April 2, 1946. E. V. CROWELL 2,397,473

MEANS FOR TESTING FORMATIONS IN WELLS

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Fig. 1.

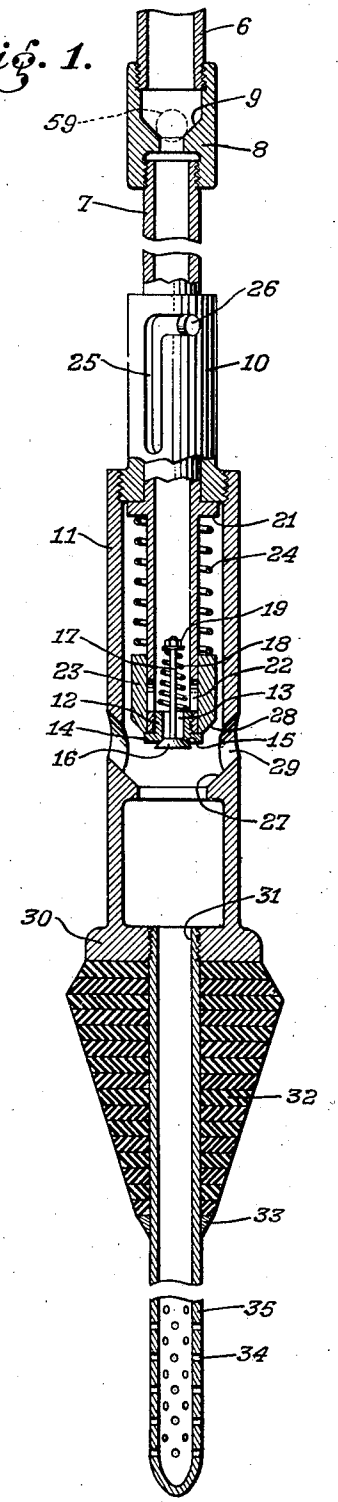
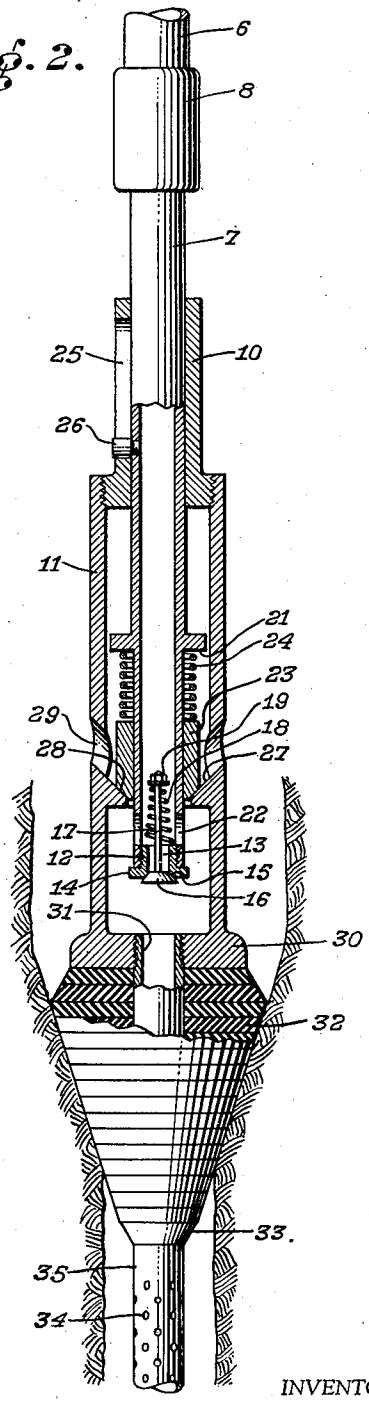


Fig. 2.



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Fig. 3.

