May 27, 1952 H. F. CYPHER 2,598,512

METHOD FOR RUNNING A LINER IN FLOWING GAS WELLS

Filed Feb. 28, 1947 2 SHEETS—SHEET 1

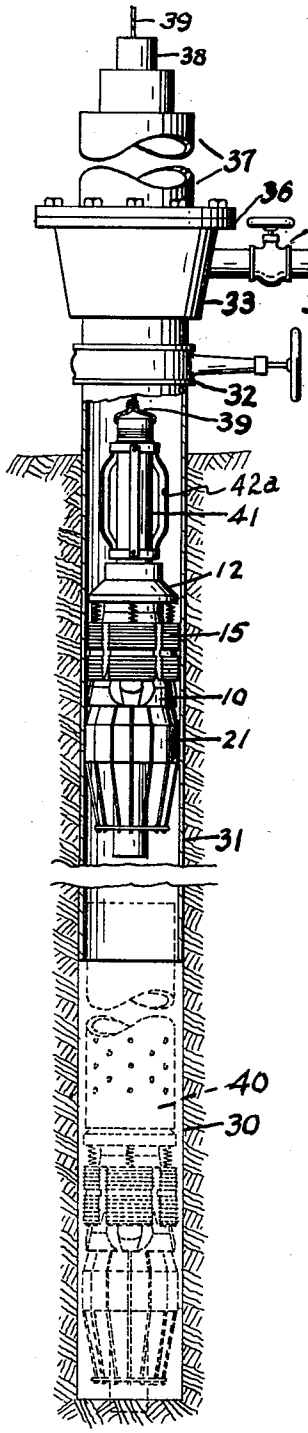


Fig. 1.

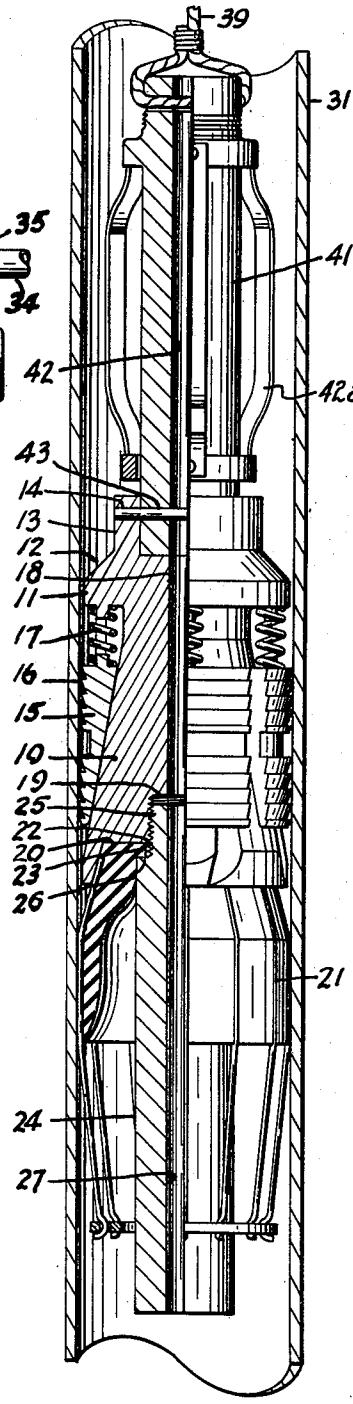


Fig. 2.

