May 5, 1953 L. E. BROWN ET AL 2,637,400

WELL TESTER

Filed April 15, 1946 4 Sheets-Sheet 1

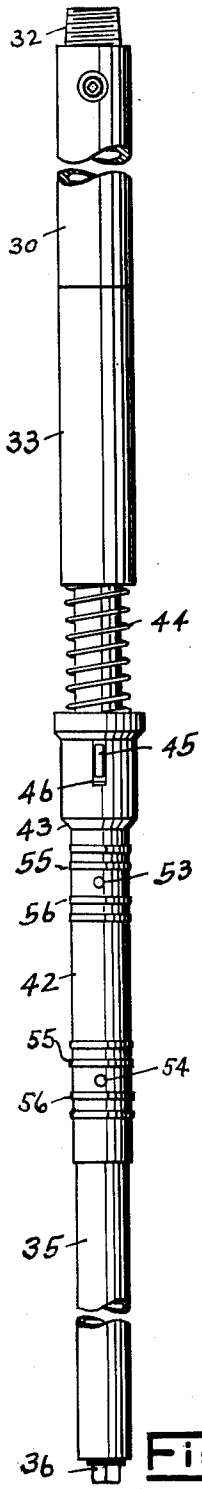


Fig. 3.

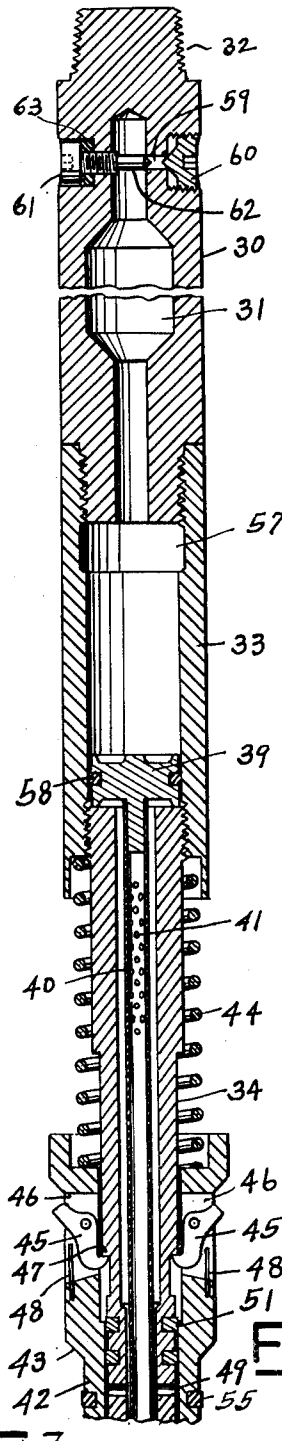


Fig. 1.

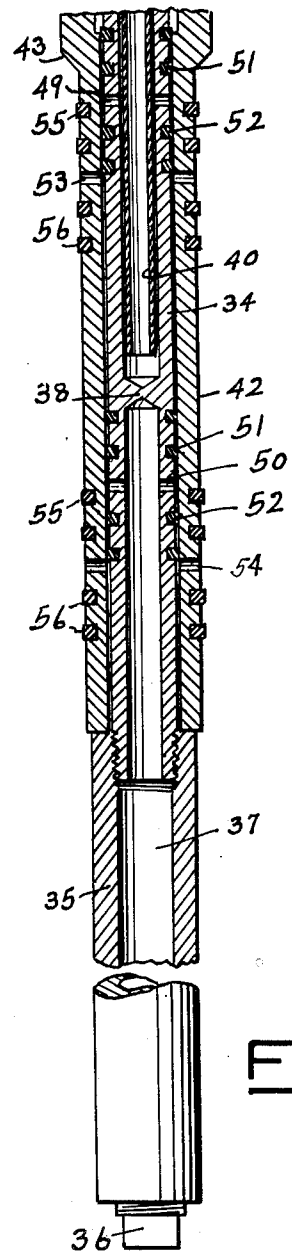


Fig. 2.

