July 25, 1950 J. LYNES 2,516,580

FORMATION TESTING TOOL

Filed July 3, 1944 4 Sheets-Sheet 1

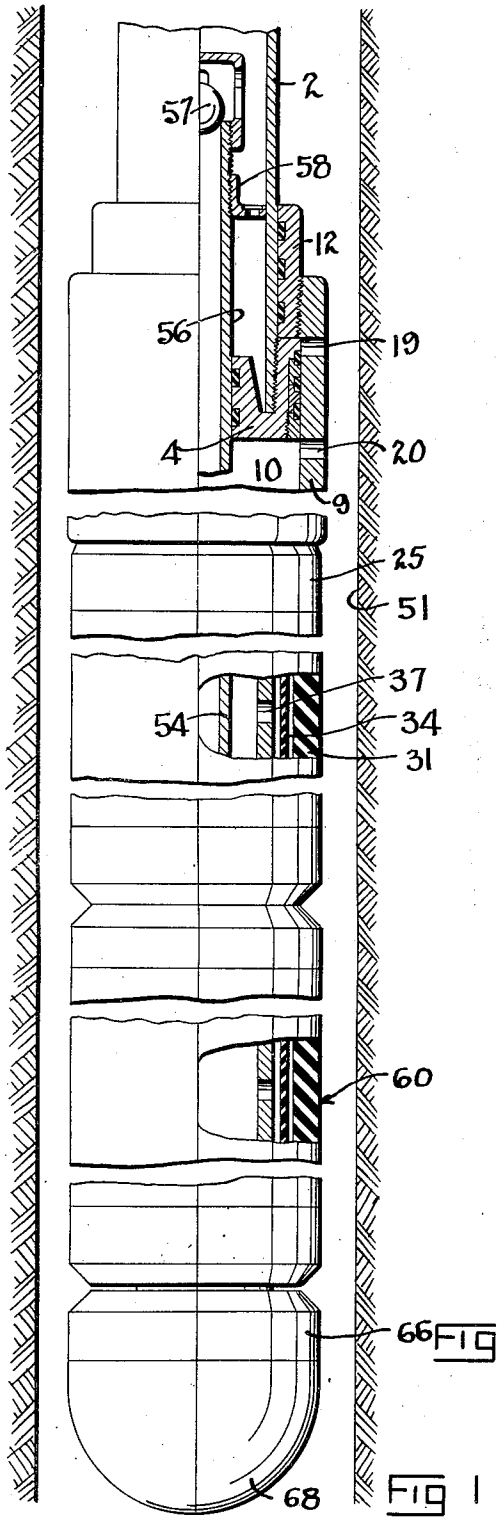


Fig 1

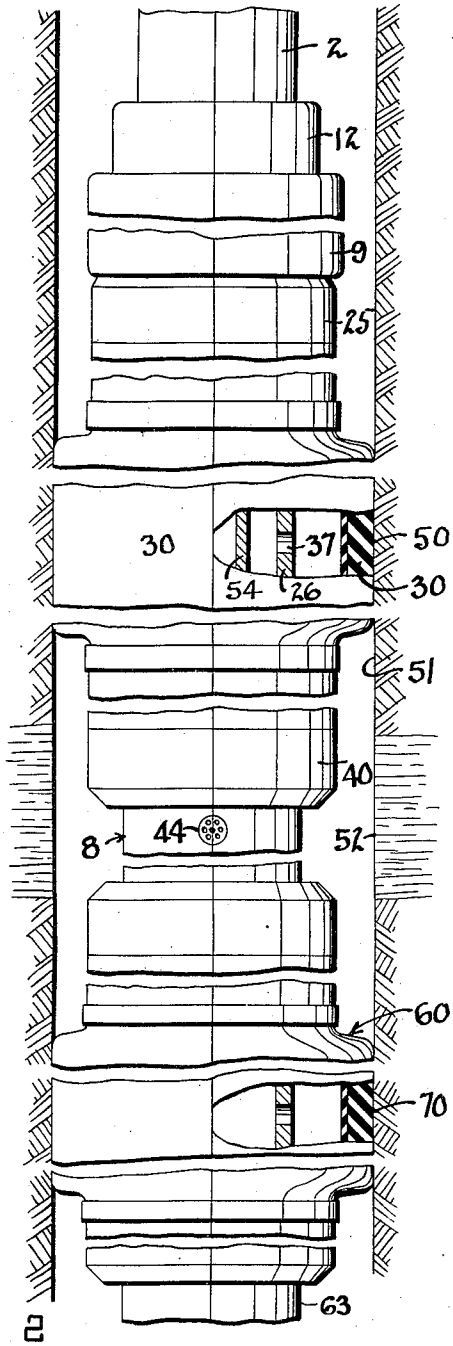


Fig 2

