Aug. 29, 1939. C. IDEN 2,171,000

FORMATION TESTER

Filed March 21, 1938 2 Sheets-Sheet 1

Fig. 1.

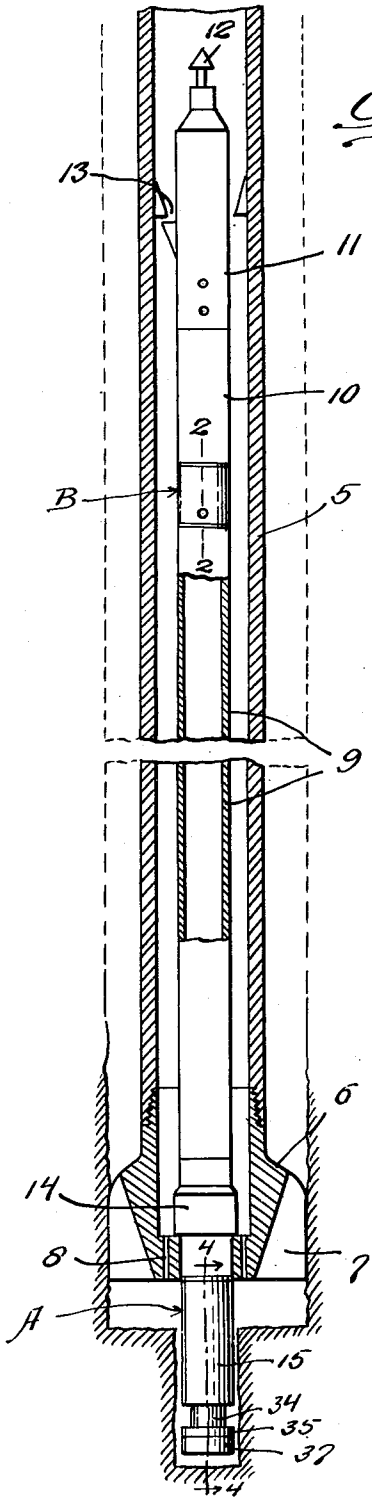


Fig. 2.

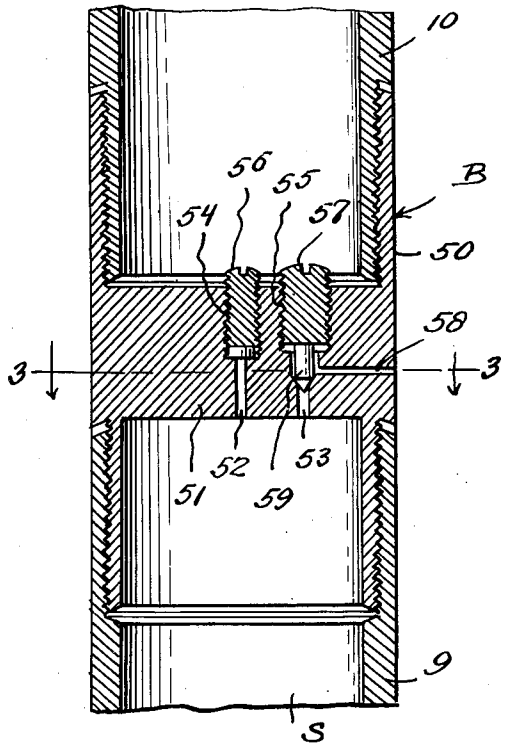
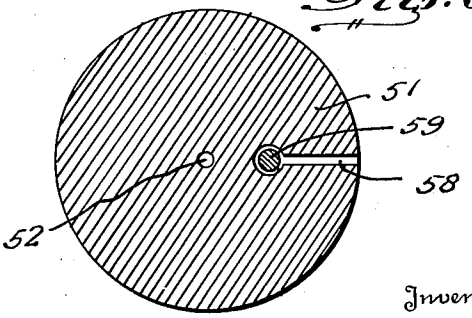


Fig. 3.



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Fig. 4.