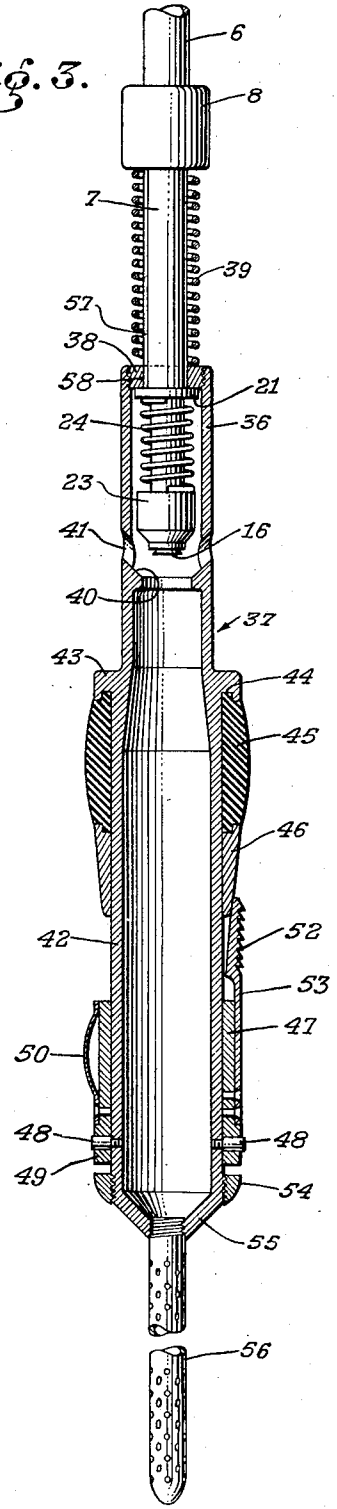


Fig. 4.

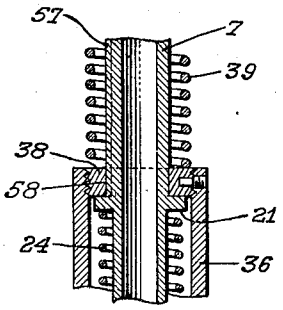
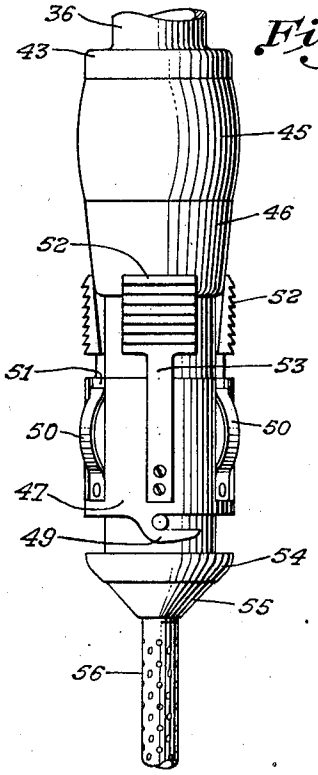


Fig. 5.



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UNITED STATES PATENT OFFICE

2,397,473

MEANS FOR TESTING FORMATIONS IN WELLS

Erd V. Crowell, Glendale, Calif.

Application November 15, 1938, Serial No. 240,484

2 Claims. (Cl. 166—10)

This invention relates to means for testing formations in wells, and more specifically, to apparatus adapted to be lowered in a well shaft or casing on an empty tubing string or the like, embodying packing means to seal off a zone in the well below a predetermined level, and operable thereupon to communicate the tubing string below the packing means to receive samples of the fluid from said zone and to again seal the tubing string to enable the removal from the well of the entrapped fluid for subsequent examination, uncontaminated by other fluid in the well. This application is a continuation-in-part of my copending application Serial No. 180,392, filed December 17, 1937, for Oil well devices.

It is, therefore, a general object of the present invention to provide a tubular member normally closed to pressure therearound adapted to be lowered through fluid in a well, and carrying packing means to confine a zone in the well to be tested, and thereafter open the tubing to receive a sample of the fluid from said zone.

It is a further object to provide a testing device comprising superimposed telescopic sections of drill pipe or tubing to be lowered into a well bore with a packer adapted to seal the annular space between the lower section and the wall of the well bore thus to form a confined zone therebelow; the lower section and packer having a vent to facilitate the by-passing of drilling fluid therethrough as the device is being raised or lowered in the well bore, and having a composite valve means for opening or closing the vent and selectively opening or closing communication between said upper section and the surrounding well bore through said lower section.

Another object is the provision of valve means contained in telescopically associated sections of tubing carrying a well packer to permit ejection of mud fluid under pressure introduced at the well surface from the device either above or below the packer to remove obstructions in the well bore tending to bind the string against removal, said valve means being further adapted to close against hydrostatic pressure of fluid within the tubing string upon withdrawal of the device from the well.

