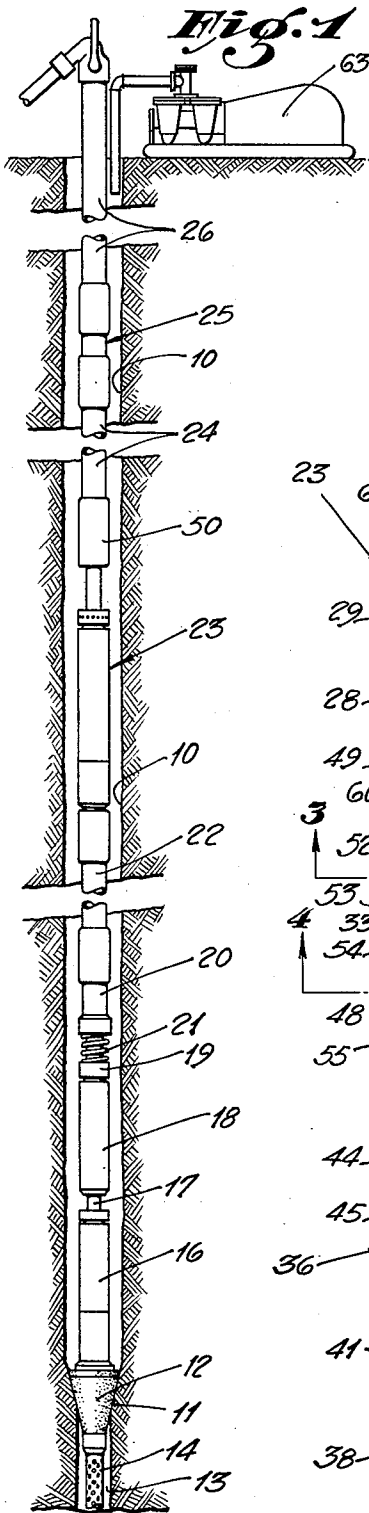
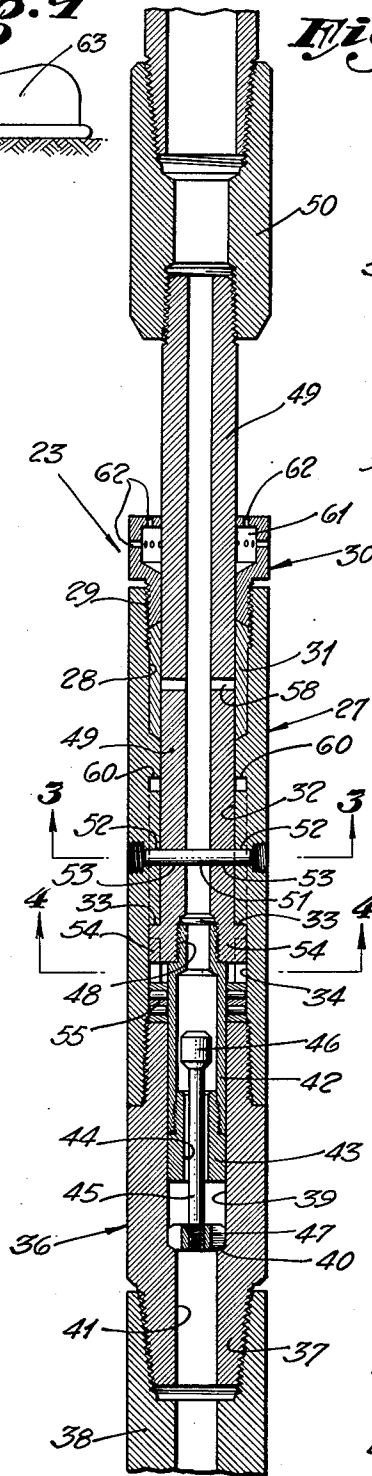
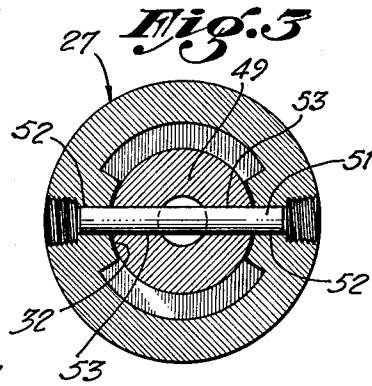
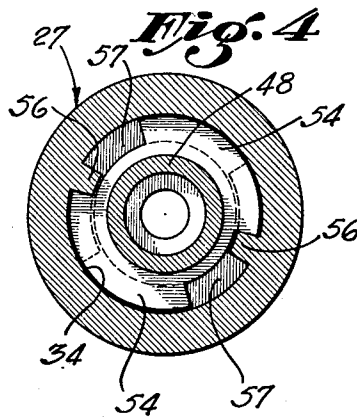