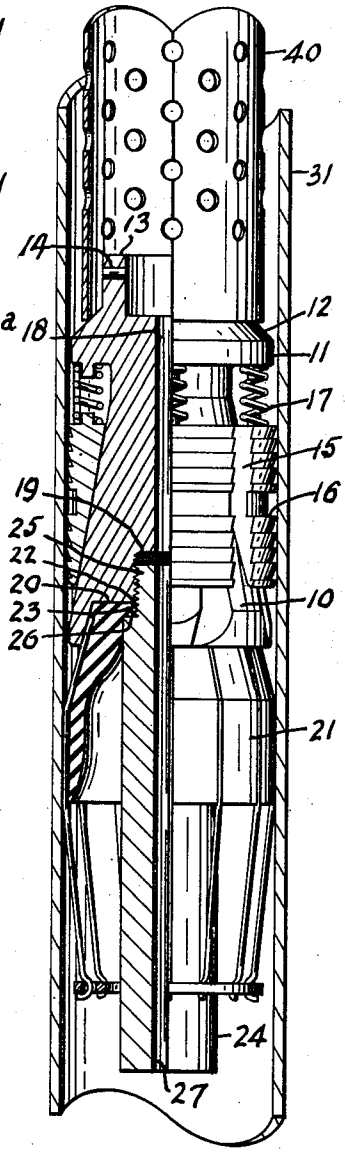


Fig. 3.

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METHOD FOR RUNNING A LINER IN FLOWING GAS WELLS

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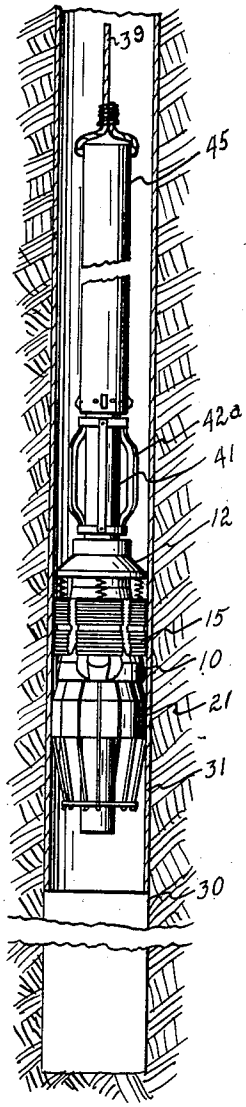


Fig. 4.

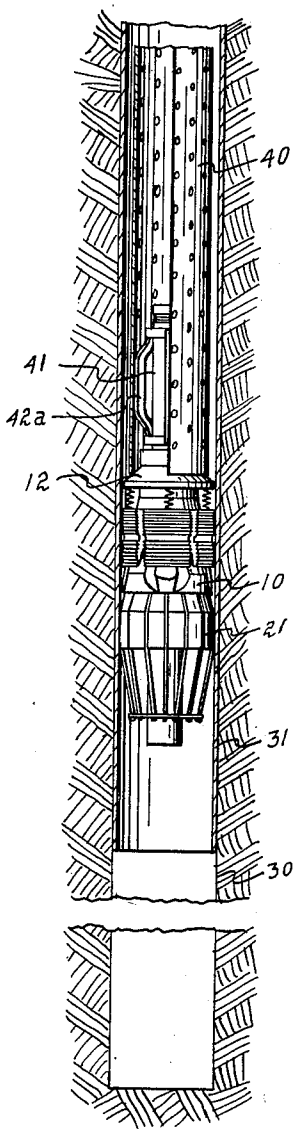


Fig. 5.

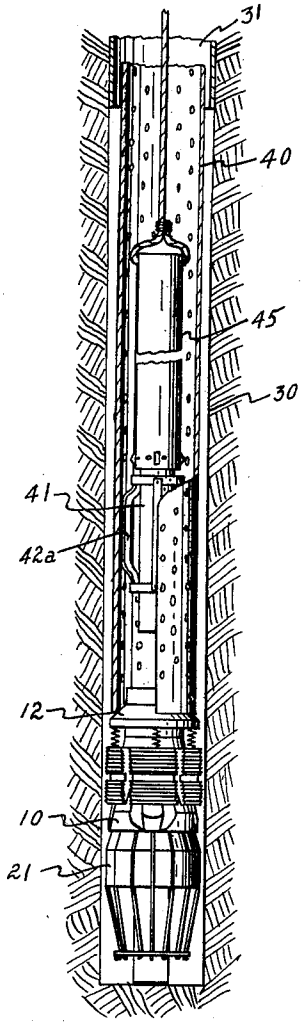


Fig. 6.

