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ART AND APPARATUS FOR SEALING OFF OIL WELLS

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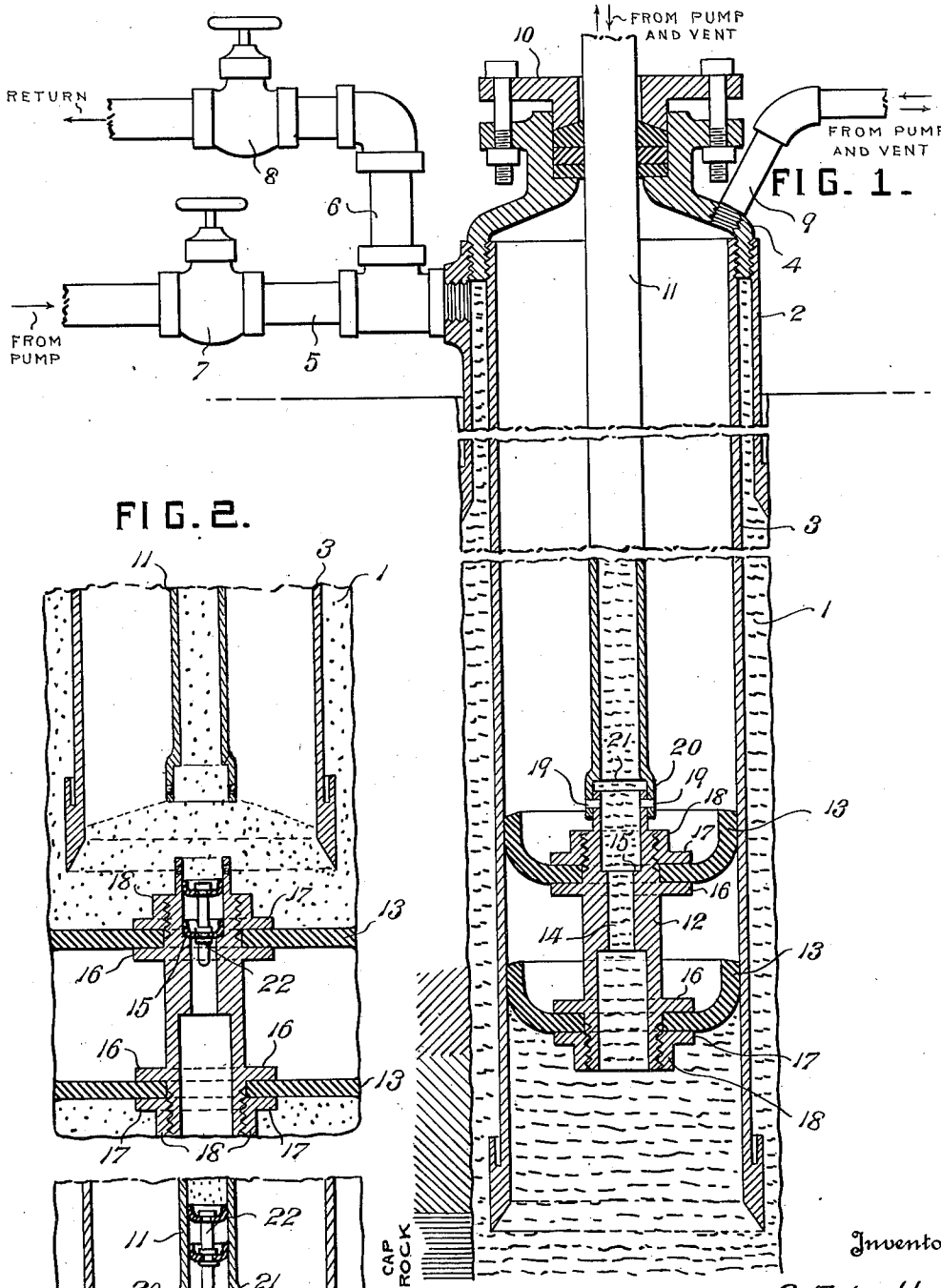



FIG. 1.

FIG. 2.