Another object is to provide an auxiliary valve means adapted for placement in the device after reception of the sample by the tubing string to insure retention of the sample therein while removing the apparatus from the well.

Other objects and salient features of my invention, such, for example, as simplicity of operation and construction involving a minimum number of parts, and ease of assembly, will be apparent to those of skill in the art from an examination of the following description read in the light of the accompanying drawings, in which:

Fig. 1 is a sectional view partly in elevation of one embodiment of my invention illustrating the parts in the positions they assume as the device is lowered into a well;

Fig. 2 is a sectional view partially in elevation of the apparatus shown in Fig. 1 as positioned in a well while receiving a sample;

Fig. 3 is a view in section similar to Fig. 1 of another embodiment of my device;

Fig. 4 is an enlarged section of the telescopic connection between the tubing and packer body;

Fig. 5 is an enlarged elevation of a hook wall packer and slip mechanism comprising a part of the embodiment of Fig. 3.

Referring to the drawings in detail, the numerals of which indicate similar parts throughout the several views, 6 designates a tubing string to the lower end of which the apparatus of my invention is connected for lowering in the well. A tubing extension 7 is connected to tubing string 6 by means of a coupling 8, the bore of which is restricted to form an upwardly directed annular valve seat 9 for a purpose later referred to.

Referring particularly to the embodiment of Figs. 1 and 2: The tubing extension 7 protrudes telescopically into a tubular member 10 and into an integral housing-head 11 of the packer later to be described, of larger diameter than member 10 which is threaded onto the lower end of the member. The lower end of the tubing extension 7 is internally threaded to receive an insert 12 having an opening 13 therethrough. An annular flanged lower end 14 of the insert abuts against the end of the extension. The lower end of the bore of insert 12 is flared to form a valve seat 15. A downwardly opening valve 16 to contact seat 15 is provided with a concentric valve stem 17 extending upwardly into the bore of extension 7. A conical spiral spring 18 seats on the upper end of insert 12 and bears against an adjusting nut 19 threaded on the upper end of stem 17 to normally retain valve 16 on its seat. The bore of the tubing extension 7 is preferably of uniform diameter but the outside diameter of the lower portion of the extension is reduced. An annular spring seat 21 is integrally formed with extension 7 so as to encircle the extension at the lower end of its diametrically larger portion. Ports 22 through the wall of the tubing extension directly above insert 12 are normally closed by a sleeve valve 23 encircling the tubing

extension and supported on the portion of flange 14 of the insert which protrudes laterally outwardly beyond the periphery of the tubing extension. It will be observed that head 11 of the packer (later to be described) thus forms a housing for valve 23. A helical spring 24 encircles the tubing extension between the sleeve valve 23 and spring seat 21 to resist opening movement of the sleeve valve. An inverted L-shaped slot 25 is cut through the wall of tubular member 10 into which a stud 26, welded or otherwise secured to the tubing, extends. The slot 25 and stud 26 are located with respect to one another in positions whereby the engagement of the stud in the horizontal portion of the slot locks the tubing extension against telescopic movement within member 10 and housing-head 11 of the packer, with spring seat 21 against the lower end of tubular member 10. Intermediate the ends of housing-head 11 and below the lower end of tubing extension 7 a distance less than the length of the vertical portion of the slot, the bore of the housing-head 11 is restricted to form an upwardly directed beveled valve seat 27. The opening through valve seat 27 is of a diameter greater than the diameter of the insert flange 14 and tubing extension 7, but less than the outside diameter of sleeve valve 23 to permit the telescopic extension of the lower end of the tubing extension through valve seat 27, whereupon the beveled lower end 28 of sleeve valve 23 will close the bore of the housing-head 11 by contact with seat 27. The housing-head 11 is provided with a series of lateral ports 29 directly above seat 27 which communicate the bore of the body with the well.

The housing-head 11 of the packer later described is formed at its lower end with an integral base 30 having an axially threaded opening into which the upper end of a tube 31 is threaded. A rat hole packer 32 is mounted on tube 31 intermediate the base 30 of housing-head 11 and a collar 33 welded or otherwise secured on the tube, which assists in supporting the packer. The tube 31 is perforated below packer 32 as at 34 to form a screen 35 for the reception of fluids from the portion of the well to be tested.