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UNITED STATES PATENT OFFICE

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METHOD FOR RUNNING A LINER IN FLOWING GAS WELLS

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2 Claims. (Cl. 166—21)

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This invention relates to a method of running a liner in a flowing gas well.

In many cases gas wells have been completed for production from open producing formations, that is, the portion of the bore hole opposite the producing formation is not lined with perforated casing. As a result, the flow of gas, particularly when in large volume and under high pressure, will, if no corrective steps are taken, often cause caving of the sand, shale, or other material comprising the producing formation into the well bore which may completely shut off the flow of gas or reduce it greatly. In such cases it is often desirable or necessary to insert a perforated liner inside the well bore opposite the producing formation to support the latter against caving while permitting relatively free flow of the gas into the well.

Heretofore, when it became necessary to insert a liner in such a producing gas well, it was necessary to "kill" the well, as by pumping heavy mud into the well in order to shut off the flow of gas to allow the performance of the operations necessary to insert the liner. This was a relatively costly, time consuming and generally unsatisfactory arrangement, and since the mud fluid sealed the pores of the producing formation, it was often difficult to bring the well back into satisfactory production.

The method, in accordance with the present invention, employs novel steps and apparatus designed to shut-off and control the flow of gas in a manner which will permit the ready insertion of a liner without the necessity for killing the well with mud fluid, to thereby avoid the disadvantages of more conventional methods.

Accordingly, a principal object of this invention is the provision of an improved method for running a liner in a flowing gas well.

An important object is to provide a plugging device which is insertable in a well casing and which is operative to shut off the major portion of the gas flowing from a well to permit running a liner therein without killing the well.

Another important object is the provision of a choke plug which is adapted to be set in place by a pressure differential created thereby within the well.

Other and more specific objects and advantages of this invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate one useful embodiment in accordance with this invention.

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In the drawings:

Fig. 1 is a sectional elevation through a well showing the positions therein of the apparatus during different stages in a liner-setting operation;

Fig. 2 is an enlarged quarter-sectional operation of the plugging device showing the details thereof when in the plugging position;

Fig. 3 is a view similar to Fig. 2 showing the relationship of the plugging device and a liner at one stage in the liner setting operation; and

Figs. 4, 5 and 6, are views illustrating several stages in another embodiment of a liner setting operation in accordance with this invention.

Referring to the drawings, and to Figs. 2 and 3 in particular, a form of device particularly adapted for use in the method of this invention comprises an upwardly tapering generally conical body 10 the upper end of which is provided with a laterally extending annular flange 11, the upper surface of which is upwardly and inwardly tapered to form a conical seat 12 which surrounds a tubular boss 13 extending vertically above seat 12. Registering holes 14—14 (only one shown) extend through opposite sides of boss 13. A plurality of angularly spaced, pipe gripping slips 15 are slidably mounted on the conical surface of body 10 and have upwardly directed teeth 16 on their outer surfaces. A plurality of coil springs 17 are held in compression between the upper ends of slips 15 and the under surface of flange 11 whereby they tend to force slips 15 downwardly and outwardly relative to the sloping surface of body 10. The latter is provided with an axial passageway 18 of relatively small diameter, the lower end of which is counter-bored to form a socket 19 which is internally threaded. The lower end of body 10 is further counterbored to form an annular seat 20. A conventional generally tubular swab or packer cup 21, constructed of rubber or other resilient rubberlike materials, has its upper end seated in seat 20 and its open end downwardly directed. The upper end of cup 21 is provided with a central opening 22 of slightly greater diameter than socket 19, the inner edge of opening 22 forming a lip 23. The wall of cup 21 decreases in thickness toward its lower end terminating in a thin outwardly flaring edge. A tubular nipple 24 has one end portion 25 reduced in diameter to form an annular shoulder 26, the reduced portion 25 being externally threaded for reception in socket 19. Shoulder 26 is adapted to grip lip 23 by compression against seat 20 when nipple 24 is inserted through swab cup 21 and end portion 25 is

screwed into socket 19, to thereby hold swab cup 21 tightly in place against the lower end of body 10. Nipple 24 has a central passageway 27 which registers with passageway 11 in body 10.