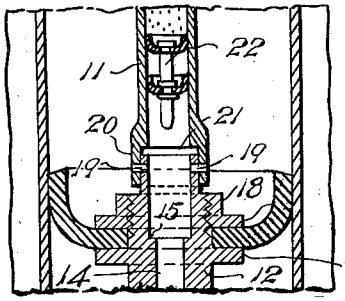


FIG. 3.

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# UNITED STATES PATENT OFFICE

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## ART AND APPARATUS FOR SEALING OFF OIL WELLS

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This invention relates to improvements in the art of values conservation in the treatment of oil and gas wells, and more particularly to the effective conditioning of the parts preparatory for cementing bottom areas of the well and including such cementing.

The essential object in view is the cementing of the well with maximum efficiency, and in a manner to effect dependable, superior results.

More specifically stated, my present invention is intended to overcome the difficulties which are now largely encountered in sealing wells, such as where circulation cannot be established outside of the well casing and where oil and gas are escaping from the sand in the bottom of the well up into the higher sands or porous strata, or again where water from the upper strata is passing down outside of the casing into the oil and gas sands, under which conditions present known methods have mostly failed. When a condition of this kind is encountered, it is difficult to place the cement in a body in the bottom of the well casing.

In some instances, it has been proposed to run a tube, acting as a tremmie pipe, to the bottom of the well, and then cement is forced down through the tubing, the tubing raised above the cement and then pressure applied.

However, the time of raising the tubing and getting a tight joint at the bradenhead so pressure may be applied is so great and the location of the cement at the bottom so uncertain that these processes amount to nothing more than guesswork regarding these important factors.

My aim is to eliminate the guesswork entirely, and this is done by the use of a special type of bottoming plug, the positioning of which as well as the casing in relation thereto assures the success of the sealing operation with the exclusion of deleterious action or substances from influencing or diluting the cement during delivery and setting thereof.

With these and other objects in view as will in part hereinafter become apparent and in part be stated, the invention comprises certain novel steps and combinations of steps of the art of well cementing, and certain novel structures and combinations of structures as hereinafter specified and claimed.

In the accompanying drawings,—

Figure 1 is a somewhat diagrammatic, sectional elevation of a well and equipment fragmentarily shown for the saving of space embodying the features of the present invention, the sealing plug being shown partly moved to its lowermost position.

Figure 2 is a view similar to Figure 1 of the bottom portions of the well with the parts in the final position for receiving cement.

Figure 3 is a fragmentary view of the plug and parts as the valve is approaching the plug to seal it.

Referring to the drawings by numerals, 1 indicates an oil or gas well having the usual outer tubing 2 at its upper portion, and the main casing 3 having the usual well space exteriorly of casing 3. A casing head 4 engages the upper end of casing 3 and tube 2, and communicates with a pipe 5 having a branch pipe 6, pipe 5 being valved at 7, and pipe 6 being valved at 8. Pipe 5 beyond valve 7 communicates with an appropriate pump, not illustrated, while pipe 6 beyond valve 8 discharges into the slush pit of mud fluid or other place of supply of circulating fluid. A fluid pressure pipe 9 communicates with casing head 4, and pipe 9 also communicates with a pump, not illustrated, and is preferably provided with a by-pass vent, not illustrated. The casing head 4 is also provided with an appropriate packing gland 10 through which extends the tremmie or drill pipe 11, which is connected with an appropriate pump, or source of pressure fluid, and is also vented as and when required, said pump and vent not being shown in the drawings.

All of the parts above referred to are of common and well known construction, and any conventional part may be utilized for any of such parts. It has heretofore been proposed, after the casing 3 has reached the required relation with respect to the cap rock and the oil sands or strata, to close or shut off the oil from the casing and then deliver cement to the bottom of the casing and upward outside the casing where the cement is allowed to set to seal the well against admis-

sion of deleterious and extraneous seepage from higher strata. Difficulty, however, has been experienced from various reasons, including the fact that such plugs as have been heretofore used, while sometimes closing off the oil, have not been successful in completely excluding rising gas. Gas finding its way into the unset cement and passing up through the cement both by agitation and dilution interferes with the setting and renders the cementing action negative or largely so, and in some instances the rising gas prevents setting and causes the cement to settle as a comminuted silt affording no protection.