Dec. 28, 1943.

M. O. JOHNSTON
MEANS OF TESTING WELLS

2,337,752

Filed Dec. 16, 1940



MORDICA O. JOHNSTON,
INVENTOR:
BY *James M. Abbott*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,337,752

MEANS OF TESTING WELLS

Mordica O. Johnston, Glendale, Calif.

Application December 16, 1940, Serial No. 370,329

1 Claim. (Cl. 166—1)

This invention relates to oil field practice and particularly pertains to a means of testing a well.

At present it is common practice in oil well drilling to test the formation being penetrated by the well bore. This is usually accomplished by running a string of drill pipe into the well, at the lower end of which is mounted a testing tool which includes a packer and a valve adapted to be manipulated to establish communication between the string of pipe and the zone in the well below the shoulder upon which the packer is seated, and after which the valve may be closed to remove the column of connate fluid which has been yielded by the formation and which has accumulated within the string of pipe. This operation is carried out when the well bore is filled with the drilling fluid used in the well. It will be evident that when the packer is set at the bottom of the well the length of open drilled hole occurring below the packer will be filled with the drilling fluid. This fluid will rise through the tester when the valve is open and will be lifted in the drill string by the column of connate fluid yielded from the formation and which will pass upwardly to a column height as created by the fluid pressure in the formation. It will be evident therefore that when the tester valve is closed after a test has been made the column of fluid trapped within the string of pipe, and commonly called the sample, may be stratified with a portion of its length being composed of the drilling mud. The presence of this stratum of drilling mud within the sample chamber will produce contamination of the sample, thus while the general character of the connate fluid may be ascertained from the entrapped sample and the fluid yield may be indicated by the height of the column of fluid within the drill stem, it is evident that due to the contamination of the sample the quality of the sample cannot be ascertained with certainty. This is objectionable and highly dangerous due to the fact that the fluids which spill onto the derrick floor when the joints are broken may be combustible and may result in the starting of damaging fires. Furthermore, it is evident that these mixed fluids will drain into the supply of circulating mud, and since the circulating mud is expensive it is desirable that it shall not be contaminated. It is the principal object of the present invention, therefore, to provide means for obtaining an uncontaminated sample of well fluid of known quantity and to remove the other mixed fluids from the drill string acting as a sample chamber so that there will not be any

danger of fire or undue contamination of the stock of drilling fluid.

It also occurs in making tests, as heretofore explained, that the sample chamber within the drill string may on different occasions be filled with a fluid sample varying in height; thus in running the string of drill pipe out of the well caution must be taken each time a drill pipe joint is broken to ascertain when the top of the column of fluid sample has been reached so that it may be examined, and for the further reason that when a joint is broken below the accumulation of fluid in the drill string a "wet job" is pulled so that liquid drains from the broken joint and splatters all over the well rig and the drilling crew.

The present invention contemplates means for testing a well which involves the use of a well testing tool supported by a tubular string of drill pipe and carrying a packer and a valve by which a testing zone may be created in a well bore and after which the valve may be manipulated to permit an inflow of connate fluid from the testing area and the subsequent entrapment of the fluid within the supporting string of pipe, said structure also carrying a valve within the string of pipe at a predetermined point above the testing tool and by which the length of pipe above the last named valve may be drained to insure the recovery of an uncontaminated fluid sample beneath the two valves, while handling the fluids in a manner to prevent possible combustion and fluid contamination.

The invention is illustrated by way of example in the accompanying drawing, in which:

Figure 1 is a view in section and elevation showing the assembled structure of the structure embodying the present invention.

