May 1, 1945. E. E. BYRD 2,374,922

METHOD OF COMPLETING WELLS

Filed Oct. 5, 1942 3 Sheets-Sheet 1

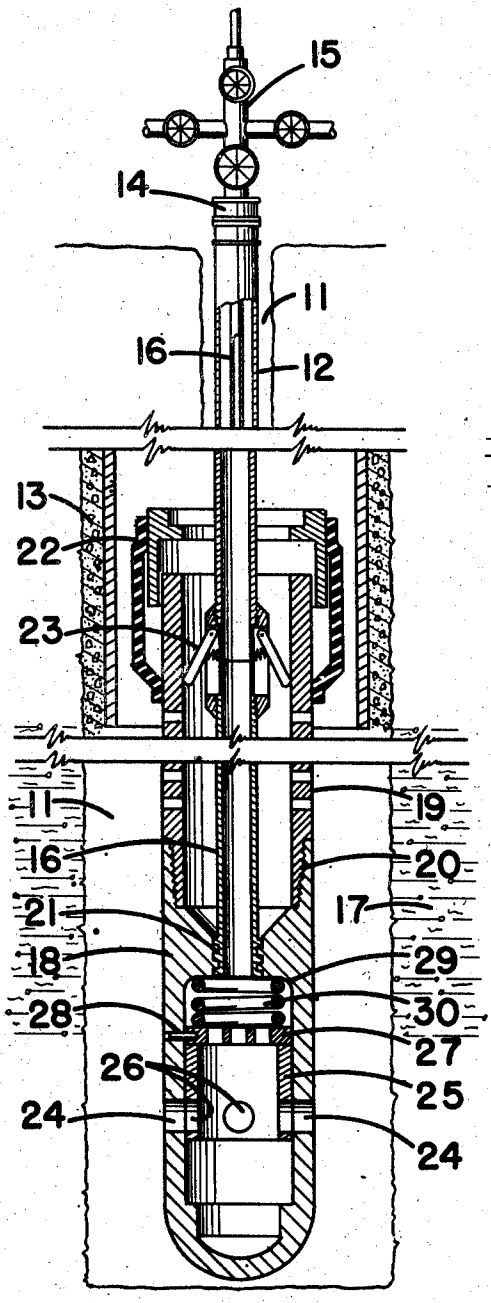

FIG. 1.

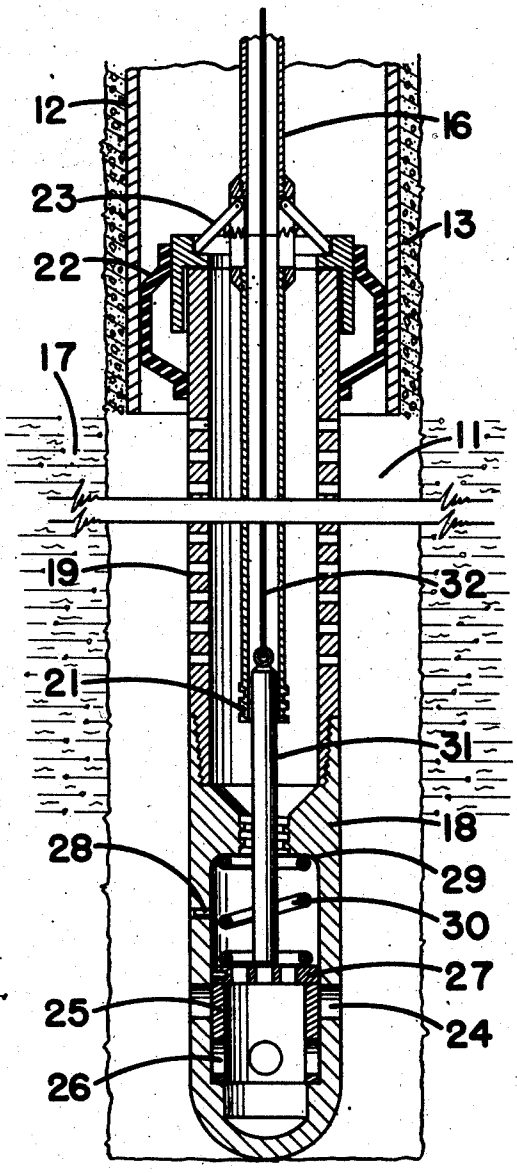

FIG. 2.

