, to provide a means of this class which incorporates a regulator located at the bottom of the well and a remote control arrangement at the mouth of the well whereby the rate of flow from the well may be regulated at will without removing the regulator from the well;

Second, to provide a means of this class wherein a novel hydraulic control arrangement is utilized to regulate the rate of flow;

Third, to provide a means of this class which may be incorporated with a packer and utilize the inner casing above the packer as the conduit to effect hydraulic control;

Fourth, to provide a means of this class which is particularly simple yet sturdy of construction and readily installed;

Fifth, to provide a method of controlling well flow wherein a pair of concentric fluid conduits are so arranged that one forms a link in a hydraulic control and the other a means for discharging fluid from the well; and

Sixth, to provide on the whole a simple and efficient method of controlling well flow.

With these and other objects in view as may appear hereinafter, reference is made to the accompanying drawings, in which:

Figure 1 is a diagrammatical view of my means in its one form as it appears in a well showing the regulator therein and its control at the mouth of the well; Figure 2 is a longitudinal sectional view on an enlarged scale taken through 2—2 of Figure 1; Figure 3 is a diagrammatical view similar to Figure 1 showing a modified form of my means which is incorporated with a packer and utilizes the inner well casing as its control conduit; Figure 4 is an enlarged fragmentary sectional view of the coupling between the tubing string and packer taken through 4—4 of Figure 3; and Figure 5 is a further enlarged longitudinal sectional view of the regulator taken substantially through 5—5 of Figure 3.

Attention is first directed to Figures 1 and 2 which illustrate my well flow control means in its one form. In Figure 1 there is illustrated a conventional well casing 1 extending to a formation 2 and partly filled with liquid 3.

A regulator body 4 is suspended in the liquid from a pair of concentric tubing strings 5 and 6. These are illustrated as tapered strings, each increasing in capacity toward the top of the well.

The regulator body 4 is provided with a bore therethrough, the upper end 4d of which is screw-

threaded in part for connection with the outer tubing string 6. Below the upper end 4d, the bore forms a constriction 4c and again enlarges to form a receiving chamber 4b.

The upper end of the constriction 4c is threaded to receive a short connector tube 8 which extends upwardly into the upper end 4d of the regulator body bore and is flared to facilitate connection with the inner tubing string 5.

Below the receiving chamber, the bore of the regulator body is further enlarged to form a regulator chamber 4a and is closed at its lower end by a plug 7. A passage 4e extends along one side of the bore between the lower end of the regulator chamber 4a adjacent the plug 7 and the upper end 4d so that fluid from between the tubing strings 5 and 6 may enter the regulator chamber 4a.

The receiver chamber 4b is intersected by a plurality of radiating inlet ports 4f which are directed upwardly as well as radially inwardly and are relatively disposed axially to define a helix so that they may be closed successively. For this purpose, a double piston means 9, comprising a smaller piston 9a fitting the receiver chamber 4b, and a larger piston 9b fitting the chamber 4a is reciprocally mounted in the two chambers. A strong spring 10 bears between the shoulders formed between the two chambers and the larger piston to urge the piston means downwardly.

At the mouth of the well, the outer tubing string 6 is supported from the casing 1 by a plug 11, and is sealed around the inner tubing string 5 by a plug 12. A lateral pipe 13 leads from the tubing string 6 to a suitable hydraulic device 14 which may comprise a cylinder 14a in which is mounted a piston 14b controlled by a jack screw 14c.

My method of operation is as follows: The regulator body is lowered at the end of the outer tubing string 6 to the desired depth: Thereupon the inner tubing string 5 is positioned and secured to the connector tube 7 and the plug 11 is positioned. The space between the two tubing strings is filled with a suitable liquid so that the liquid enters the chamber 4a below the piston head 9b. By varying the pressure of the liquid the piston means 9 is caused to raise or lower to uncover the desired number of ports and thereby determine the amount of fluid from the well to be admitted to the inner tubing string 5.

Attention is now directed to Figures 3, 4 and 5 wherein my means is shown incorporated with a packer. In this arrangement a well bore is

shown with several sets of casings designated 21, 22 and 23. A single tubing string 24 supports a packer which is preferably a multiple ring packer and a special adaptation of the structure embodied in my patent for Packers, issued September 5, 1933; Patent Number 1,926,017.