Fig. 2 is an enlarged view in vertical section showing the novel circulating valve.

Fig. 3 is an enlarged view in transverse section through the circulating valve showing the temporary locking means.

Fig. 4 is an enlarged view in transverse section through the circulating valve showing the key members disposed between the mandrel assembly and the barrel.

Referring more particularly to Figure 1 of the drawing, a structure is shown with which the present invention is practised. Here it will be seen that a well bore 10 is formed with a shoulder 11 adjacent to its lower end to receive a packer 12. Below the shoulder is a confined testing area 13 into which a perforated nipple 14 extends. The packer as here indicated is a

rathole packer and is part of a tester assembly embodying the structural details of a tester generally indicated at 15 and disclosed in U. S. Patent No. 2,073,107 issued to Mordica O. Johnston on March 9, 1937. In this structure an equalizer valve 16 is mounted directly above the packer and is connected by a tubular connection 17 to the main valve housing 18. The valve within this housing opens when a test is to be made and is closed to entrap the test. The main valve is mounted upon a tubular mandrel 19 which extends upwardly from the main valve housing and reciprocates therein. The upper end of the tubular mandrel connects with a coupling collar 20. Interposed between the coupling collar and the main valve housing is an expansion spring 21 which normally maintains the main valve on its seat. A suitable length of drill string 22 is disposed above the coupling 20 and represents the length of the column of fluid sample which is to be recovered. This length may be, for example, 200 feet. Directly above this length of drill pipe is a circulating valve assembly 23 with which the present invention is particularly involved. A suitable length of drill string 24 is disposed above the circulating valve assembly 23 and connects to the housing 25 of a trip valve structure, which valve is opened when a go-devil is dropped through the supporting length of drill string 26.

The circulating valve is shown in detail in Fig. 2 of the drawing. Here it will be seen to comprise a main cylindrical barrel 27 formed with a counterbore 28 at its upper end. This counterbore is internally threaded at 29 to receive the threaded extension of a packing nut 30. Within the counterbore and below the threaded extension of the packing nut packing 31 is placed. The main central bore 32 of the barrel 27 extends from the counterbore 28 downwardly to a shoulder 33. A counterbore 34 occurs at the lower end of the barrel and is threaded at 35 to receive a sub 36, the lower end of which carries a threaded pin 37 which enters the box 38 of the tool. The sub 36 is formed with a main central bore 39, the lower end of which terminates with a shoulder 40. A smaller bore 41 continues through the sub. Slidably mounted within the bore 39 is a valve sleeve 42, the lower end of which carries a threaded tubular valve seat 43. This seat has a lower diameter substantially agreeing with that of the outside diameter of the sleeve 42 so that the sleeve and the seat have a sliding fit within the bore 39. A central bore is formed through the valve seat 43 and receives the stem 45 of a movable valve element 46. The movable valve element is in the form of an enlarged head portion upon the stem 45 and when in register with the valve seat prevents the downward passage of the fluid through the bore 44. It is to be understood that the diameter of the stem 45 is sufficiently less than the diameter of the bore 44 as to permit the passage of fluid through the bore and along the stem. A guide spider 47 is secured at the lower end of the stem and in the locked position of the mandrel rests upon the shoulder 40 at the bottom of the bore 39. This spider also may be lifted to encounter the lower end of the valve seat 43 in the event sufficient fluid pressure is exerted upwardly against it.

The upper end of the valve sleeve 42 is restricted, as indicated at 48, and is threaded into the lower end of a tubular mandrel 49. The upper end of the mandrel 49 is connected to a