Inventors
Luther E. Brown
Ollin N. Williams
By
E. V. Hardway.
Attorney

May 5, 1953 L. E. BROWN ET AL 2,637,400

WELL TESTER

Filed April 15, 1946 4 Sheets-Sheet 2

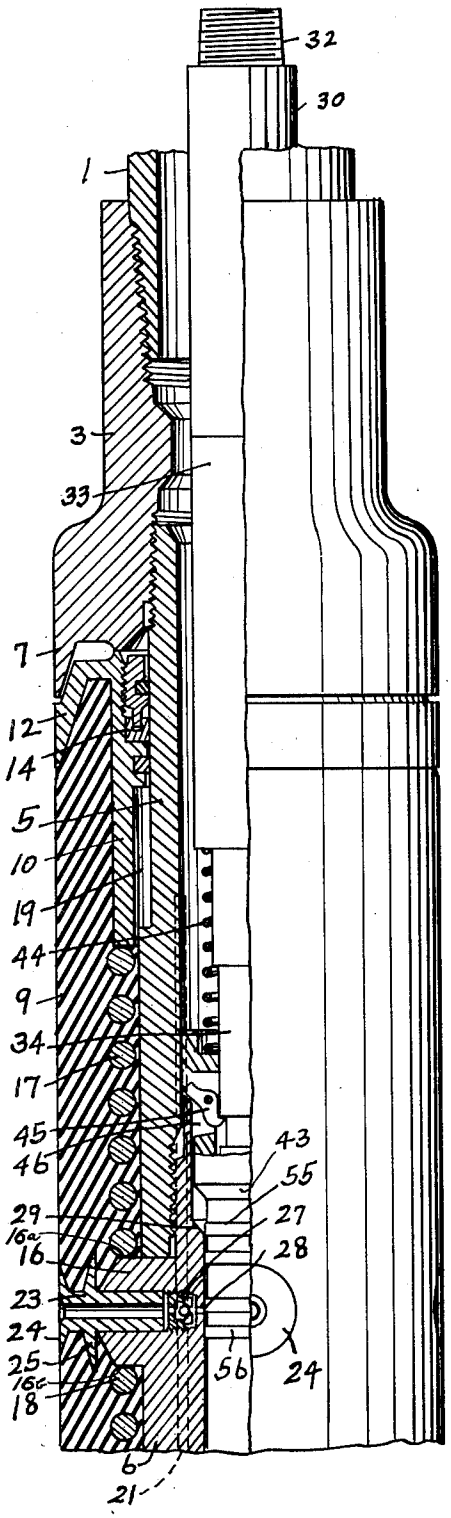


Fig. 4.

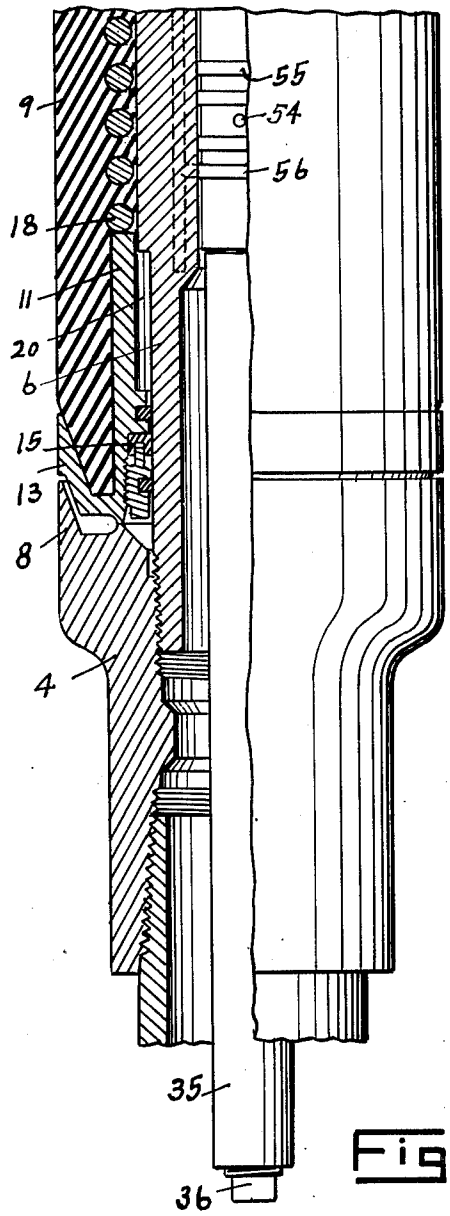


Fig. 5.