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METHOD OF COMPLETING WELLS

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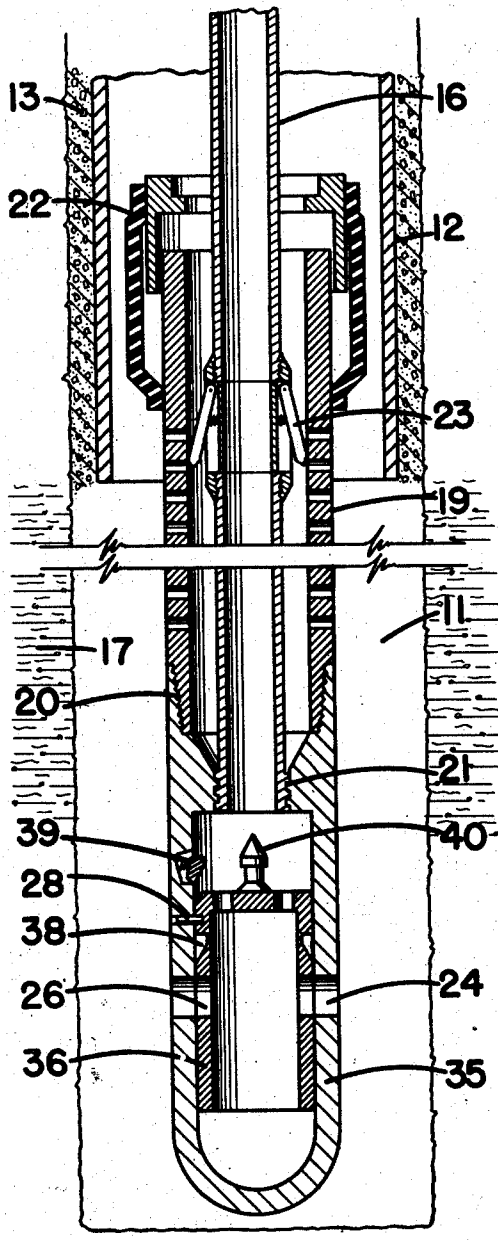

FIG. 3.

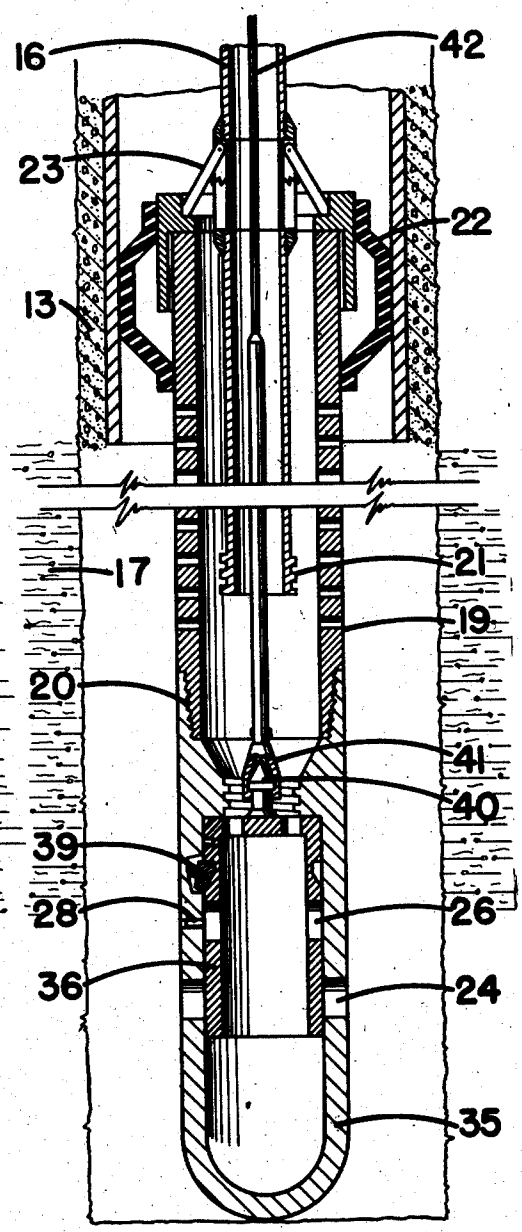

FIG. 4.