The present invention overcomes these difficulties by providing an improved plug or closure for the well designed, adapted, and capable of excluding both oil and gas during the cementing operation, and the present invention also provides for certain steps or manipulative operation destined to assure maximum efficiency in the finished cement-sealed areas.

In the practicing of my invention, I first calculate the amount of cement which it is desired to place in the bottom of the hole and up around the outside of the casing. Thrs is then reduced to the number of cubic feet or gallons of cement which it is decided to use, and calculations are made of the number of feet of casing which will be required to hold the amount of cement decided upon at the bottom of the well. After these computations have been made, a sealing plug or the main part of such plug is attached to the tubing or tremmie pipe 11 and lowered inside the casing 3 until the bottom of the plug reaches approximately that position in the casing which is just above the calculated point to which the desired amount of cement will rise when put into the well. The plug itself may be constructed in any of numerous ways, but is characterized by being provided with a passageway communicating directly with the bore of the tremmie pipe 11. An acceptable embodiment of such plug is seen in the accompanying drawing in which embodiment the plug is shown to consist of an axially bored core 12 and flexible packings 13, 13. The bore of the core 12 is preferably reduced at 14 to provide a plug valve seat 15 below the upper end of the core for reasons hereinafter to be stated. The core 12 may be of any appropriate material adapted to be readily drilled out, such, for instance, as soft brass. The packings 13 may also be of appropriate flexible material, such as heavy rubber sheeting, rubberized canvas, or other appropriate webbing. Each packing 13 is anchored to the core 12 in any of various appropriate ways, as, for example, by the provision of a fixed flange 16 for each web 13, and a detachable flange 17 for clamping the web against the respective flange 16. Each flange 17 is preferably carried by an appropriate nut 18 threaded onto the respective end of the core 12 in position for clamping the respective web or packing 13 against its respective flange 16. The upwardly extending end portion of the core 12 extends into the lower end of tremmie pipe 11, and is secured thereto by shear pins 19, 19. When the reduced extension at the upper end of core 12 is of substantially the same size as the pipe 11, so as to present an axially located bore of equal dimension with pipe 11, the lower end portion of pipe 11 must be enlarged as indicated at 20, to enclose the said reduced portion of core 12.

After the tubing 11 has been lowered into the casing, as previously stated, with the plug 12 attached by the shear pins 19 or other breakable connections, the casing head is attached to the casing 3, with the tubing 11 passing through the packing gland 10 for making an air and liquid tight joint. A small plug valve 22 having flexible packing on the top is now placed in the tubing 11, after which fluid cement is pumped in on top of the plug 22, whereby the latter is forced down until it reaches the seat 15 in the core 12 or main part of plug. The passage through the core is thus closed. Continuation of the operation of forcing the cement into tube 11 shears the pins 19 holding the plug to the tubing, and drives the whole plug down ahead of the body of cement, the cement spreading out at the lower end of the tubing after the plug has been forced off. With the continuation of the pressure through the tubing 11, the cement is forced up around outside of pipe where it is desired to place it, thus placing the cement in the bottom of the casing in a body and in an uncontaminated state, and in a condition so that pressure applied to upper part of tubing forces the cement to its place with no danger whatever of the cement being left in the tubing and rendering it difficult to remove said tubing, as is the case where the tubing is placed at the bottom of the well and used as an ordinary tremmie pipe.

