Dec. 26, 1950 E. L. AHLGREN 2,535,342

FORMATION TESTER

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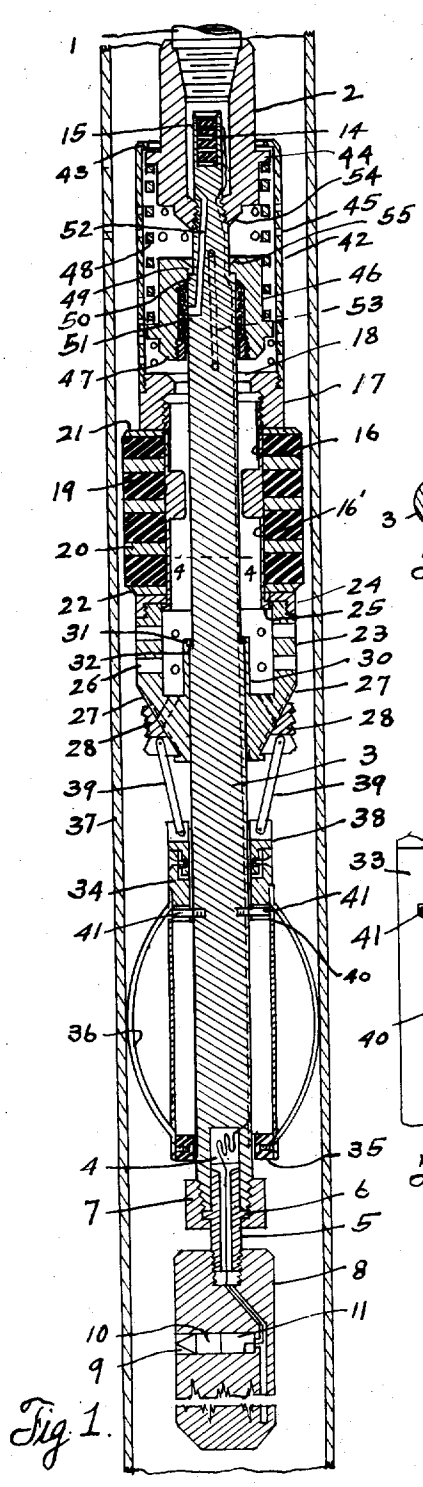


Fig. 1.

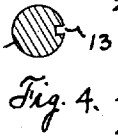


Fig. 4.

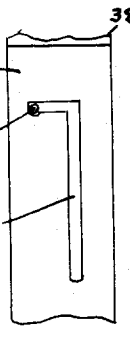


Fig. 3.