By

Inventors
Luther E. Brown
Ollin W. Williams
E. V. Hardaway
Attorney

May 5, 1953 L. E. BROWN ET AL 2,637,400

WELL TESTER

Filed April 15, 1946 4 Sheets-Sheet 3

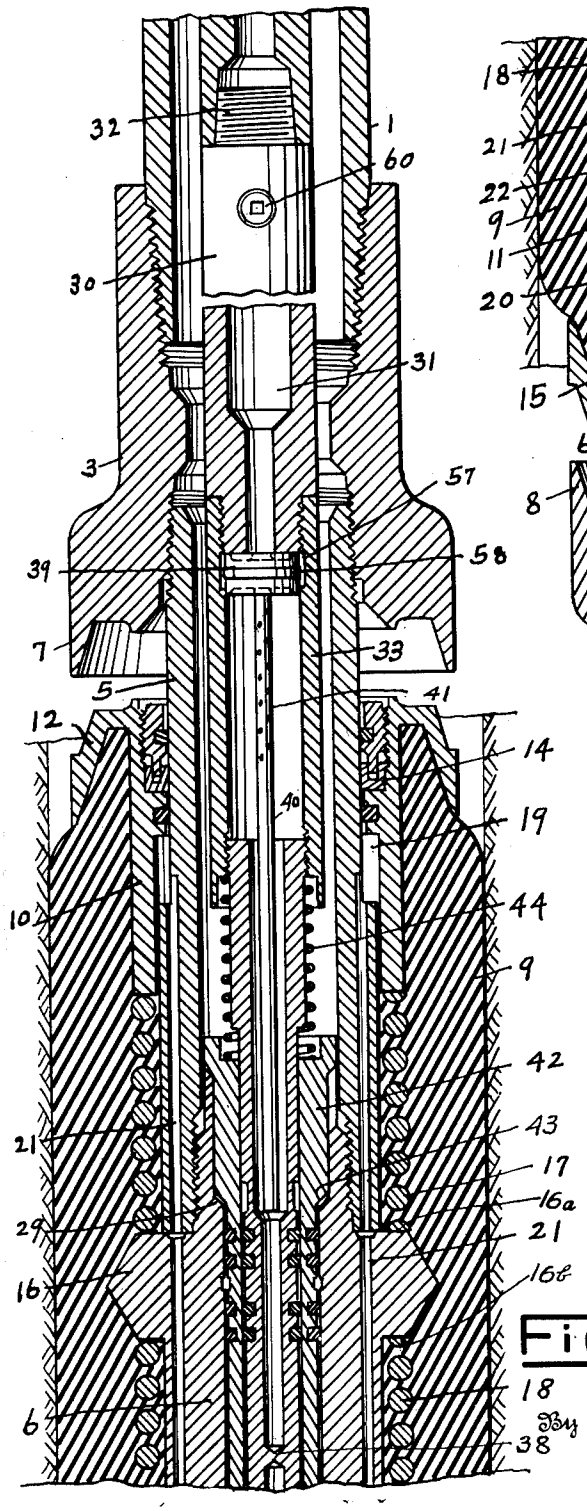


Fig. 6.

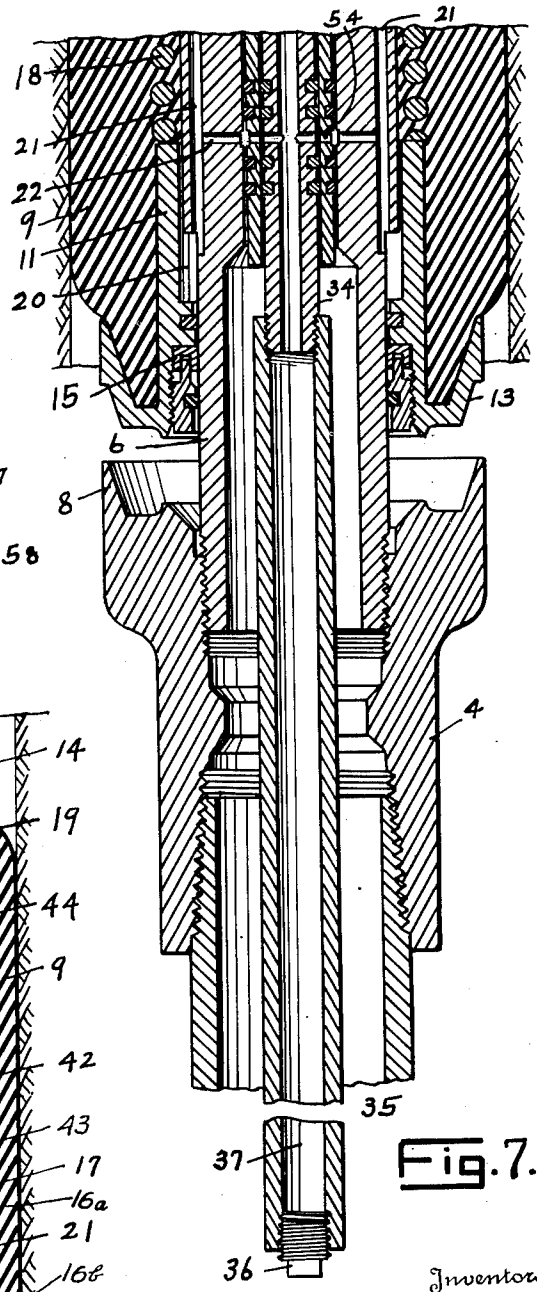


Fig. 7.

Inventors
Luther E. Brown
Ollin H. Williams
By
E. V. Hardway.
Attorney

May 5, 1953 L. E. BROWN ET AL 2,637,400

WELL TESTER

Filed April 15, 1946 4 Sheets-Sheet 4

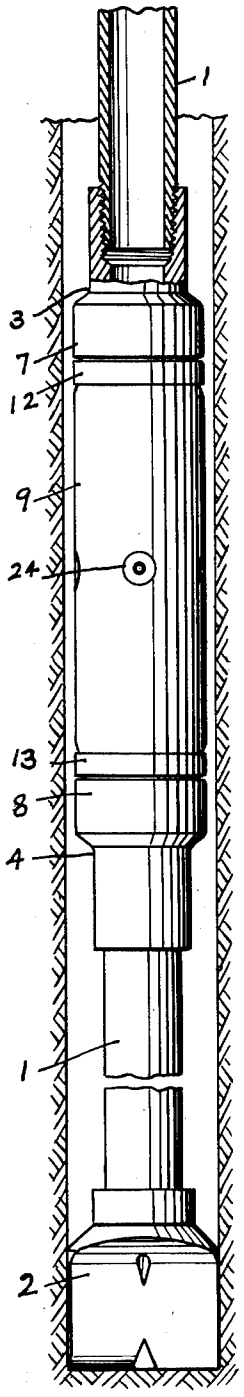


Fig. 10.