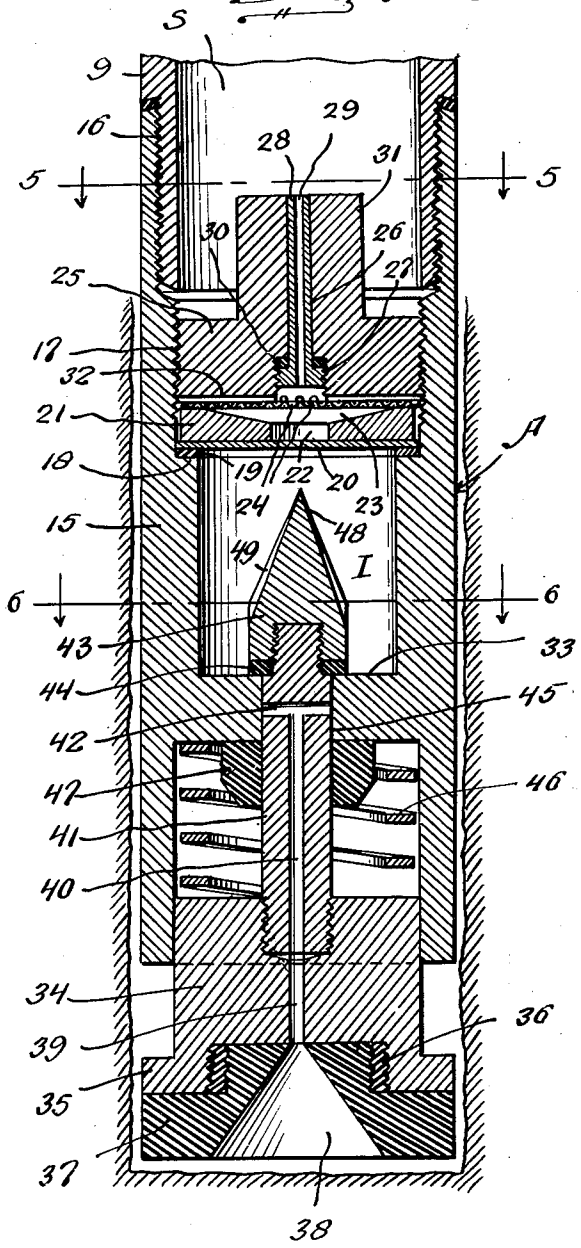


Fig. 5.

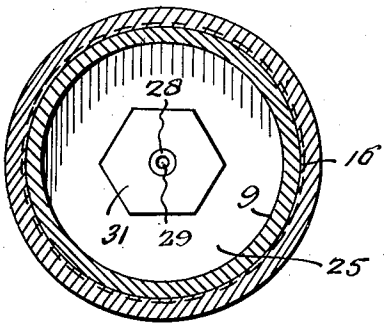
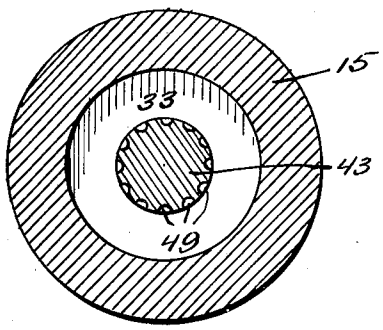


Fig. 6.



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UNITED STATES PATENT OFFICE

2,171,000

FORMATION TESTER

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Application March 21, 1938, Serial No. 197,306

8 Claims. (Cl. 166—1)

This invention relates to a formation tester for oil wells, and has more particular reference to a tester of this kind employing certain parts of the coring equipment of a rotary drilling rig.

The primary object of the present invention is to provide an improved formation tester for oil wells by means of which a true sample of the oil, gas and water in the pore space of the well may be recovered in the proportion in which they exist in the formation itself, and by means of which calculation of the gas volume of the sample may be facilitated.

A further object of the present invention is to provide a formation tester of the above kind which is comparatively simple in construction and embodies two units or assemblies which may be produced at a comparatively low cost and readily employed in connection with certain parts of the coring equipment of a rotary drilling rig, affording a formation tester whose use will not interfere with the ordinary circulation of drilling fluid in the well.