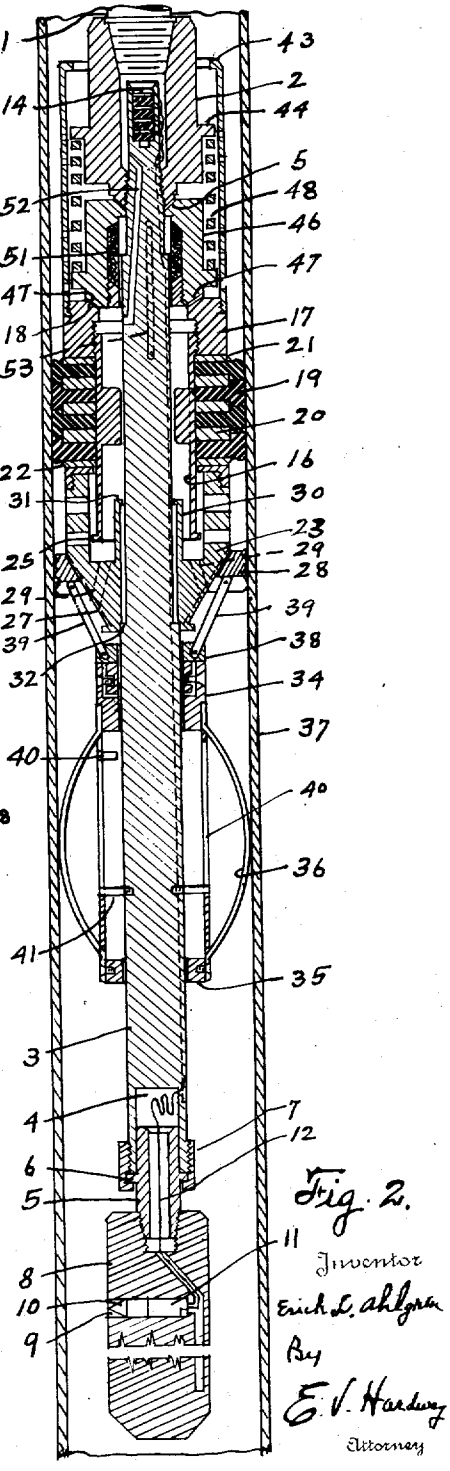


Fig. 2.

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FORMATION TESTER

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3 Claims. (Cl. 166—12)

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This invention relates to a formation tester.

An object of the invention is to provide a formation tester of the character described specially designed for use in connection with a gun unit so that the gun unit and tester may be lowered into a well and the casing perforated so as to allow fluid from the surrounding formation to enter the casing and be collected by and entrapped in a chamber within the tester.

Another object of the invention is to provide a formation tester of the character described embodying a novel type of valve assembly whereby the sample chamber in the operating string of pipe will be normally closed at its lower end, with means for equalizing the pressure above and beneath the valve of said assembly so as to facilitate the movement of the valve to closed position after a sample of the formation has been taken.

The combined gun and tester are of such construction that the various formations at different elevations may be tested without removing the tool from the well.

With the above and other objects in view the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings, wherein:

Figure 1 shows a vertical, sectional view of the combined gun and tester showing the packer collapsed and the sample chamber closed.

Figure 2 shows a vertical, sectional view showing the packer expanded and the sample chamber open to receive the sample.

Figure 3 shows a fragmentary, side elevation taken at right angles to the view shown in Figure 1; and

Figure 4 shows a cross sectional view taken on the line 4—4 of Figure 1.

Referring now more particularly to the drawings wherein like numerals of reference designate the same parts in each of the figures, the numeral 1 designates a tubular operating string of pipe which extends to the ground surface and which contains a sample chamber.

Attached to the lower end of the string of pipe there is a special coupling 2. The numeral 3 designates a cylindrical rod or bar of solid metal whose upper end is screwed into the lower end of the coupling 2 and extends on up into said coupling, said bar forming the mandrel of the testing tool.

The lower end of the bar 3 has a deep socket 4 into which the upper end of the nipple 5 is fitted. This nipple has an external annular flange 6 and a clamp nut 7 is fitted over the lower end of the nipple and screwed onto the lower end of the bar 3 and clamps the nipple in place. The nipple forms a connection for the well shooting gun 8 to the bar 3. This gun may be of any conventional construction having a plurality of radial bores as 9, only one being shown, wherein is located the projectile 10. Behind each projectile there is an explosive charge 11 through which the electrical conductor 12 extends, there being an electrical conductor for each projectile charge. These conductors extend upwardly within a groove 13 in the bar 3 and are connected at their upper ends to separate contact plates 14 located in the housing 15 into which the upper end of the bar is formed. These contact plates are insulated from said bar and from each other. The charges may be fired by suitable mechanism that may be lowered through the operating string 1 such as disclosed in my copending application, Serial No. 549,074 filed August 11, 1944, now Patent No. 2,396,768, granted March 19, 1946.