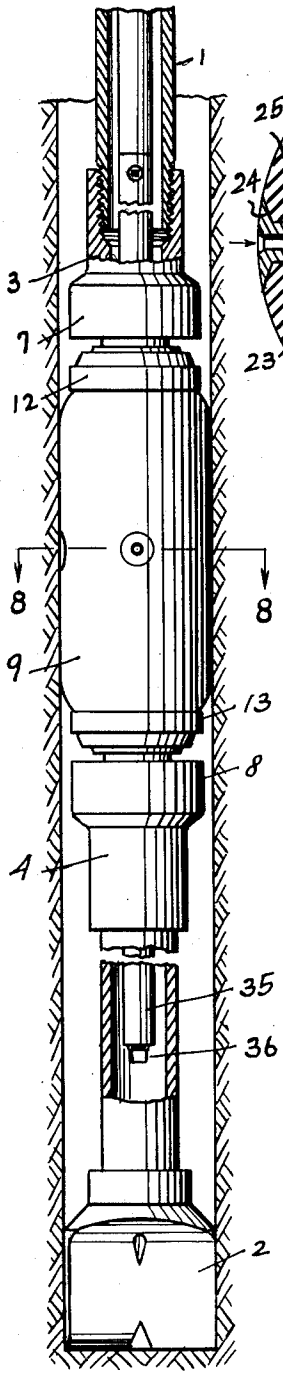


Fig. 11.

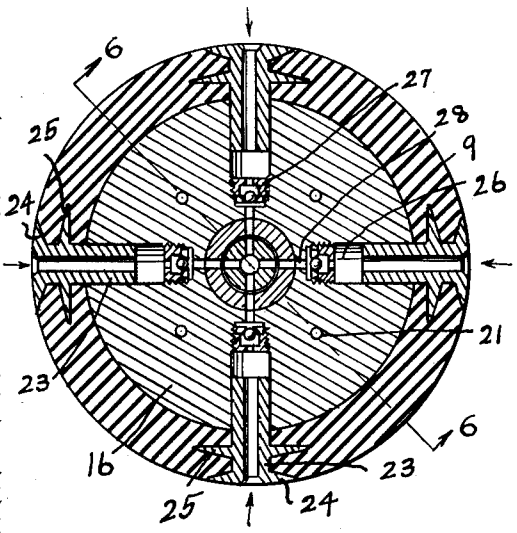


Fig. 8.

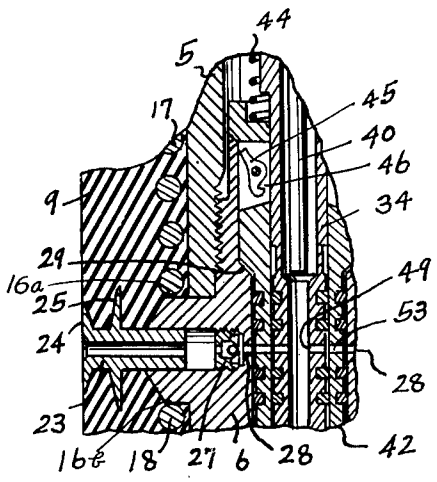


Fig. 9.

Inventors
Luther E. Brown
Ollin N. Williams

By E. V. Hardaway
Attorney

Patented May 5, 1953 2,637,400

UNITED STATES PATENT OFFICE

2,637,400

WELL TESTER

Luther E. Brown, Greggton, and Ollin W. Williams, Houston, Tex.

Application April 15, 1946, Serial No. 662,142

10 Claims. (Cl. 166—1)

1

This invention relates to a well tester.

An object of the invention is to provide a tool of the character described whereby a sample may be taken from the side wall of a well bore and withdrawn to the ground surface for inspection.

It is another object of the invention to provide a well tester of the character described embodying a wall packer which, when expanded, will seal off a substantial area of the side walls of the bore all of the way around, said tester containing a sample receiving chamber with a conduit leading inwardly through the wall of the packer and communicating with said chamber to allow the inflow of fluid from said side wall through the packer into the chamber.

It is a further object of the invention to provide a well tester of the character described equipped with means for controlling said conduit whereby the sample will be entrapped in the sample chamber.

It is a further object of the invention to provide in a well tester of the character described, a novel type of packer which has been specially designed so that it may be contracted to release the walls of the bore when it may be desired to move the tool longitudinally in the bore.

It is still another object of the invention to provide a tester of the character described wherein provision is made for equalizing the pressure of the well liquid on the inside and outside of the packer while the tool is being lowered or withdrawn with a novel arrangement for relieving the pressure within the packer to the end that the packer will be expanded into contact with the side walls of the well bore by the pressure of the well liquid outside of the packer.

A still further object of the invention resides in the provision of a novel packer assembly which has been specially designed to utilize the pressure of the well liquid outside of the packer to cause expansion of the packer when the pressure of the liquid inside of the packer has been relieved.

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 is a vertical, sectional view of the upper end of the bailer, or sample receiving and removing equipment.

Figure 2 is a side view of the lower end thereof, partly in section.

Figure 3 is a side elevation of the complete

2

bailer, or sample receiving and removing equipment.

Figures 4 and 5 are side views, partly in section, of the upper and lower ends of the packer assembly showing the bailer therein and the packer in its collapsed, or unexpanded, position.

Figures 6 and 7 are vertical, sectional views of the upper and lower ends, respectively, of the packer assembly in expanded position and with the bailer therein taken on the line 6—6 of Figure 8.