More specifically, the present invention contemplates a formation tester having a sample chamber provided with a manually operable bleeder valve, an inlet chamber, a barrier for normally preventing passage of the sample from the inlet chamber to said sample chamber, and means operable upon lowering the testor in the well to the desired point for rupturing said barrier and permitting a quantity of the oil, water and gas, as they exist in the formation, to enter the inlet chamber and then pass into the sample chamber, said last-named means automatically closing the inlet of said inlet chamber upon elevating the tester after recovering the sample, thereby effectively trapping the sample in the inlet and sample chambers.

With these and other objects and features in view, the present invention consists in certain novel details of construction, and combinations and arrangements of parts, as will be hereinafter more fully described and claimed.

In the accompanying drawings:

Figure 1 is a fragmentary view partly in elevation and partly in vertical section, showing a formation tester embodying the present invention and operatively associated with the drill pipe and drill bit of a rotary drilling rig.

Figure 2 is an enlarged fragmentary vertical section of the formation tester taken on the plane of line 2—2 of Figure 1.

Figure 3 is a horizontal section on line 3—3 of Figure 2.

Figure 4 is a view similar to Figure 2 taken on line 4—4 of Figure 1.

Figure 5 is a horizontal section on line 5—5 of Figure 4; and

Figure 6 is a similar view on line 6—6 of Figure 4.

Referring in detail to the drawings, 5 indicates the drill pipe of a rotary drilling rig, having a drill bit 6 attached to the lower end thereof, said drill bit having the usual groove 7 and passages 8 providing for the usual circulation of drilling fluid in the well during the drilling operation.

The present formation tester consists of certain special units or assemblies used in connection with certain parts of the coring equipment of the ordinary rotary drilling rig. Such usual coring equipment includes a core barrel composed of a lower section 9, an intermediate section 10, and an upper section 11 provided with the usual puller knob 12 adapted to be engaged by an ordinary fishing tool or "overshot" attached to a steel cable, as is well known in the art. Also, the core barrel is usually provided with a conventional latch-down means generally indicated at 13, for latching the core barrel in its lowered position within the drill pipe 5. One unit or assembly forming part of the present invention is generally indicated at A, and is attached to the lower end of the core barrel in place of the usual core head or bit, below the stop 14 which is provided on the lower section 9 of said core barrel for cooperating with the internal shoulder of the drill bit 6 in limiting the lowering of the core barrel to the proper position with respect to said drill bit and the drill pipe 5. This unit or assembly A is more clearly shown in Figures 4 to 6 inclusive, and consists of a tubular body 15 threaded onto the lower end of the lower core barrel section 9 as at 16 and internally threaded as at 17. At the bottom of the internal threaded portion 17, the body 15 is provided with an internal shoulder 18 on which is disposed a packing ring 19 engaged by the margin of a sealing disk or barrier 20 disposed thereon. The disk 20 is preferably of metal and normally imperforate, and disposed on this disk is a circular plate 21 having a flat bottom surface flatly contacting the upper surface of disk 20 so as to form a rigid backing for the latter, said circular plate 21 having a relatively large central opening 22. The upper surface of plate 21 is beveled inwardly and downwardly as at 23 to afford clearance between the same and the major central portion of a screen 24 disposed thereon. The parts 19, 20, 21 and 24 are firmly clamped in