The packer is provided with a central tube 25 which is specially constructed in this instance as will be brought out hereinafter. A spring cage 26 is slidably mounted on the tube 25, and arranged to engage the walls of the casing as the packer is run in. The cage 26 supports a plurality of upwardly directed yieldable hook arms 27 which fit around a cone 28 so that the hook arms may be moved into engagement with the walls of the casing. Suitable catch means are provided for securing the arms in a non-engaging position. Above the cone 28 are a plurality of expander rings 29 which receive packer rings 30 therebetween as to be expanded into fluid tight relation with the casing.

A special connector body 31 is provided above the uppermost expander ring 29. Said connector body is cylindrical in form with a conical valve face 31a at its lower end which seats against a coacting face provided in the upper and inner portion of the uppermost expander ring. The expander rings are spaced from the tube 25 as indicated by A, so that said valve face 31a controls flow of fluid between the upper and lower zones in the casing 23, designated B and C respectively, defined by the packer rings.

The upper end of the connector body 31 is provided with a socket 31b which receives the lower end of the tubing string 24. Said tubing string is provided with an end member 32. A collar 33 is secured to the connector body and surrounds the tubing string above the end member so that the tubing string has a limited sliding connection; key means being provided, however, to prevent relative rotation. The lower extremity of the end member 32 forms a valve which closes a plurality of by-passes 31c leading from the passage space A. Ports 31d are formed in the sidewalls of the socket 31b so that when the tubing string 24 is raised, communication is established between the zones B and C through passage A whereby the pressures may be equalized and the packer readily withdrawn. Once the packer is released further passages are formed between and around the several packer rings.

The tube 25 of the above described packer comprises an outer shell 25a and an inner shell 25b connected together at their ends to define therebetween an elongated annular space which is intersected by ports at its upper and lower extremities to form a passage 25c. The upper end of the tube 25 is secured within the connector body 31 with its interior communicating with the interior of the tubing string 24. The upper end of the passage 25c is disposed opposite a channel 31e formed within the connector body, said channel having ports 31f communicating with the zone C established by the packer. A sealing connection is provided between the tube and connector body on either side of the channel 31e so two independent passages communicating with the interior of the tubing string and zone C respectively extend through the packer.

The lower end of the tube 25 fits within the upper end of bore extending through a regulator body 34, similar in construction to the regulator body 4. The interior of the tube 25 communicates with a receiver chamber 34a constituting

the intermediate portion of the regulator body bore. Below the receiver chamber 34a, the bore is further enlarged forming a regulator chamber 34b, which is defined in part by a plug 35 closing the lower end of the regulator body. Said chambers receive a double piston means 36 similar to the piston means 9 and comprising a smaller piston 36a fitting the chamber 34a, and a larger piston 36b fitting the chamber 34b. A strong spring 37 fits within a socket 36c extending upwardly in the piston means 36 and urges the piston means upwardly.

The receiver chamber 34a is intersected by a plurality of ports 34c disposed helically or in any other axially off-set relation to be sequentially closed or opened as the piston 36a is moved up or down.

The portion of the regulator chamber 34b between the shoulders on the piston means and between the chambers 34a and 34b is intersected by a passage 34d extending along a side of the regulator body and turning in at its upper extremity to intersect a channel 34e surrounding the tube 25 opposite the lower end of the passage 25c therein. Suitable means are provided for sealing the tubing relative to the regulator body above and below the channel 34e.

The upper extremity of the inner casing 23 is closed by a plug 38 through which the tubing string 24 extends. A conduit 39 intersects the side of the casing 23 and leads to a hydraulic control device 40 as in the first described structure.

The method of operation involving the above structure is similar to the first arrangement. After the packer is set, the zone C of the casing is filled with liquid thereby filling the passage 25c, 34d and operating end of the regulator chamber 34b. The ports 34c are normally closed by action of the spring 37. Hydraulic pressure introduced through the zone C, passage 25c to the regulator chamber tends to open the ports against the action of the spring 37.

It should be noted here that either of the structures illustrated may be arranged to operate in the reverse order; that is, in the first structure, the spring 16 may be positioned to close the ports 4f and the controlling liquid introduced above the larger piston 9b; while in the second structure the spring 37 may open the ports and the controlling liquid introduced below the piston means 36.