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METHOD OF COMPLETING WELLS

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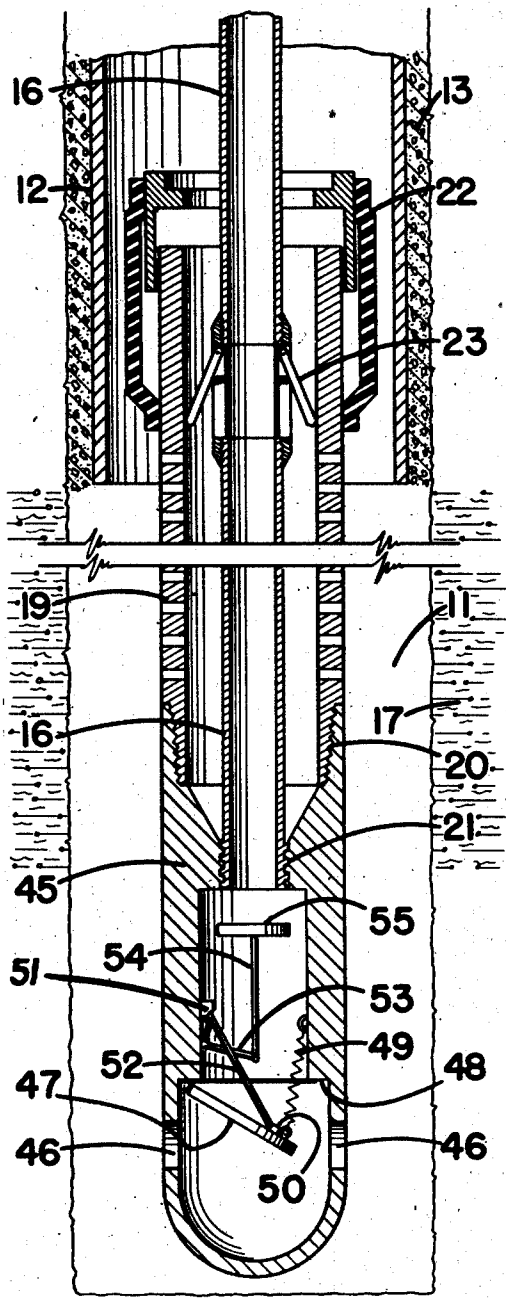

FIG. 5.

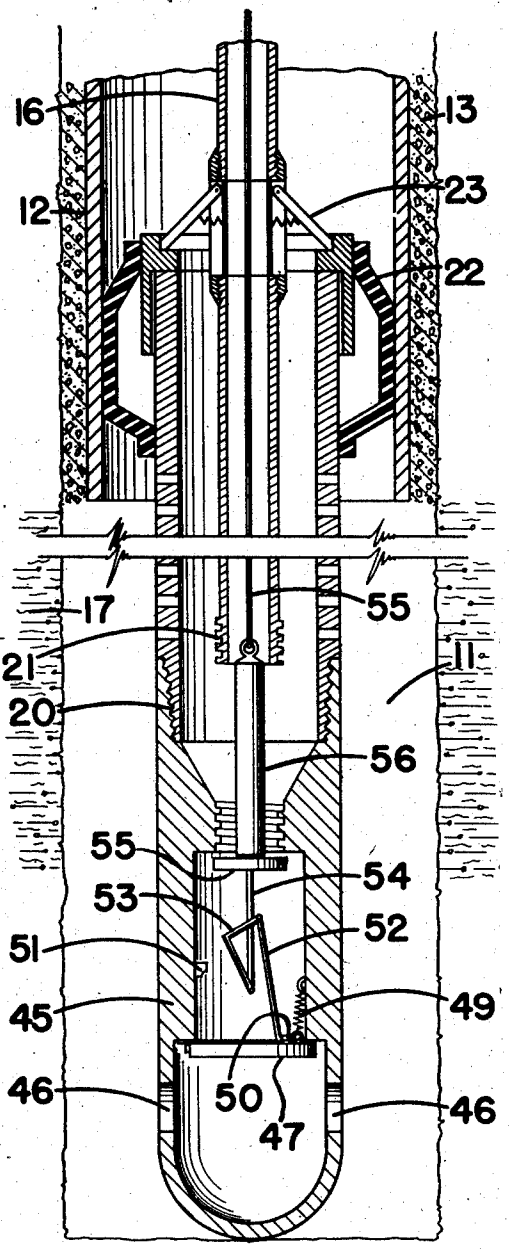

FIG. 6.

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UNITED STATES PATENT OFFICE

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METHOD OF COMPLETING WELLS

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Application October 5, 1942, Serial No. 460,749

2 Claims, (Cl. 166—21)

The present invention is directed to a method of completing wells, in which a screen or perforated liner is placed in the well adjacent a producing formation.