coupling collar 50 which in turn is secured by a tool joint to the length of drill string 24. It is to be understood that the barrel 27 and the mandrel 49 with the valve sleeve 42 have reciprocating motion with relation to each other. These elements are however temporarily locked together by a shear pin 51 which extends through radial openings 52 in the barrel 27 and similar openings 53 in the mandrel. The lower end of the mandrel is fitted with enlarged head segments 54 which slide in the bore 34 of the barrel in the space between the shoulder 33 in the barrel and a lower bearing assembly 55. Extending inwardly within the bore 34 are radial keys 56 against which the head segments 54 bear while the shear pin is in its locking position. Formed longitudinally and diametrically of the bore 32 in the barrel are a pair of arcuate keyways 57 which will accommodate the segment portions 54 of the mandrel and will permit the mandrel to be raised with relation to the barrel after the shearing operation has taken place. Attention is directed to the fact that a space occurs within the bore 34 and between the lower end of the mandrel 49 and the bearing assembly 55, this space being sufficient to allow a downward movement of the mandrel within the barrel to sever the shear pin 52 when desired. Formed through the mandrel at a point in its length are ports 58. These ports are normally closed and sealed by the packing 31 within the counterbore 28 of the barrel. The length of the segmental keyways 57 are such as to insure that when the mandrel is raised within the barrel until the shoulders 59 of the case 54 encounter a shoulder 60 at the end of the keyways 57 the ports will register with a chamber 61 within the packing nut 30. A plurality of openings 62 are formed through the wall of the packing nut so that fluid may be discharged from the ports 58 into the chamber 61 of the packing nut and from thence outwardly through the openings 62.

In the operation of the present invention the structure is assembled as shown in Fig. 1 of the drawing. The circulating valve unit is disposed at a desired height above the testing tool 15 as represented by the length of the string of drill pipe 22. This length is selected by the operator in an estimation based upon a probable height at which the sample fluid will be elevated in the drill string by pressure conditions existing in the testing area 13 and which would cause the mud fluid from this area and the connate fluid from the formation to rise in the drill string 22 to a point above the position at which the circulating valve is positioned and to a level above that at which the trip valve 25 is positioned. It is also to be pointed out in this connection that when lowering a drill string carrying the apparatus indicated in Fig. 1 into a well of appreciable depth the pressure exerted by the column of fluid standing in the well may be sufficient to collapse an empty string of drill pipe. Under such conditions it often occurs that the operator fills the drill string with fluid or oil from the closed testing valve in the tester 15 to the trip valve 25. This fluid does not represent a test and should be evacuated from the drill string as well as the drilling fluid which has entered the testing column from beneath the packer 12 when the valve of the testing tool 15 is opened.

When the assembled structure shown in Fig. 1 is lowered into the well it is understood that the valve of the testing tool 15 is closed, and that the circulating valve 23 is in the closed and

locked position shown in Fig. 2 of the drawing. Of course, the trip valve 25 is closed also. The structure shown in Fig. 1 is lowered into the well through the column of fluid standing in the well. The packer 12 is set on the shoulder 11 and seals off the testing area 13. The weight of the drill string upon the spring 21 will open the tester and establish communication through the tester and the packer to the string of pipe 12. In the event that the string of pipe is loaded with fluid up to the level of the trip valve 25 when it is lowered into the well, it is evident that nothing will happen. During this time the shear pin 51 is holding the mandrel 49 and the barrel 27 of the circulating valve in the position shown in Fig. 2, where it will be seen that the valve element 56 is positively held off of the valve seat 43 and the ports 58 are closed within the barrel. After sufficient weight has been imposed upon the testing tool 15 to open the main valve therein but not sufficient weight to shear the pin 51 in the circulating valve, the trip valve 25 is opened. In the type of trip valve here shown the valve remains open after it has been opened by the dropping of a go-devil. The connate fluid from the formation represented by the testing area 13 is then free to rise through the main valve of the tester and upwardly through the bore 44 of the valve seat 43 in the circulating valve structure 23 and through the trip valve 25 to a height in the drill string representing a fluid head comparable with the fluid pressure in the testing area. It will be evident that any liquid which may have been placed in the drill string below the trip valve 25 "to load" it while lowering into the well and the first liquid discharged from the testing area 13 will be elevated in the drill string 26, after which the connate fluid from the formation in the testing area 13 will rise through the tester, the circulating valve structure and the trip valve. When the test has been completed, as judged by the fact that there is no further increase in the fluid column within the drill string, additional weight may be imposed upon the structure by the drill string, at which time the force exerted upon the mandrel 49 of the circulating valve will shear the shear pin 51 as the lower end of the mandrel moves down in the space 34 within the barrel and rests upon the bearing structure 55. After the shearing operation the segments 54 of the head on the mandrel may be rotated to register with the longitudinal arcuate keyways 57. The mandrel may then be raised. When it is raised the valve seat 43 will be drawn upwardly to engage the under face of the valve head 46. This will close the passageway 44 to prevent down-flow of fluid and will of course isolate the column of liquid standing in the section of drill string 22 and above the valve of the tester which is now closed. Further upward movement of the mandrel will cause the mandrel ports 58 to register with the chamber 61 in the packing nut 30. The passageway in the mandrel will then be in communication with the fluid column within the well bore. A mud pump 63 at the top of the well may then be set in motion to force fluid downwardly around the drill string 26. The drilling fluid may then be forced inwardly through the ports 62 of the packing nut 30, and then from the chamber 61 through the ports 58 and into the drill string. This will cause the fluid in the drill string above the level of the ports 58 to be elevated as the drill string fills with drilling fluid from the well and until the material is forced outwardly through the grief