It should be noted further that both of the structures herein described are particularly suitable for automatic control of the well flow by providing means for operating the hydraulic device 40 or 14 which is responsive to flow or pressure within the tubing string 24 or 5.

I claim:

1. In a flow regulating device for wells; a body member adapted to be lowered into a well hole; a hydraulic responsive regulating valve incorporated in said body member and arranged to admit various quantities of fluid from the well hole into the body member; a first conduit connected with said body member to transport fluid admitted by said valve means to the mouth of the well; a second conduit arranged for the most part, in substantially concentric relation with the first conduit and communicating with said regulating valve; and a hydraulic control means positioned externally of the well utilizing said second conduit for controlling said regulating valve.

2. A flow regulating device for wells comprising: a body member including, a chamber there-

in, and independent ports communicating with said chamber from the exterior of said body member; a pair of substantially concentric tubing strings adapted to form separate fluid channels from said body member to the top of said well one of said channels communicating with said chamber; a piston in said chamber adapted to open and close said ports; and hydraulic means operable from the mouth of said well through the other of said channels for actuating said piston.

3. A flow regulating device for wells comprising: a body member including, a chamber and ports communicating with said chamber from the exterior of said body member; a pair of substantially concentric tubing strings adapted to form separate fluid channels from said body member to the mouth of said well, one of said channels communicating with said chamber; a piston in said chamber adapted to open and close said ports; resilient means for urging said piston to movement in one direction; and hydraulic means, operable from the mouth of said well through the other of said channels for overbalancing the urge of said resilient means to actuate said piston in the opposite direction.

4. In a flow regulating device for wells: a packer arranged when set to separate a well casing into an upper and lower zone; a tubing string connected with said packer; means providing a pair of flow channels leading through said packer into said lower zone and communicating respectively with said tubing string and the upper zone of said well casing; a regulating valve communicating with one of said flow channels to admit various quantities of fluid from the lower zone therein; and a hydraulic means operable exteriorly of the well and utilizing the other of said flow channels for controlling said regulating valve.

5. In a flow regulating device for wells: a packer arranged when set to separate a well casing into an upper and lower zone; a tubing string connected with said packer; means providing a pair of flow channels leading through said packer into said lower zone and communicating respectively with said tubing string and the upper zone of said well casing; a regulating valve communicating with one of said flow channels to admit various quantities of fluid from the lower zone therein; a yieldable instrumentality for urging the regulating valve in one direction; and hydraulic means operable exteriorly of the well and utilizing the other of said flow channels for urging the regulating valve in the opposite direction.

6. In a means for controlling well flow: a bottom hole flow regulator comprising an inlet chamber having independent axially displaced inlet ports, valve means for progressively opening or closing said ports, and a hydraulic responsive instrumentality for controlling said valve means; a pair of fluid conduits extending from the mouth of the well and communicating with said regulator said conduits being in substantially concentric relation for approximately their full lengths, one of said conduits connected with said inlet chamber, the other with said instrumentality; means for varying the pressure in the conduit associated with said instrumentality and thereby control flow into said chamber and through the other conduit.

7. In a means for controlling well flow: a bottom hole flow regulating valve; a fluid responsive control mechanically associated with and positioned in proximity to said valve; a flow channel leading from said valve to the mouth of the well; and a fluid channel for introducing fluid pressure to said control disposed for the most part in substantially concentric relation with said flow channel and extending from said control to the mouth of the well.

8. In a means for controlling well flow; a bottom hole flow regulator; and a pair of substantially concentric conduits leading from said flow regulator to the mouth of the well; said flow regulator incorporating a valve means for admitting well fluid to one of said conduits, and control means responsive to the pressure of fluid in the other of said conduits and controllably connected with said valve to vary the quantity of well fluid admitted thereby.

9. In a means for controlling well flow: a casing and a tubing string therein forming therewith a pair of substantially concentric flow channels; a packer carried by said tubing string and adapted to seal the space between said tubing string and casing, said packer including a pair of conduits extending therethrough, one communicating with said tubing string and the other with said casing above the packer; a bottom hole flow regulator connected with both of said conduits and through said conduits with said tubing and casing; said flow regulator incorporating a valve means for admitting well fluid to one of said conduits, and control means responsive to the pressure of fluid in the other of said conduits and controllably connected with said valve to vary the quantity of well fluid admitted thereby.

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