The above described device is employed for setting a liner in a flowing gas well in the following manner: Referring to Fig. 1, a well 30 has its bore conventionally lined with a casing 31 to a point somewhere above the gas producing formation therein, the unlined portion of the well bore containing the gas-producing formation being often several hundred feet in length. The upper end of casing 31 will normally be conventionally equipped with a master gate valve 32 and a casing head 33 having an outlet pipe 34 equipped with a valve 35. The top of casing head 33 is provided with a flange 36 for the tight connection thereto of a conventional hollow lubricator 37, the upper end of which is closed by the usual oil-saver 38 which forms a stuffing box for a wire line 39 conventionally employed for running tools into a well.

It will be assumed that it is desired to run about 500 feet of perforated liner 40 in the well. The plugging device in accordance with this invention will be connected to a suitable hollow tool 41, having an axial passageway 42 therethrough, and provided on the exterior thereof with a plurality of radially extending bow springs 42*a*, by inserting the end of the tool into boss 13 and passing a soft metal shear pin 43 through holes 14 and a suitable opening in the end of the tool. The upper end of tool 41 will be tied to the lower end of wire line 39, and this spring of tools will first be suspended in lubricator 37 in the conventional manner. Master gate valve 32 and valve 35 will both be closed at this stage of operations and the lower end of lubricator 37 will be bolted to the top of the casing head. Master gate valve 32 will now be opened allowing the gas in the well to enter the casing head and lubricating and equalize the pressure throughout this closed system. The plugging device will now be lowered by means of line 39 into the well to a depth somewhat greater than the length of liner to be set in the well. By virtue of the open passageways 27, 18 and 42, and the equalized pressure in the casing, the tools may be lowered through the casing without resistance except for the nominal frictional resistance of slips 15 and swab cup 21 on the casing wall, but this resistance will be overcome by the weight of the tools.

When the plugging device has reached the desired depth, valve 35 will be opened and the gas in the upper portion of casing 31 vented to the open air. This will immediately reduce the pressure above the plugging device and create a very substantial pressure differential across the tool due to the restricted area of the passageways through the tools. The higher pressure gas below the plugging device will now act against the interior of swab cup expanding the latter into tight sealing engagement against the casing wall while, at the same time driving body 10 of the plugging device in the upward direction. This movement aided by the opposing pressure of coil springs 17 against slips 15 will drive the teeth of the latter into gripping engagement with the casing wall, thereby setting the plugging device solidly in the casing. A sharp upward pull applied to line 39 will break shear pin 43 and tool 41 will now be drawn back up into lubricator 37, leaving the plugging device set in the well. The lubricator, containing tool 41 will now be removed from the casing head, leaving the top of the well open. While some gas will now continue to flow from the hole, the volume and pressure thereof will be relatively small, due to the restriction in flow by the limited area of the passageways through the plugging device and the relatively large open area of the casing section above the plugging device. This volume and pressure will be insufficient to interfere with the subsequent operations for running liner 40. The latter will now be inserted into the well through the open end of the casing head, using conventional liner running tools, until the desired length of liner has been run into the well. Next, a conventional liner setter (not shown), or other conventional tool, which is attached to the tool string in the lubricator, will be connected to the upper end of the liner and lubricator 37 will be re-attached to the top of the casing head. The liner will now be lowered a sufficient distance in casing 30 until the lower end of the liner comes to rest on conical seat 12 of the plugging device (see Fig. 3). Valve 35 will now again be closed and the pressure above the plugging device will again be allowed to equalize with that below the device, whereby the force tending to force slips 15 and swab cup 21 into tight engagement with the casing wall will be relieved. With this pressure relieved, the weight of liner 40 will be sufficient to push the plugging device downwardly in the well as the liner is lowered therein and when the plugging device reaches the open hole portion of the well it will fall to the bottom of the well out of the way of the descending liner which will be lowered to the desired point in the well and set therein by conventional means. The setting tool will then be released from the upper end of the liner in a conventional manner and withdrawn into the lubricator. Master gate valve 32 can then be closed, shutting in the well until the usual well head connections are replaced on the casing head, after which the well can be put back on production in the usual manner.