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Around, and spaced outwardly from, the bar 3 there is a tubular packer support 16 providing a passage 16' through the packer and threaded onto the upper end of the tubular support 16 there is the tubular packer expander 17 whose upper end is formed with an upwardly flared valve seat 18. Around the packer support there is a packer formed of rings 19 of resilient material which are arranged alternately with respect to metal rings 20 and this packer is embraced by the upper and lower end plates 21, 22 which also surround the packer support 16. The packer expander 17 abuts the upper plate 21 and beneath the lower plate there is a jaw expander 23 slidably connected with the packer support and onto the upper end of which is screwed a flange nut 24 which abuts the lower plate 22 and through which the packer support extends. The lower end of the packer support 16 has an outwardly turned flange 25 which is beneath and engages with the inwardly turned flange of the nut 24 so as to interlock the jaw expander 23 with the packer support 16.

The expander 23 is hollow and is provided with the inlet ports 26 and its lower end has the downwardly tapering faces 27 on which the casing engaging jaws 28 are mounted to slide, said jaws having a dovetailed connection with their corresponding faces. The jaw expander 23 also has the ducts 29 leading from beneath the expander into the interior passage 16' thereof. The jaw expander 23 has an internal tubular skirt 30 which closely surrounds the bar 3 and whose upper end has an internal annular flange 31 which is engageable with an external upwardly facing shoulder 32 on said bar 3 so as to limit the downward movement of the expander 23 relative to said bar.

Surrounding the bar 3 beneath the jaw expander there is a tubular frame 33 having the upper and lower inside rings 34 and 35 secured

thereto and to which the upper and lower ends of the outwardly bowed springs 36 are attached. These springs are in yieldable and frictional engagement with the well casing 37 when the tool is in the well.

There is an anchor ring 38 which has a swiveling connection with the ring 34. Links 39 are pivoted at their lower ends to the ring 38 and at their upper ends to the corresponding jaws 28.

The frame 33 has inverted J-slots 40. The upper ends of these slots are turned to the left, as shown in Figure 3 and there are the pins 41 whose inner ends are attached to the bar 3 and whose outer ends project through the slots 40. When the frame 33 is in its lower position, relative to the bar 1, as shown in Figure 1, the pins 41 will rest in the laterally turned ends of the J-slots 40, as shown in Figure 3, so as to hold said frame in said lower position and this will hold the jaws 28 in their lower position on the expander 23 and said jaws will thus be also in their inner position out of contact with the casing 37 with the flange 31 resting on the shoulder 32.

There is a tubular valve housing 42 whose lower end is screwed onto the upper end of the expander 17 and whose upper end has an inwardly turned flange 43 which is engageable with an external annular flange 44 on the coupling 2. The valve housing 42 is provided with perforations 45 and within said housing there is a valve body 46 whose lower end is formed into a valve 47 arranged to seat on the seat 18; also within the housing 42 there is a coil spring 48 which is interposed between the flange 44 and the valve body 46.

The upper end of the valve body 46 has an internal annular flange 49 which is engageable with an external upwardly facing shoulder 50 on the bar 3 and housed within the valve body 46 is a suitable seal ring 51 which closely surrounds the bar 3.

There is a duct 52 through the upper end of the bar 3 whose upper end leads from the cavity within the coupling 2 and whose lower end leads outwardly through the bar and is closed by the seal ring 51 when the valve body 46 is in its upper position, as shown in Figure 1. Within the bar 3 there is also a duct 53 whose upper and lower ends lead outwardly through the bar and communicate with the interior of the valve housing 42 above and beneath the valve body, as shown in Figure 1, when the valve 47 is open and the lower end of the duct 52 is closed, as shown in Figure 1. This duct 53 allows pressure of the liquid in the casing to equalize above and beneath the valve body when it is attempted to lift the valve 47 off of the seat 18, as will be more specifically explained hereinafter.