If the producing formation penetrated by a borehole is unconsolidated or incompetent, it is necessary, or at least very desirable, to place a screen or perforated liner in the well adjacent the producing formation. It is almost inevitable that foreign materials, such as cuttings, will be present in the borehole while the screen liner is being set and these foreign materials coat not only the surface of the producing formation but will be deposited on exterior of the screen in conventional completion operations.

The present invention is directed to a method of completing wells which ensures the removal of foreign material trapped in the annulus between the screen and the wall of the well before production of fluid through the screen is initiated.

The method of the present invention may be practiced with a variety of borehole equipment. In the drawing, several embodiments of suitable equipment are illustrated. It will be apparent, however, that the method of the present invention is not necessarily limited to the use of the specific equipment shown, but, rather, the devices illustrated are typical. Undoubtedly workmen skilled in the art will be able to design other equipment capable of being used in performing the method of the present invention.

In the drawings,

Fig. 1 illustrates an arrangement suitable for the practice of the present invention, with the device in position for bypassing the screen liner in cleaning foreign matter from the annulus between the screen and the wall of the borehole;

Fig. 2 is a fragmentary view of the arrangement shown in Fig. 1 with the device manipulated to close the bypass and bring fluid from the producing formation through the screen;

Fig. 3 is a fragmentary view illustrating another apparatus suitable for use in practicing the present invention adjusted to bypass the screen;

Fig. 4 illustrates the same embodiment set to allow fluid flow through the screen;

Fig. 5 illustrates another type of apparatus arranged to bypass fluid from a producing formation around a screen liner; and

Fig. 6 shows the arrangement of Fig. 5 with the bypass closed.

Referring now specifically to the drawings, and first to Figs. 1 and 2, a borehole 11 is provided with a casing 12 cemented at its lower end with cement plug 13 and with tubing hanger 14 and christmas tree 15. Arranged within the well and supported by hanger 14 is tubing 16.

In the lower portion of the well adjacent producing formation 17 is an assembly comprising shoe 18 secured to the lower end of a screen 19 by mating screw threads 20. This assembly is attached to the lower end of tubing 16 for lowering into the borehole by suitable means, such as left hand threads 21. The upper end of the screen is provided with a suitable packer 22 and secured to the tubing for operating the packer is setting tool 23. The packer and setting tool are conventional to the art and, accordingly, will not be described in detail. It is believed that the operation of this portion of the equipment will be obvious from the subsequent description.

The wall of shoe 18 is pierced by ports 24. Slidingly arranged within the shoe is a slide valve 25 of general cylindrical shape provided with ports 26 mating with those in the shoe. A circular perforated plate 27 is secured to the upper portion of cylindrical member 25 to form a unitary member.

Shear pin 28 extends through a suitable opening in the wall of shoe 18 into a corresponding opening in the wall of cylindrical member 25 to hold the sleeve valve in open position with ports 24, 26 coinciding, while the device is being lowered into the borehole and foreign matter is being removed therefrom prior to the employment of the screen for production. The upper end of shoe 18 is provided with a suitable interior ledge 29, and retained between ledge 29 and the upper surface of member 25 is a coil spring 30 biasing the slide valve downwardly.

In completing a well the screen, shoe, and tubing will be arranged in the lower portion of the borehole in the manner illustrated in Fig. 1. Tubing 16 will then be released from the screen and shoe assembly by resting the shoe on the bottom and rotating the tubing to the right to release left-hand thread 21. The tubing will then be withdrawn so that setting tool 23 will engage packer 22 and the weight of the tubing then employed to set packer 22. With these preliminary steps completed, flow of fluid will be initiated by swabbing tubing 16 or equivalent manipulation. The procedure of swabbing to bring in a well is, of course, conventional to the art.

The flow initiated will come through side ports 24, 26, thus bypassing the screen 19. This step of flowing fluid from the producing zone through ports 24, 26 will be continued until foreign bodies from the annular space between the wall of the

hole and plugging agents deposited on the face of the producing formation during the drilling of the well are carried out of the borehole. With the well arranged as above described, fluid flow will be possible through screen 19 in addition to flow through ports 24, 26. However, the resistance to flow of fluid by the screen will be greater than flow through the ports and substantially all of the flow will be through ports 24, 26. Accordingly, the foreign matter present in the annulus between the screen assembly and the wall of the borehole and plugging agents from the face of the producing formation will be carried through ports 24, 26 and upwardly out of the hole, and little or no material will be carried under pressure against the exterior wall of the screen.