In the embodiment of my invention illustrated in Figs. 3–5, the tubing extension 7, secured to the tubing string by coupling 8 and constructed as above noted, is adapted to telescope into the upper diametrically reduced portion 36 of a tubular packer body 37, which portion 36 forms a housing for valve 23 and its seat 40. The packer body is normally suspended on the spring seat 21 of tubing extension 7 by a collar 38 slidably encircling the tubing and threaded into the upper end of the body. A helical spring 39 encircles the extension so as to seat on collar 38 and bear at its upper end against valve coupling 8 to resist telescopic contraction of the packer body 37 and tubing extension 7.

Intermediate the ends of the upper reduced portion of the packer body an annular valve seat 40 is formed in the bore on which sleeve valve 23 is adapted to seat as above noted, in connection with the embodiment of Figs. 1 and 2. Lateral ports 41 through the upper portion of the body communicate the interior of the packer body and the well for a purpose hereinafter described.

The diametrically enlarged lower portion 42 of packer body 37 is integrally formed with an exterior annular flange 43 recessed as at 44 on its underside for the engagement of an annular hook wall packer 45. Conventional slip mechanism is provided to expand the packer within a well casing or shaft comprising an expanding element 46 slidable on packer body 37 and secured to the lower end of packer 45. A sleeve 47 on the packer body below expanding element 46 is normally held against vertical movement on the packer body by the engagement of a pair of studs 48 located on opposite sides of the packer body with corresponding hooks 49 formed integrally with the lower end of the sleeve. A plurality of outwardly bowed leaf springs 50 are secured in spaced relation around the lower end of sleeve 47 by suitable means and with their upper ends retained slidably in vertical grooves 51 formed in the sleeve. A series of slips 52 are held on the expanding element by attachment of the lower end of their respective stems 53 to sleeve 47. A collar 54 is threaded on the exterior of the lower end of the packer body and has an outside diameter substantially equal to the same diameter of the sleeve to limit downward movement of the sleeve. The lower end of the packer body is again telescopically reduced as at 55 and formed with an interiorly threaded opening for attachment of a screen 56. The tubing string and packer body are held against relative rotation by a key 57, welded or otherwise secured on the tubing extension above spring seat 21 to engage in a key way 58 formed in the collar 38 throughout the telescopic movement of the tubing and packer body.

The operation of my invention is briefly described as follows: It is a general procedure to install the tester embodying the invention on the bottom of the drill pipe or tubing string 7 as illustrated, with valve 16 closed and valve 23 closing ports 22 thus preventing any fluid from entering the drill pipe or tubing while being lowered in the well. As the device is lowered to position fluid in the well will be by-passed by flowing into screen 35 or 56 through the packer body and returning into the well above the packer through ports 29 or 41. Should the device become wedged in the casing or well shaft as a result of restrictions of the bore of either due to cavings or accumulated debris thereabove, mud fluid may be introduced into the tubing string and pumped downwardly under pressure to displace valve 16 and circulate from the ports to the well surface through the well shaft or casing around the tubing string to thereby remove the objectionable matter and free the string. It will be observed that circulation from the well surface may be established through the screen if desirable, as when, for example, cavings in the well shaft should bind the packer or adjacent portion of the string below the ports 29 and 41, by telescoping the tubing into the packer body and opening ports 22 for communication with the lower bore of the packer body.

When the packer on the tester reaches the proper point above the formation to be tested, the packer is set to exclude any of the drilling fluid outside of the drill pipe or tubing from flowing downward to the formation to be tested. Various types of packers may be substituted for the rat hole and hook wall packers illustrated. The operation of said packers to cause them to seal off a zone in the well to be tested will be apparent to those of skill in the art and requires no detailed explanation. When the packer is set at the desired location, the tubing string is again lowered to telescope the tubing extension 7 into the packer body to seat sleeve valve 23 and thus close the ports 29 or 41 to communication with