stem of the swivel head. The fluid is then conducted to the mud pits, or if contaminated is thrown away. This circulation is continued until the fluid flows clear at the point of discharge. It will be evident that during this time the valve head 46 is positively seated upon the valve seat 43 so that this fluid does not contaminate the sample which has been entrapped between the main valve of the tester 15 and the valve 46 and within the length of drill pipe 22. Thus, all of the contaminating fluid will be discharged from the drill pipe 26 above the circulating valve. Attention is directed to the fact that when the packer 12 is drawn from its seat the main valve of the tester 15 is closed. There will not therefore be an opportunity for the fluid columns in the drill string and the well to equalize, thus insuring that the sample of fluid standing in the length of drill string 22 will be sealed off by the main valve in the tester 15 and the valve 46 in the circulating valve. When the drill string is further withdrawn to a point where the openings 62 in the circulating valve are above the level of the column of drilling fluid standing within the well, it will be evident that the column of fluid within the drill string and above the openings 62 will drain out of the drill string and into the well. Thus, when the drill string is "pulled" it will not result in a wet job save for a definite column height, and furthermore, it will be insured that an uncontaminated quantity of connate fluid of definite volume will be drawn in each test. It will be evident that since the column of fluid within the drill stem and above the valve structure is clean drilling fluid which has displaced the mixed fluids of the well completely, that this drilling fluid may drain back into the well as the drill string is lifted and as the fluid flows from the drill string through the ports 58 and the opening 62 in the packing nut 30. Since the fluid draining back into the well is the same as that present in the well above the packer, it will be evident that the drilling fluid will not be contaminated. It will further be seen that a large quantity of mixed fluids will not be stored in the drill string to be discharged on the floor of the derrick with possibility of starting a conflagration.

It will be understood that it is not essential that liquid be forced downwardly by the mud pump since the surplus column above the closed circulating valve will drain out as the drill string is withdrawn. It is also to be pointed out that in some instances it might be desirable to evacuate the length of drill string above the circulating valve by the use of fluids under pressure, such for example as air or gas.

It will thus be seen that the method and means of obtaining an uncontaminated quantity of connate fluid while making a well test as here shown is simple as to apparatus and steps of procedure, and that more accurate results can be obtained relative to the character of the fluid yield from the formation tested than has heretofore been possible.

While I have shown the preferred form of my invention and the method of practising the same, it is to be understood that various changes may be made in the steps of the method and the combination and arrangement of parts of the apparatus by those skilled in the art without departing from the spirit of the invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

In combination with a well testing tool and a

supporting string of pipe therefor; a circulating valve unit to be interposed at a point in the length of said pipe above the testing tool, said unit including a tubular barrel, one end of said barrel being connected to a section of the string of pipe, an operating stem, one end of which is connected to another section of the string of pipe, said stem being reciprocally mounted within the barrel and positively engaging means on the same to prevent relative rotation between the barrel and the stem by permitting relative reciprocal movement therebetween, a flow valve structure within the unit through which fluid

may pass, a discharge valve structure within the unit and from which fluid in the upper string of pipe may discharge into the well bore, said discharge valve structure being operated by relative longitudinal movement of the barrel and stem to close the flow valve and open the discharge valve, and releasable interlocking means initially holding the stem and barrel against longitudinal movement in position maintaining the flow valve opened and the discharge valve closed.

MORDICA O. JOHNSTON.