place on the shoulder 18 by a plug 25 threaded at 17 in the body 15 and having a central opening therethrough as at 26. The lower end of opening 26 is counterbored to receive the threaded enlarged lower end 27 of a nozzle 28 fitted in the opening or passage 26 and having a restricted central passage 29 therethrough. Suitable packing is provided at 30 between the internal shoulder of plug 25 and the head 27 of nozzle or brushing 28. The upper portion of plug 25 is externally reduced in size and is of polygonal formation as shown at 31 to facilitate the application of a wrench thereto for use in threading the plug 25 in place. Also, the bottom face of plug 25 is preferably provided with radial grooves 32 insuring free flow or fluid and gas to the central opening 29 of nozzle or bushing 28 after passing through the screen 24. Near its lower end, the body 15 is provided with a horizontal or transverse partition or division wall 33, and it will thus be seen that an inlet chamber I is provided between the partition 33 and disk 20, and a sample chamber S is provided in the lower section 9 of the core barrel above the plug 25, the disk or barrier 20 normally preventing passage of fluid or gas into said sample chamber S. The screen 24 prevents passage of small grains of sand into the restricted passage 29 of nozzle or bushing 28 so that the latter will not become clogged. Slidably fitted in the lower end of body 15 is a head or plunger 34 having an enlarged lower end 35 and provided in such lower end with an internally threaded recess receiving a threaded ring 36 to which is secured or vulcanized the reduced upper end of a packer 37. The packer 37 is provided with a downwardly flared central opening 38 which communicates at its upper end with a central passage 39 provided through the head 34 and communicating with a central longitudinal passage 40 provided in a stem 41 having its lower end threaded into the upper end of head 34 as shown in Figure 4. The longitudinal passage 40 of stem 41 terminates short of the upper end of stem 41 where it communicates with a transverse passage 42 provided in said stem 41. The upper end of stem 41 is reduced and threaded to receive a head 43 provided at the bottom with a packing ring 44 arranged to seat on the partition 33 and prevent passage of fluid or gas between the stem 41 and the wall of the central opening 45 provided in partition 33 and in which stem 41 is slidably fitted. The head 43 and its packing 44 is normally held in lowered seated position by means of a helical compression spring 46 disposed in the lower end of body 15 and surrounding the stem 41 between the partition 33 and the head 34. When in this normal lowered position, the stem 41 is so positioned that its transverse passage 42 is disposed between the top and bottom surfaces of partition 33 and therefore closed. Further prevention of leakage through the central opening 45 of partition 33 upwardly into inlet chamber I is prevented by a packing ring 47 surrounding the stem 41 on the underside of partition 33. It will be noted that the spring 46 is sufficiently strong to offset any tendency of the movable parts to vibrate or move from shock or contact of head 35 with the drill pipe, to such an extent that the head 43 might rupture disk 20, although allowing the latter to occur when the tester is intentionally dropped with force to effect impact of packer 37 with the bottom of the well hole. The head 43 may effectively puncture the disk 20 when this is done, centrally of said disk 20, and for this purpose the upper end of head 43 is pointed as at 48. This pointer upper end of head 43 is preferably provided with longitudinal grooves 49 to allow drainage of fluid or gas between the same and the wall of the hole pierced in disk 20. The packer 37 may be of any suitable material such as rubber or composition, and when it engages the bottom of the hole it will effectively seal off a chamber within the flared opening 38, from the annular space between the formation and the unit A. While the packing shown is designed to be used where the bottom of the hole is approximately flat, it will be seen that the shape of the packer will depend upon the shape of core head or bit used in the drilling operation. For instance, if a diamond-shaped bit is used, it will leave a V-shaped bottom, and it would then be necessary to use a cone-shaped packing in place of the one shown.

The other unit or assembly forming part of the present invention is indicated generally at B, and is more clearly shown in Figures 2 and 3. This unit or assembly consists of a tubular body 50 forming a coupling between the core barrel sections 9 and 10 and provided with an intermediate transverse partition or division wall 51 having two longitudinal passages 52 and 53 whose upper end portions are counterbored and threaded as at 54 and 55 to receive plugs 56 and 57 provided with screw driver kerfs or the like to facilitate turning thereof. Communicating with the intermediate portion of passage 53 is a lateral passage 58 leading to the exterior of the body 50 and forming with the passage 53 a bleed opening for the sample chamber S below the partition 51. Arranged to close the passage 53 is a valve head 59 adapted to be unseated by pressure within the sample chamber S and to be forcibly seated by threading the plug 57 downwardly, unseating of valve head 59 being permitted when the plug 57 is threaded upwardly. The plug 56 is merely provided to form a closure for passage 52 so as to normally cut off communication between the sample chamber S and the chamber afforded within the intermediate core barrel section 10 and upper core barrel section 11, removal of the plug 56 permitting a pressure gage to be threaded into the upper portion 54 of passage 52 so that said gage will be subject to the pressure within the sample chamber S.