A modification of the liner setting method in accordance with this invention is illustrated particularly in Figs. 4, 5 and 6. In this modification, the tool string connected to line 39, will include a releasable tool 45, such as a conventional over-shot setting tool, which is releasably connected to the upper end of tool 41, the latter being connected to the plugging device by means of shear pin 43 in the manner previously described. This string of tools is lowered into the well casing and the plugging device set therein in the manner previously described (see Fig. 4). Thereupon, setting tool 45 will be released in any suitable or conventional manner from its attachment to tool 41 and withdrawn from the well, leaving tool 41 connected to the plugging device by means of shear pin 43. (See Fig. 5.) Liner 40 is then run into the well in the manner previously described, and is set down on seat 12. Tool 41 will enter the lower end of liner 40 as the latter is lowered on to seat 12, and bow springs 42*a* will frictionally engage the inner wall of liner 40 (see Fig. 5). When the pressure in casing 31 is equalized to release the plugging device, in the manner previously described and liner 40 is subsequently lowered to push the plugging device ahead of it as the liner descends to the depth at which it is to be set, the engagement of tool 41 with the liner will hold the plugging device in place in the end of the liner and will prevent its coming loose and lodging cross-wise in the well so as to stop passage of the liner into the well. When the plugging device reaches the bottom of the well, the liner setting tool is re-

leased from the liner and withdrawn from the well. Thereafter, releasable tool **45** or a similar tool, will be run on line **39** through lubricator **37** and down into the well through the interior of liner **40** and will be hooked on to the upper end of tool **41** (see Fig. 6). An upward strain will then be taken on line **39** sufficient to break shear pin **43**, whereby tool **41** will be released from the plugging device and withdrawn from the well through the interior of liner **40** (Fig. 6).

It will be understood that various changes and alterations may be made in the details of the method steps in accordance with this invention without departing from the scope of the appended claims but within the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. The method of running a liner into a flowing gas well, comprising, inserting into a gas well while under full pressure of the gas a plugging device expandible into sealing engagement with said well in response to a differential pressure across the plugging device to thereby shut off the major portion of the gas flow from the upper portion of the well above said plugging device, releasing gas from said upper portion to establish said differential pressure across said plugging device to thereby effect said shut-off, thereafter introducing a liner into said upper portion of said well, then equalizing the gas pressure across said plugging device, to thereby release said sealing engagement of the plugging device with the well, and lowering the liner to displace the plugging device downwardly to permit the liner to attain the desired depth in the well.

2. The method of running a liner into a flowing gas wall, comprising, inserting into the casing of a gas well while under full pressure of the gas a plugging device releasably connected to a lowering line, said plugging device being expandible into sealing engagement with said casing in response to a differential pressure across said plugging device to thereby shut off the major portion of the gas flow from the upper portion of said casing above said plugging device, releasing gas from said upper portion of the casing to establish said differential pressure across said plugging device to thereby effect said shut off, releasing said lowering line from the plugging device, withdrawing said lowering line from the well, introducing a liner into said upper portion of said casing, releasably connecting said lowering line to the upper end of said liner, closing in the upper end of said casing to equalize the gas pressure therein across said plugging device to thereby release said sealing engagement of the plugging device with said casing, lowering said liner on said lowering line to displace the plugging member downwardly to permit the liner to attain the desired depth in the well, and releasing said lowering line from the liner for withdrawal from the well.

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