After the flow has been continued at such a rate and for such a period of time as to remove foreign material from the bottom of the well, the slide valve may be closed and production brought through screen 19. The closing of the valve is accomplished by shearing pin 28. The valve in closed position is illustrated in Fig. 2. In this figure also is shown tripping weight 31 suspended by wire line 32. The dropping of weight 31 on plate 27 shears pin 28 whereupon prompt closing of the valve is insured by the action of spring 30. It is convenient to attach the tripping weight to a wire line to withdraw it from the borehole, but this is unnecessary and, if desired, a weight may be dropped down the tubing to shear the pin 28 and allowed to remain in shoe 18. Upon the closing of ports 24, 26 flow of fluid is diverted through screen 19, and the well is then allowed to produce in the conventional manner.

A modification of apparatus suitable for performing the steps described above is illustrated in Figs. 3 and 4. In this embodiment, shoe 35 is provided with side port 24. Within the shoe is slidably arranged cylindrical member 36 provided with port 26. These two members are held in position by shear pin 28. Near the upper end of member 36 is a circular groove 38. A suitable spring-actuated catch 39 is arranged in the interior wall of the shoe to engage groove 38 when member 36 is moved into an upward position to close ports 24. Member 36 is provided with a suitable spearhead 40 arranged for engaging a conventional fishing tool.

The shoe illustrated in Fig. 3 is attached to a string of tubing and to a well screen in the same manner as that shown in Figs. 1 and 2, and the same manipulative steps are employed when using this device until it is desired to close the side ports 24. When this stage of the manipulation is reached, a suitable grappling means is lowered on a wire line to engage spearhead 40. An upward pull of the wire line then raises member 36 to close ports 24 and the engagement of catch 39 with groove 38 retains the assembly in this position. The device for manipulation to close ports 24 is illustrated in Fig. 4 with a grappling tool 41 engaging spearhead 40 and secured to wire line 42.

Still another embodiment suitable for practicing the present invention is illustrated in the fragmentary views of Figs. 5 and 6. This device is used in the same manner as that illustrated in the preceding figures. Shoe 45 is provided at its lower end with side ports 46, and a slight distance upwardly a hinged trap door 47 is arranged to cooperate with ledge 48 to form a fluid-tight seal. During the washing operation the trap door is open, as in Fig. 5, and when the washing operation is completed the trap door may be closed, as in Fig. 6. A spring 49 is attached both to the trap door and the shoe to bias the door in a closed position. A suitable trigger arrangement is provided for retaining the door in open position during the washing operation, and for closing the door at the option of the operator. Such a suitable arrangement is shown in the drawing comprising lug 50 attached to door 47, ledge 51 secured to the wall of the casing shoe, member 52 fitting between the ledge and lug, bent lever 53 pivoted to the upper end of member 52, and member 54 extending upwardly, with its upper end secured to circular member 55. When it is desired to operate the trigger to release the trap door a suitable means, such as body 56, may be lowered on line 57 to drive circular piece 55 downwardly, which, in turn, operates the trigger to force the upper end of member 52 out of contact with ledge 51. The device with the door in closed position is illustrated in Fig. 6.

From the above description it will be evident that various types of apparatus may be employed in performing the manipulative steps of the present invention. It is accordingly my intention not to be restricted to any particular apparatus but to claim, instead, a method of completing wells wherein foreign matter is cleaned out of the hole after the screen is in position. The manipulative steps make available a substantial velocity of fluid flow for cleaning the face of the producing formation and the lower part of the borehole without the deposition of these foreign materials on the screen, with resulting clogging of this member.

Having fully described and illustrated the practice of the present invention, what I desire to claim is:

1. A method of completing wells, comprising the steps of arranging a screen in the well adjacent a producing formation, packing off the annular space between the screen and the face of the producing formation from the remainder of the well, flowing fluid from said packed off annular space while by-passing said screen until substantially all foreign material has been removed from the face of the producing formation and the bottom of the borehole, and subsequently producing said well only from said packed off space through said screen without disturbing said screen.

2. In the completion of a well wherein a screen is arranged in said well adjacent a producing formation, the steps of packing off the annular space between the screen and the face of the producing formation from the remainder of the well, bypassing said screen to flow liquid from said packed off annular space to the surface of the earth through ports of substantially less resistance to flow than said screen, continuing said flow until the face of the producing formation and the packed off annular space between the face of the hole and screen is substantially free of foreign matter, and subsequently changing the direction of flow to produce all fluid from said packed off annular space through said screen without disturbing said screen.

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