Figure 8 is a cross-sectional view taken on the line 8—8 of Figure 11.

Figure 9 is a fragmentary, vertical, sectional view of the packer assembly with the packer expanded.

Figure 10 is a side elevation, of the testing tool, partly in section, and showing the packer collapsed; and

Figure 11 is a side elevation of the tool, partly in section, showing the packer expanded and the tool in position to take a sample.

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 conventional tubular drill stem which extends to the ground surface and to the lower end of which a conventional drill 2 may be connected.

Incorporated into the drill stem are upper and lower special couplings 3 and 4 which are connected by intermediate upper and lower drill stem sections 5 and 6, these sections 5 and 6 being threaded together, at their adjacent ends, and whose remote ends are screwed into the respective upper and lower couplings 3 and 4, as more clearly shown in Figures 4 to 7, inclusive.

The lower end of coupling 3 is enlarged and formed with a downwardly flared hood 7 and the upper end of coupling 4 is enlarged and formed with an upwardly flared hood 8.

The special drill stem sections 5 and 6 form, in effect, a packer support and they are surrounded by an expansible sleeve-like packer 9 which is formed of rubber or other suitable expansible material.

Within the upper and lower ends of packer 9 are upper and lower hollow cylindrical plungers 10 and 11 whose outer ends are formed into annular, retracted caps 12 and 13, which embrace the upper and lower ends, respectively, of the packer 9 and form heads therefor. These plungers are formed of rigid material and are provided at their upper and lower ends, respectively, with stuffing boxes, 14 and 15 which surround, and

form seals with, corresponding drill stem sections 5 and 6.

The upper end of drill stem section 6 is provided with an external annular rib 16. This rib has upper and lower annular faces 16a and 16b and converges outwardly from said faces, as more clearly shown in Figure 6.

Interposed between the inner ends of plungers 10 and 11 and the opposing faces of rib 16, and preferably embedded in material of packer 9 are upper and lower strong coil springs 17 and 18 which are placed under compression, when the packer is expanded. These coil springs reinforce and strengthen the packer and also assist in collapsing the packer when it is desired to do so.

Between plungers 10 and 11 and upper and lower drill stem sections 5 and 6, respectively, are pressure chambers 19 and 20 which are connected by ducts 21 which extend through the sections 5 and 6 of the drill stem, as more clearly shown in Figures 6, 7 and 8. Ducts 22 lead inwardly from the ducts 21, near their lower ends through the wall of the drill stem section 6 and into the interior thereof.

There are inlet tubes 23 which open outwardly of and extend radially through the packer 9 and into bores 26 in the rib 16. The outer ends of these tubes are formed with annular flanges 24 which are countersunk into packer 9 and said tubes 23 also have intermediate annular flanges 25 which are embedded in the material of the packer so as to anchor tubes 23 in place. Any desired number of tubes 23 may be provided, four being shown. The tubes 23 are slidable in bores 26 in rib 16, and anchored at the inner ends of said bores, inwardly of tubes 23, are inwardly opening valve assemblies 27 and leading inwardly from these bores to the interior of the drill stem are ports 28. The valve assemblies 27 allow inflow of outside fluid inwardly through tubes 23 but close to prevent outflow of fluid through said tubes.

Above the tubes 23 lower drill stem section 6 is provided with an inside downwardly tapering seat 29.

Before lowering the tool as above described into the well bore chambers 19 and 20 and ducts 21 and 22 may be filled with oil, or other suitable fluid, or they may be left empty to become filled with well liquid as the tool is lowered. In either event as the tool is lowered into a well filled with liquid to the desired location for making a test of the side wall stratum the pressure of the well liquid on the outside of packer 9 and in chambers 19 and 20 will be the same.

Referring now more particularly to Figures 1, 2 and 3, there is shown a bailer, or sample receiving and removing equipment, wherein numeral 30 designates a hollow cylindrical housing containing a sample receiving chamber 31. The upper end of housing 30 is provided with an outwardly threaded pin 32 for the connection thereto of a cable socket. It is contemplated that the bailer will be lowered down through the drill stem by a cable attached to said socket and leading to the ground surface.

Screwed onto the lower end of housing 30 is a cylinder 33 and screwed into the lower end of said cylinder and depending therefrom is a tubular stem 34. The lower end of the stem 34 is screwed into the upper end of a vacuum tube 35 whose lower end is closed by plug 36. This vacuum tube 35 contains a vacuum chamber 37 which extends on up into stem 34 and whose upper end is closed by a transverse partition 38 in the stem.

Within cylinder 33 is a plunger 39 and depending from this plunger down into stem 34 is a tube 40 whose lower end is open and said tube is provided with a plurality of perforations 41 just beneath plunger 39.

Surrounding stem 34 and supported on the upper end of vacuum tube 35 is a tubular valve 42 whose upper end is of an external diameter to fit closely within drill stem section 5 and beneath its upper end said valve 42 is provided with an external downwardly tapering seat 43 adapted to land on seat 29 of the drill stem when said valve 42 is in its lowermost position in the drill stem.