In operation the tool is assembled and let down into the well, as shown in Figure 1. The valve housing 42 will rest on the flange 44, the valve body 46 will rest on the shoulder 50 and the jaw expander 23 will rest on the shoulder 32 while the tool is being lowered and the pins 41 will be engaged in the laterally turned ends of the J-slots 40, as shown in Figure 3, to hold the casing engaging jaws 28 in their lower retracted position, as shown in Figure 1. The packer will be collapsed while the parts are in said positions. When a position has been reached in the well where it is desired to perforate and test, the operating string 1 and bar 3 may be turned to carry the pins 41 out of the laterally turned ends of the J-slots 40 but the frame 33 will be held stationary by the springs 36. Thereupon the operating string and bar 3 may be lowered relative to the frame 33 and jaws 28 into the position shown in Figure 2, the expander 23 expanding the jaws 28 into engagement with the casing 37 and these jaws being outwardly toothed, as shown, will take hold of said casing and will stop the further downward movement of the expander 23 and the packing supported thereupon. Upon further downward movement of the operating string the lower end of the coupling 2 will engage the upper end of the valve body 46 carrying the lower end of the duct 52 beneath said valve body 46 and also moving the valve body downwardly until the valve 47 seats on the seat 18 and upon further downward movement the expander 17 will be moved downwardly applying an endwise compressive force to the packer to expand it outwardly against the casing 37, as shown in Figure 2 so as to form a fluid tight seal to seal off the formation being tested from the drilling fluid in the casing above the packer. Thereupon the gun may be fired in any preferred manner or in the manner explained in my co-pending application above referred to and the casing will be perforated opposite the formation to be tested. Fluid from the formation will then flow into the casing and up through the ducts 29 and on up through the packer support 16 by way of the passage 16' and through the duct 52 and on up through the coupling 2 into the operating string and thence to the ground surface if there is sufficient well pressure. When a sample has flowed into the operating string 1 said string, and the bar 3, may be elevated. Upon such elevation the lower end of the duct 52 will be carried up into the valve body 46 and thus closed and the sample entrapped. This will also carry the upper end of the duct 53 above the valve body 46 so that the pressure of the liquid in the casing will be equalized above and beneath the valve body 46 so that upon engagement of the shoulder 50 with the shoulder 49 the valve 47 may be easily lifted from its seat 18. The flange 44 will also engage with the flange 43 thus relieving the packer of the compressive force thereon and permitting said packer to collapse and the flange 25 will engage the nut 24 and the shoulder 32 will engage the flange 31 and elevate the jaw expander 23 thus releasing the casing engaging jaws from the casing. The bar 3 may then be turned to the right to carry the pins 41 into the laterally extended ends of the slots 40 and the tool may then be lowered or elevated and again operated, if desired, or withdrawn from the well.

In order to prevent the valve body 46 from moving upwardly while the tool is being lowered into the well or is being relocated in the well, and thus opening the lower end of the duct 52 the spring 48 has been provided which holds the valve body in its lower position relative to the mandrel 3 so as to maintain said duct closed, as shown in Figure 1.

The lower end of the coupling 2 is downwardly and inwardly tapered so that when the tool is in position to take a test, as shown in Figure 2, this downwardly tapered portion 54 will seat in a correspondingly tapered seat 55 in the upper end of the valve body 46 so that the duct 53 will at this time be closed to prevent the entrance, through said duct, of the drilling fluid above.

What I claim is:

1. In a tester for wells, a bar, tubular means for connecting the upper end of the bar to a tubular operating string and communicating therewith, a jaw expander around and slidable on the bar,

means on the bar for supporting the jaw expander for limited downward movement relative to the bar, casing engaging jaws on and surrounding the bar, means frictionally engageable with a surrounding casing releasably connecting the jaws to the bar in retracted position, said jaws being engaged and expanded into engagement with the casing by said jaw expander upon release of said jaw connecting means and downward movement of the bar and jaw expander relative to the jaws, an annular packer assembly including an annular packer around the bar and supported by the jaw expander, an annular packer expander around the bar on the packer assembly and having an upwardly facing valve seat, said packer assembly and expander having a passageway therethrough with an opening in each expander through which fluid may flow from beneath upwardly through them around the bar, a valve around, and slidable on, the bar above the packer expander, means on the bar for supporting the valve in a lower position on the bar spaced above the packer expander seat, said bar having a main duct with its lower end leading from an opening in the outside surface on the bar below said tubular means and upper end opening into said tubular means connected into said string, the lower end of said main duct being closed by said valve when the valve is in said lower position and said bar having a by-pass duct whose ends terminate above and beneath said valve, respectively, when the valve is in said lower position, yieldable means surrounding said bar and engaging and urging the valve downwardly on the bar, the valve being movable downwardly by said bar into contact with the valve seat on said packer expander, to close the opening in said packer expander and expand the packer assembly, said bar being movable further downwardly relative to said valve to carry the lower end of the main duct beneath the valve and into communication with said passageway and to carry the upper end of the by-pass duct within said valve to close the upper end of said by-pass duct.