the bore of the well shaft below the packer, and to communicate the tubing string with the screen 35 or 56 through the packer body and ports 22 in the tubular extension. This telescopic contraction of the tubing extension and packer body will be effected in the embodiment of my invention illustrated in Figs. 1 and 2 after partially rotating the tubing string in a clockwise direction to bring the stud 26 into alignment with the vertical portion of the slot 25. In the embodiment of Figs. 3–5 the tubing extension may be telescoped against the tension of spring 39 after first rotating the string to disengage the studs 48 from hooks 49 to permit the further lowering of the string to expand the packer. Further telescopic contraction of the tubing extension and packer body will displace upwardly valve 23 on the tubular extension and allow the flow of oil, gas or water, if present, from the formation into the empty tubing string. If gas were present in the formation, it would flow freely through the empty drill pipe or tubing, its volume being measured at the surface. After the tester has been allowed to remain open for a desired period of time, valve 23 is then closed and the packer unseated by elevating the drill pipe or tubing to remove the device with the entrapped sample of water or oil received from the formation.

Valve 16 will remain closed in response to the urge of spring 18 unless it is necessary to circulate through the tubing string and ports 29 or 41 from the well surface. If circulation is desirable through the screen the tubing and packer body may be telescoped and the circulating fluid pumped into the packer body through ports 22 in the tubing screen. The nut 19 on the valve stem may be adjusted to compress the spring whereby the latter will resist considerable pressure from within the tubing string tending to open the valve and, accordingly, may be adapted to maintain the closed position of the valve against the hydrostatic weight of the fluid comprising the sample or circulating fluid remaining in the tubing as the tubing is removed from the well. Where it is desirable to maintain a light tension on spring 16, e. g., to avoid excessive pressure incident to circulating should it be necessary, the sample may be entrapped in the tubing string by dropping a ball valve 59 into the tubing when preparing to remove the apparatus. The ball will fall through the fluid comprising the sample and close the bore of coupling 9 by engaging seat 9 as shown in dotted lines in Fig. 1, to prevent the drainage of the sample from the tubing string as the latter is raised. It will also be observed that valve 16 will close the bore of the tubing string to pressure fluid in the well above the zone tested after the packer is dislodged preparatory to withdrawing the apparatus, and thus prevents contamination of the sample by such fluids. If the formation is dry, it would be established by the absence of oil, water, or gas from the tubing.

It will be understood that numerous changes in proportion, number and shape of the various parts may be made, that a spring 39 (Fig. 3) may be employed in lieu of the pin and slot in the apparatus of Fig. 1 to resist telescopic contraction of the relatively moving parts, and that packers of any conventional type may be substituted for those shown, all without departing from the spirit of my invention as defined by the appended claims, in which, when I mention a "string of tubing telescopically received" I refer to the tubing string 6, and the tubing extension 7 with all necessary couplings. By "flow line" is meant the tubular conduit members through which fluid is conducted into, through, or out of any selected portion of the well. "Pipe" is meant to include tubular conduit members which, in my preferred embodiment, include tubing string 6, necessary couplings and sections thereof, tubing extension 7, packer housing-head 11, or the same tubing and its extension, and tubular packer 37, and any extension therebelow to the well screen, although I do not limit my invention to such specific elements. By "means to anchor" I refer to any device by which the flow line is secured at a selected point within the well, a preferred embodiment of which is described above as conventional slip mechanism for hook wall packer 45.

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

1. In a well testing device for use in a well shaft, a pair of telescopically connected tubular members, one of said members forming a head for a packer and having a lateral port therein communicating the bore of the lowermost tubular member below the packer with the well shaft above the packer through said head, a single valve member movable in said head and actuated by telescopic contraction of said tubular members to close said communication with the well shaft and open communication between said tubular members through said head, and means operable in response to relative rotation between said members for controlling relative movement between said members longitudinally.

2. A circulating valve assembly adapted for use with a pipe in a well shaft consisting essentially of two conduit members, one superposed relative to the other, telescoped and secured together for limited relative movement and mounted above a packer, one of said members forming a housing-head for the packer and having lateral ports therein communicating the bore of said member below the packer with the well shaft above the packer, and a valve in said housing-head for establishing and interrupting the flow of fluid from the section of the well shaft below the packer to the section above the packer through said housing-head adapted to establish and interrupt the flow of fluid through the packer to the upper conduit member, said valve being opened and closed by manipulation of the conduit members.

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