Surrounding stem 34 and interposed between the lower end of cylinder 33 and the upper end of valve 42 is a strong coil spring 44. Stem 34 is normally latched in its upper position relative to valve 42 by means of latches 45, 45 which are pivotally mounted in vertical side slots 46, 46 cut through the upper end portion of valve 42. The lower ends of these latches are inwardly turned and normally engage under an external annular shoulder 47 on stem 34 and are maintained in said engaging position by flat springs 48, 48 whose lower ends are secured to valve 42 and whose upper ends press inwardly against the lower ends of the latches to hold them engaged, as shown in Figure 1. The upper ends of the latches extend out beyond valve 42.

Stem 34 has upper, radial inlet ports 49 above partition 38 and lower, radial outlet ports 50 beneath said partition and above and beneath these respective ports are seal rings, 51, 52, which are countersunk into stem 34 and forms seals between it and valve 42. Tubular valve 42 has upper and lower inlet ports 53, 54 and above these ports 53 and 54 are external annular seal rings 55 while beneath said respective ports are annular seal rings 56, all countersunk into valve 42 as illustrated in Figure 2.

With the bailer assembled as shown in Figures 1, 2 and 3, it may be let down into the drill stem until seat 43 lands on seat 29. Just before said seat 43 so lands the outer ends of latches 45 will strike the upper end of drill stem section 6 and the lower inwardly turned ends of said latches will be disengaged from shoulder 47 and stem 34 may thereupon move downwardly relative to sleeve valve 42. When seat 43 lands on seat 29 inlet ports 54 of the valve will register with ducts 22 and upon further downward movement of stem 34 relative to valve 42 lower ports 50 of said stem will register with ports 54 of the valve and ducts 22 of the drill stem.

Fluid, under pressure, in pressure chambers 19 and 20 and ducts 21 will thereupon be relieved into vacuum chamber 37. This will decrease the pressure within packer 9 so that the pressure within the packer will be much less than the pressure on the outside of the packer and, there being low pressure in chambers 19 and 20, the pressure of well liquid outside of the packer will force plungers 10 and 11 toward each other, further compressing springs 17 and 18 and causing an expansion of packer 9 into contact with the walls of the bore as shown more clearly in Figures 6, 7 and 11.

At the same time inlet ports 53 of valve 42 will register with ports 26 through the drill stem and inlet ports 49 of stem 34 will register with ports 52 of sleeve valve 42 to allow an inflow of fluid from the surrounding stratum of the bore through tubes 23, past valve assemblies 27 and

into the interior of stem 34. This fluid will pass upwardly through tube 40 and out through ports 41 and the pressure of the inflowing fluid will lift plunger 39.

Seal rings 51 and 52 form fluid tight seals between stem 34 and sleeve valve 42 and seal rings 55 and 56 form fluid tight seals between said sleeve valve 42 and section 6 of the drill stem.

As shown in Figure 1, the upper end of the bore wall of cylinder 33 has an inside annular, relatively wide, groove 57 therein and when the plunger 39 reaches said groove, as is shown in Figure 6, inflowing fluid, both that which passes up around tube 40 and that which passes up through said tube and out through ports 41 will pass around plunger 39 and will flow on up into sample chamber 31. Tube 40 and plunger 39 will, initially, retard the inflow of liquid through tubes 23. The first fluid flowing in through these tubes will be drilling fluid or fluid contaminated with drilling fluid and, therefore, provision has been made for retarding inflow of such fluid until the packer has been fully seated against the walls of the bore so as to reduce as much as possible entrance of contaminated fluid from surrounding stratum into the sample receiving chamber.

The bailer is allowed to remain in said position for a time until a sample of the contents of the surrounding stratum has had time to flow into and fill sample chamber 31. Thereupon the bailer is withdrawn from the well. Upon initial upward movement of the bailer stem 34 will first move upwardly thus carrying ports 49 and 50 out of registration with ports 53 and 54 and will be latched in its upper position by engagement of latches 45 with shoulder 47 and the closing of ports 49, 50 will entrap this sample in chamber 31. Plunger 39 will also move downwardly into its lower position, the plunger has an annular seal ring 58 therearound, and countersunk therein, which forms a seal with walls of cylinder 33, and this also assists in trapping the fluid.

Upon initial upward movement of the bailer the upper end of vacuum tube 35 will engage the lower end of sleeve valve 42 and said sleeve valve will be pulled out of the packer and the bailer may then be removed to the ground surface to be broken up and the sample inspected.

The upper end of sample chamber 31 has an outlet port 59 which is normally closed by a screw plug 60. Opposite plug 60 there is a screw 61 screwed through the wall of housing 30 and whose inner end terminates in a needle valve 62 which when screwed into its inner position will close port 59. The head of screw 61 is countersunk into the housing and the screw is surrounded by a suitable packing 63 to prevent leakage.

If it be desired to test the pressure within the sample chamber plug 60 may be removed while valve 62 is closed and a pressure gauge substituted for said plug and valve 62 then opened and the gauge will register the pressure.

Upon withdrawal of the bailer fluid in the chambers 19 and 20 will then be exposed to the pressure of the well liquid which may enter said chambers through ducts 22 and 21 and springs 17 and 18 will then force plungers 10 and 11 in opposite directions apart from the packer thus causing the packer to collapse so that the tool may be relocated in the well bore for an additional test or may be withdrawn.