In conjunction with the foregoing method of emplacing the cement in a well, I may employ my special method of counterbalancing pressure which is disclosed and broadly claimed in my co-pending application. This is applied in a manner now to be set forth. The advancing of cement about the outside of casing 3, effecting as it does the displacement of mud fluid, or other liquid at the exterior of the casing, the overflow is permitted to escape through pipe 5 and through branch 6 with the valve 8 sufficiently nearly closed to substantially resist the advance of the fluid from the exterior portions of the well so as to resist the oncoming cement and thereby maintain the same compact and free from diluent. When the required quantity of cement has been delivered to cement the

exterior portions of the well at the bottom part thereof about casing 3 as required with a sufficient quantity to leave a plug or portion of cement within the lower end of casing 3 of adequate depth for the required purposes, the valve 8 is closed and valve 7 is opened and the pump with which pipe 11 communicates is started for creating and maintaining a reverse pressure equalizing the pressure within the tremmie pipe 11 and exerted on the inner end of the cement, and if any pressure losses occur from seepage or otherwise, the back pressure through pipe 5 is raised to compensate for such losses, so that an equalized or balanced pressure is maintained on the opposite ends of the cement and the cement is thereby permitted to set under the most favorable conditions incident to being subjected to compression.

It should be understood that the webs 13 are of such material and so dimensioned as to absolutely insure sealing contact with the surrounding walls of the lower portion of the well just beneath the lower end of casing 3, and to effect this result the packings or webs 13 are largely compressed while descending the casing 3 and expand to engagement with the well walls after passing the lower end of casing 3. The downward thrust pressure through the pipe 11 will be sufficient to assure firm seating of the plug and to cause the lower packing or web 13 to rest firmly on the oil sands of the well.

This method is also useful in cementing casing in wells drilled with cable tools, and in wells where ordinary methods of cementing as practiced in wells drilled by rotary drills are employed, carrying the cement to its place without contamination.

What is claimed is:—

1. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing while allowing liquid contained in the well casing to escape through the plug, locating the plug in sealing position with respect to the well, and delivering cement down upon the plug and past the lower end of the casing.

2. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing while allowing liquid contained in the well casing to escape through the plug, locating the plug in sealing position with respect to the well, sealing the plug against escape of liquid therethrough, and delivering cement down upon the plug and past the lower end of the casing.

3. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing while allowing liquid contained in the well casing to escape through the plug, locating the plug in sealing position with respect to the well, seating a valve closing the plug against escape of liquid, and delivering cement down upon the plug and past the lower end of the casing.

4. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing, employing a pipe in engagement with the plug to force the plug down the casing through applying pressure to dislodge the plug from the pipe, and discharging cement through the pipe down upon the plug and out beneath the lower end of the casing.

5. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing, employing a pipe in engagement with the plug to force the plug down the casing, flowing liquid from beneath the plug through the plug and up the pipe, and continuing the downward movement until the plug reaches substantially the bottom of the casing, thereafter dislodging the plug from the pipe by passing cement under pressure through the pipe, and discharging said cement down upon the plug and out beneath the lower end of the casing.

6. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing, employing a pipe in engagement with the plug to force the plug down the casing, flowing liquid from beneath the plug through the plug and up the pipe, and continuing the downward movement until the plug reaches substantially the bottom of the casing, sealing the plug against passage of liquid therethrough, delivering cement through said pipe under pressure to displace the plug therefrom, and thereafter flowing the cement upon the plug and about the lower end of the casing.

7. In the art of cementing oil and/or gas wells, passing a sealing plug down a well casing together with a tremmie pipe having a shear pin connection with said plug, moving the plug to a point adjacent well-sealing position by pressure exerted in said tremmie pipe, severing the connection between the plug and pipe by said pressure, and delivering cement upon the plug and about the lower end of the casing.

8. A sealing plug for oil and gas wells, comprising a core having a longitudinal bore, and packing outstanding from the core, the bore of the core being formed with a valve seat located to have the bore closed by a valve moving to said seat from above, the valve being movable through the core, and means to force cement through the core against the valve when seated to thus break the plug from said core.

9. In the art of cementing wells, the process which consists of emplacing a sealing plug in the well casing, mechanically moving the plug to a point of proper location in the casing whilst liquid below the plug passes above the same, then shutting off the liquid passage space of the plug through which said liquid passes, applying pressure to the

plug after the shutting off action aforesaid is completed to separate the plug from the mechanical means for locating it properly in the casing, and then forcing cement down upon the plug to eject the plug from the casing and cause the plug to act upon the cement to facilitate the passage of the cement to a point exterior to the casing.

In testimony whereof I affix my signature.

CHARLES F. LYTLE.