2. In a tester for wells, a bar, tubular means for connecting the upper end of the bar to a tubular operating string and communicating with said string, a tapered jaw expander around the bar and slidable relative thereto, means on the bar for supporting the jaw expander for limited downward movement relative to the bar, casing engaging jaws movably supported on said jaw expander, means frictionally engageable with a surrounding casing releasably connecting the jaws to the bar in retracted position, said jaws being engaged and expanded into engagement with the casing by said jaw expander upon downward movement of the bar and jaw expander relative to the jaws, an annular packer assembly including an annular packer around the bar and movably supported thereon, an annular packer expander around the bar on the packer assembly and having an upwardly facing valve seat, said packer assembly having a passageway therethrough through which fluid may flow from beneath upwardly around the bar, a valve around, and slidable on, the bar above the packer expander, means for supporting the valve on the bar in a position spaced above the packer expander and out of engagement with said valve seat, said bar having a duct with its lower end leading from an opening in the outside surface of the bar below said tubular means and whose upper end opens into said tubular means, the lower end of said duct being closed by said valve when the valve is in said spaced position, yieldable means surrounding said bar and engaging and urging the valve downwardly on the bar, the valve being movable downwardly by said bar into contact with the valve seat on the packer expander to close the passageway in said packer and to expand the packer, said bar being movable further downwardly relative to said valve to carry the lower end of the duct beneath the valve and into communication with said passageway.

3. In a tester for wells, a tubular operating string adapted to be lowered into a well, a bar, tubular means for connecting the upper end of the bar to said string and communicating therewith, a packer assembly slidable on the bar and having a passageway therethrough through which fluid may flow from beneath upwardly around said bar, said packer assembly comprising a tubular packer around the bar, and upper tubular packer expander around the bar above the packer, and a lower tubular expander around the bar beneath the packer and engageable by said bar for movement therewith, said lower expander having downwardly tapering faces at its lower end, casing engaging jaws mounted on said lower expander for sliding movement relative to said tapering faces, resilient means slidably carried on said bar below said lower expander and frictionally engageable with said casing, link means operatively connecting said jaws and said resilient means, for moving said jaws outwardly along said tapering faces into engagement with a surrounding casing upon downward movement of said bar, releasable means connecting said resilient means with said bar for movement therewith to retain said jaws in retracted position, an upwardly facing valve seat on said upper packer expander, a valve around and slidable on the bar above the upper expander for movement into and out of engagement with said valve seat, means on the bar for supporting the valve out of engagement with said valve seat, said bar having a main duct with its lower end leading from an opening in the outside surface of the bar below said tubular means and whose upper end opens into said tubular means connected into said string, the lower end of said main duct being closed by said valve when said valve is supported by said supporting means out of engagement with said valve seat, and said bar having a by-pass duct whose ends terminate above and beneath said valve, respectively, when the valve is out of engagement with the valve seat, yieldable means surrounding said bar and engaging and urging the valve downwardly on the bar, the valve being movable downwardly by said bar and said bar being movable further downwardly relative to said valve after the valve engages said seat to carry the lower end of the main duct beneath the valve and into communication with said passageway and to carry the upper end of the by-pass duct within said valve to close the upper end of said by-pass duct.

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