What we claim is:

1. In a wall tool, a packer assembly comprising a tubular packer support open to a well bore at its lower end, an expansible sleeve-like packer around and supported on the support, tubular plungers formed of rigid material forming the ends of the packer and slidable on the support and forming fluid tight joints therewith, a pressure chamber between each plunger and the support, said assembly having a port connecting the chambers into the interior of the support whereby the fluid pressure within the chambers and on the outside of the packer will be equalized when the tool is submerged in liquid in a well bore and means for lowering the pressure in said chambers to allow the movement of the plungers toward each other by the pressure of the well fluid outside of the packer to cause expansion of the packer.

2. In a well tool, a packer assembly comprising a tubular packer support, an expansible sleeve-like packer around the support, tubular plungers formed of rigid material forming the ends of the packer and slidable on the support and forming fluid tight joints therewith, a separate pressure chamber between each plunger and the support, an opening in said support below said packer communicating the exterior of the packer with the interior thereof, said assembly having a passageway connecting the chambers and opening into the interior of the support whereby the fluid pressures within the chambers and on the outside of the tool about the packer will be equalized when the tool is submerged in the liquid in a well, a hollow stem in the support, said stem being closed at its lower end and having an inlet opening exteriorly of the stem, and said stem being independently movable in the support to a position to establish communication between said passageway and said inlet to direct fluid from said chambers into said stem to reduce fluid pressure within said chamber to permit the movement of the plungers toward each other under the influence of the pressure of the well fluid outside of the packer to expand the packer.

3. In a well tool, a packer assembly comprising, a tubular packer support open at its lower end to a well bore, a sleeve-like expansible packer around the support and supported thereby, plungers within the ends of the packer around the support in sealing relation therewith and whose outer ends form end heads for the packer, a pressure chamber in the assembly between the plungers, said assembly having a duct leading from the chamber and opening interiorly of the support to direct the liquid in which the assembly is submerged in a well into said chamber to equalize the pressure in the chamber and on the outside of the packer, a removable hollow stem in said support, said stem having a fluid receiver therein and an inlet in communication with said receiver and opening exteriorly of the stem, said stem being movable in the support to a position to establish communication through said duct between said chamber and said receiver to lower the pressure in said chamber and to cause the pressure of said well fluid outside said packer to move the plungers toward each other to expand the packer.

4. In a well tool, a packer assembly comprising a tubular packer support, a sleeve-like expansible packer around the support and supported thereby, tubular, rigid supporting elements within the ends of the packer and slidable on the support in sealing engagement therewith, an opening in the lower end of said support communicating the exterior of the packer with the interior thereof, a pressure chamber in the assembly between said

supporting elements, said assembly having a duct leading from said chamber and opening into the interior of the support to admit the liquid in which the assembly is initially submerged in a well bore into said chamber to equalize the pressure in the chamber and on the outside of the packer, a hollow stem closed at its lower end insertable in said support and having a fluid receiver therein and an inlet in communication with the receiver and opening exteriorly of the stem, packing means on the stem above and below said inlet engageable with the support to form a seal between the exterior of the stem and the interior of the support above and below said inlet, said stem being movable in the support to a position to establish communication through said duct between said chamber and said receiver to lower the pressure in said chamber to permit expansion of the packer by the endwise compressive force of the pressure of the liquid in the well bore outside of the packer, exerted against the ends of the packer.

5. In a well tester, a packer assembly comprising, a tubular packer support open at its lower end to a well bore, a sleeve-like expansible packer around the support, supporting elements within the ends of the packer around, and slidable on the support in sealing engagement therewith, a pressure chamber in the assembly between said elements, said assembly having a duct leading from said chamber and in communication with the interior of the support to admit the liquid in which the assembly is submerged in a well into said chamber to equalize the pressure of the liquid in the chamber and the pressure on the outside of the packer, means for reducing the pressure in said chamber to effect expansion of the packer by endwise compressive force of the liquid outside of the packer, against the packer, sample container means lowerable into the support, said packer having fluid inlet means mediate its ends opening exteriorly of the packer and in communication with the interior of the support, a conduit in said sample container means communicating with said fluid inlet and sample container means and a sleeve valve in the support between said inlet and said conduit and movable relative to said container means for controlling communication between said fluid inlet and the sample container means.

6. In a well tester, a packer assembly comprising, a tubular packer support adapted to be lowered into a well bore, an expansible packer around the support, means communicating the interior of said support with a well bore and the exterior of the packer with the interior thereof, supporting elements within the ends of the packer around, and slidable on the support in sealing engagement therewith, an internal pressure chamber in the assembly between the elements, said assembly having an internal duct which leads from said chamber and which is in communication with the interior of the support to admit the liquid in which the assembly is submerged in the well into said chamber to equalize the pressure of the liquid in the chamber and the pressure of the liquid in the well bore on the outside of the packer, said packer having a test fluid inlet mediate its ends opening exteriorly of the packer and in communication with the interior of the support, a removable hollow stem closed at its lower end and disposed in the support, said stem having sample container means therein and a passageway opening exteriorly of the stem and in communication with said sample container means, a fluid receiver in the lower end of said stem separate from said sample container means, said stem also having an opening communicating with said receiver and with the exterior of the stem, and a sleeve valve slidable on the stem and seated in said support, said valve having spaced ports therethrough, one of which is communicable with the test fluid inlet and the other of which is communicable with the internal duct said stem being movable relative to the seated valve to establish communication through one of said ports between said chamber and said receiver to lower the pressure in said chamber to effect expansion of the packer by endwise compressive force of the liquid in the well bore outside of the packer against the packer and to establish communication through the other of said ports between said test fluid inlet and said sample container means.