In operation, the tester is lowered through the drill pipe with the passages 52 and 53 closed as in Figure 2, with the disk 20 unpunctured, and with the head 34 lowered to the position of Figure 4 wherein the head 43 is seated upon the partition 33 and the transverse passage 42 is closed or within the opening 45 of partition 33. Thus, the inlet chamber I is closed and so is the sample chamber S. With the drill pipe and bit disposed in spaced relation to and above the bottom of the hole as shown in Figure 1, the tester is lowered until the stop 14 engages the internal shoulder of drill bit 6, whereupon the tester is latched down by the latching means 13. The drill pipe and drill bit are then lowered to the bottom of the hole, and when sufficient weight is placed on the head 34 and its packer 37, the latter seals the central portion of the bottom of the hole off from the annular space between the testing tool and the formation wall. The spring 46 is then compressed, causing the perforating head 43 to pierce the disk or barrier 20, allowing fluid and gas in or below the area defined by the lower end of the flared opening 38 of packer 37 to flow through the passages 39, 40 and 42 into the inlet

chamber I, then through the perforation in disk 20 and the opening 22 in plate 21 to and through the restricted passage 29 in bushing or nozzle 28. In flowing to and through the bushing 28, the fluid and gas pass through the screen 24, and the latter prevents passage of small grains of sand into the restricted passage 29 so as to prevent clogging of the latter. Sufficient time is allowed for the sample chamber S to fill to bottom hole pressure, after which the drill pipe is raised to the position of Figure 1 so as to allow the spring 46 to seat the piercing head 43 upon the partition 33 again. This prevents escape of the oil, gas and water from the inlet chamber I and sample chamber S when the tester is fished out of the hole by the use of a fishing tool attached to a steel cable and engaged with the puller knob 12. When at the surface, the latch-down and pulling unit including core barrel section 11 is unscrewed from the core barrel section 10 and the valve 59 is permitted to open by backing up or threading outwardly and upwardly the plug 57. This allows the contents of the sample chamber S to flow under pressure into a graduated container by way of the passages 53 and 58. By proper measurement, the amount of oil and other fluid may be recorded, and if the bottom hole pressure was recorded, the volume of gas may be calculated. If a pressure gage is threaded in the upper portion 54 of passage 52 after removal of plug 56, prior to the testing operation, the volume of gas and air in the barrel, which fills the space not occupied by the fluid, may be calculated. Since the only air in the barrel is that which was originally run in the hole, the amount thereof will be deducted to determine the exact amount of gas recovered in the sample. The head 43 is preferably threaded on stem 41 and has a polygonal lower portion engageable by a socket wrench to facilitate threading of said head onto said stem.

What I claim as new is:

1. In a formation tester for oil wells, the combination of a tubular member having a sample chamber therein and provided at the top of said sample chamber with a bleeder passage, a manually operable valve for closing said bleeder passage, a disruptable closure in the bore of said tubular member normally closing the bottom of said sample chamber, a plunger for disrupting said closure upon impact against the bottom of a well, said plunger being provided with a central passage and having a bottom head provided with a packer arranged to engage the bottom wall of the well hole to seal off the central portion of said bottom wall from the annular space between the tester and the formation wall.

2. In a formation tester for oil wells, the combination of a tubular member having a sample chamber therein and provided at the top of said sample chamber with a bleeder passage opening through one side of said tubular member, a manually operable valve for closing said bleeder passage, a disruptable closure in the bore of said tubular member normally closing the bottom of said sample chamber, a plunger for disrupting said closure upon impact against the bottom of a well, said plunger having a closure disrupting and valve head at the top, a spring normally retracting said plunger to a lowered position, and valve means including said head for automatically preventing passage of the sample from the bottom of the sample chamber when the tester is elevated.