7. In a well tool, a packer assembly comprising, an open ended tubular packer support adapted to be lowered into a well bore, a sleeve-like expansible packer around the support, tubular rigid supporting elements within the ends of the packer and slidable on the support in sealing engagement therewith, a pressure chamber in the assembly between the elements, said assembly having a duct leading from said chamber and opening into the interior of the support to admit the liquid in which the assembly is submerged in the well bore into the chamber to equalize the pressure of the liquid in the chamber and the pressure of the liquid in the well bore on the outside of the packer, a hollow stem insertable in the support and having an inlet opening exteriorly of the stem and in communication with the interior thereof, means initially closing said inlet opening, means in said support for opening said inlet opening, said stem being closed below said inlet opening and movable in the support to open said inlet opening and establish communication between said duct and said inlet to lower the pressure in said chambers and cause the movement of said elements toward each other by the endwise compressive force of the pressure of the liquid in the well bore outside of the packer exerted against said elements to expand the packer, and yieldable means in the assembly cooperable with said support and said elements to urge said elements apart.

8. A well tester for obtaining samples of the fluid content earth formations traversed by a bore hole, comprising an open ended tubular support adapted to be lowered into the bore hole, an expansible packer mounted on the support and having end members slidably mounted on said support in sealing relation thereto, said support and packer forming an assembly including an internal pressure chamber within the packer between the end members and said assembly having a duct therein in communication with said chamber and with the interior of the support to admit liquid from the well bore in which the assembly is submerged to equalize the pressure in the chamber and on the outside of the packer, said packer having a test fluid inlet opening exteriorly of the packer and in communication with the interior of the support, a hollow stem insertable in the support, said stem having a sample container therein and a passageway communicating with the sample container and opening exteriorly of the stem, a fluid receiver in said stem separate from said sample container means, said stem having an opening in communication with said receiver and opening exteriorly of the stem, a sleeve

valve around and slidable on the stem and seatable on a valve seat formed in the support, said valve having spaced ports disposed in registration with said duct and said fluid inlet when seated on said valve seat and said stem being movable in the valve to a position to establish communication through one of said ports between said duct and said fluid receiver to reduce the pressure in said chamber to cause expansion of the packer by endwise pressure of the liquid in the well bore outside the packer and to establish communication through the other of said ports between said fluid inlet and said sample container to admit a fluid sample to the container from a surrounding formation.

9. In a well tester, a packer assembly comprising, a packer support adapted to be lowered into the well, an expansible packer around the support and supported thereon, supporting elements within the ends of the packer around, and slidable on the support in sealing engagement therewith, said assembly containing an internal pressure chamber and also having an external duct which leads from said chamber into the interior of said support and which is initially in communication with the liquid in which the assembly is submerged in the well to equalize the pressure of the liquid in the chamber and the pressure of the liquid on the outside of the packer, test fluid inlet means in the wall of the packer, a stem having sample container means positioned in the support, a low pressure chamber insertable in said support for permitting exit of fluid from said pressure chamber, a conduit in said stem communicable with said fluid inlet means and sample container means, and valve means on the stem controlling communication of said low pressure chamber with said internal duct to permit expansion of the packer by the endwise compressive force of the liquid outside of the packer against the packer, said valve means being also adapted to control communication between said fluid inlet means and sample container means.

10. A well tester for obtaining samples of the fluid content of earth formations traversed by a bore hole comprising an open ended tubular support adapted to be lowered into a bore hole, a sleeve-like expansible packer formed of flexible material mounted on the support and whose ends are slidable relative to the support and in sealing engagement therewith, said packer containing a pressure chamber between said ends and said assembly having a duct in communication with said chamber and terminating in a port in communication with the liquid in which the packer is submerged in the well bore to equalize the pressure of flow within the chamber and the chamber of fluid on the exterior of the packer, a stem lowerable in the support and containing a lower pressure chamber having an inlet communicating with said low pressure chamber and adapted to be brought into registration with said port, said inlet having means for closing the same openable to relieve the pressure from the chamber within the packer to permit the expansion of the packer by the endwise pressure of the liquid in the well bore outside of the packer on the packer, said packer having a test fluid inlet mediate its ends opening exteriorly of the packer and in communication with the interior of a fluid receiving chamber in the stem for containing the sample obtained, valve means carried by said stem controlling the flow of a sample into said fluid receiving chamber.

LUTHER E. BROWN.
OLLIN W. WILLIAMS.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,098,484	Brundred et al.	Nov. 9, 1937
2,138,375	Grant	Nov. 29, 1938
2,177,203	Bradley	Oct. 24, 1939
2,196,668	Ragan	Apr. 9, 1940
2,227,731	Lynes	Jan. 7, 1941
2,390,372	Johnston et al.	Dec. 4, 1945
2,404,825	Brown et al.	July 30, 1946
2,516,581	Lynes	July 25, 1950