3. In a formation tester for oil wells, the combination of a tubular member having a sample chamber therein and provided at the top of said sample chamber with a bleeder passage opening through one side of said tubular member, a manually operable valve for said bleeder passage, a puncturable closure for the bottom of said sample chamber arranged in the bore of said tubular member and normally preventing passage of fluids and gas into said sample chamber, a plunger having a pointed head for puncturing said closure upon impact of the plunger against the bottom of a well, a plug in the bore of said tubular member above said puncturable closure defining a restricted inlet passage for said sample chamber, a rigid apertured disk arranged in the bore of said tubular member and forming a rigid backing for said puncturable closure above the latter, and a screen interposed between said plug and said rigid disk.

4. A formation tester for oil wells including a tubular member having a sample chamber provided with a top bleeder outlet, a manually operable valve for said bleeder outlet, a barrier normally preventing passage of the sample into said chamber, a partition defining an inlet chamber in said tubular member below said sample chamber, and plunger means operable upon lowering the tester in the well for rupturing said barrier, said plunger having a rupturing head cooperating with said partition for normally preventing passage of gas and fluids into said inlet chamber.

5. In a formation tester for oil wells, in which the well is provided with the usual bore and bottom rat hole, a drill pipe having a drill bit at the bottom thereof, a sectional core barrel arranged in the lower portion of said drill pipe and provided at the top with means to facilitate fishing thereof from the well, latch-down means for said core barrel including cooperating elements carried by the core barrel and the drill pipe, a bottom hole packer and valve unit attached to the lower end of the core barrel in lieu of the usual core bit and projecting downwardly through the drill bit, a wall member interposed between the sections of said core barrel, and a barrier arranged in the upper portion of said bottom hole packer and valve unit cooperating with said wall member to provide a sample chamber therebetween, said wall member having a bleeder passage opening through the same at one side of the core barrel and provided with a manually operable shutoff valve, and said bottom hole packer and valve unit including plunger means for disrupting said barrier upon impact against the bottom of the rat hole.

6. In a formation tester for oil wells, in which the well is provided with the usual bore and bottom rat hole, a drill pipe having a drill bit at the bottom thereof, a sectional core barrel arranged in the lower portion of said drill pipe and provided at the top with means to facilitate fishing thereof from the well, latch-down means for said core barrel including cooperating elements carried by the core barrel and the drill pipe, a bottom hole packer and valve unit attached to the lower end of the core barrel in lieu of the usual core bit and projecting downwardly through the drill bit, a wall member interposed between the sections of said core barrel, a barrier arranged in the upper portion of said bottom hole packer and valve unit cooperating with said wall member to provide a sample chamber therebetween, said wall member having a bleeder passage opening through the same and provided with a manually operable shut-off valve, and said bottom hole packer and valve unit including a spring-pro-

jected plunger having a head for disrupting said barrier upon impact against the bottom of the rat hole and for automatically preventing escape of gas and fluids from the bottom of the sample chamber when the core barrel is fished from the well.

7. In a formation tester for oil wells, a core barrel provided at the top with a puller knob and at a point near the top with a latch-down element arranged to cooperate with a latch-down element on the interior of a drill pipe, means including a top wall and a bottom barrier defining a sample chamber therebetween within the core barrel, and a unit attached to the bottom of the core barrel in lieu of the usual core bit and including a spring-projected plunger having a head for puncturing said barrier upon impact against the bottom of a well and for automatically preventing escape of gas and fluids from the sample chamber when the core barrel is fished from the well.

8. In a formation tester for oil wells, a section core barrel provided at the top with a puller knob and at a point near the top with a latch-down element arranged to cooperate with a latch-down element on the interior of a drill pipe, means including a top wall member and a bottom barrier defining a sample chamber therebetween within the core barrel, a unit attached to the bottom of the core barrel in lieu of the usual core bit and including a spring-projected plunger having a head for puncturing said barrier upon impact against the bottom of a well and for automatically preventing escape of gas and fluids from the sample chamber when the core barrel is fished from the well, said wall member being interposed between the sections of said core barrel and having a bleeder passage leading from the top of the sample chamber and opening through said wall member at one side of the core barrel, and a manually operable shut-off valve for said bleeder passage.

CHRISTIAN IDEN.