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FORMATION TESTING TOOL

Filed July 3, 1944 4 Sheets-Sheet 2

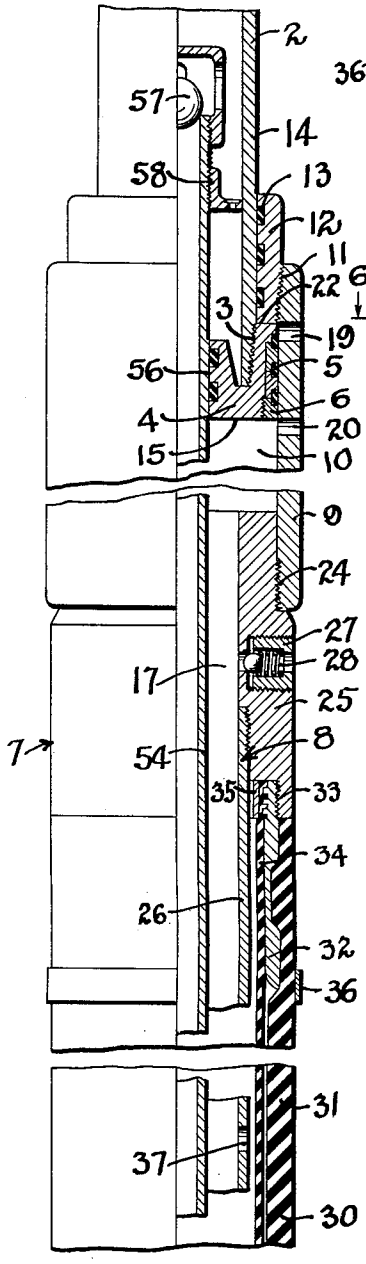


Fig 3

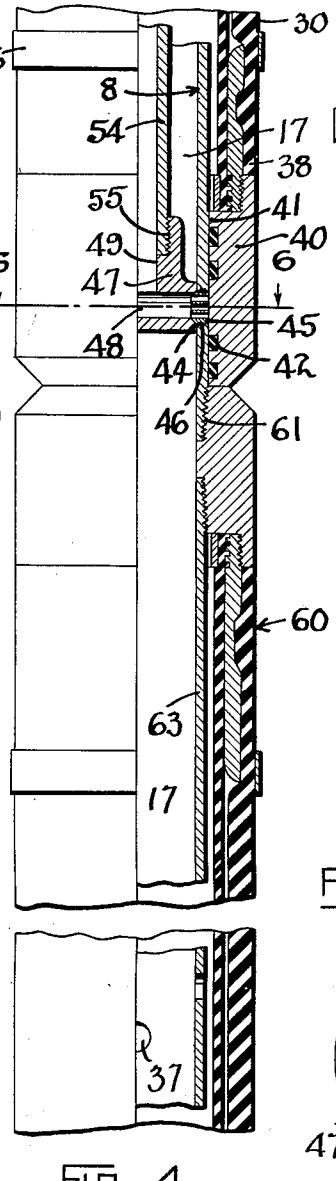


Fig 4

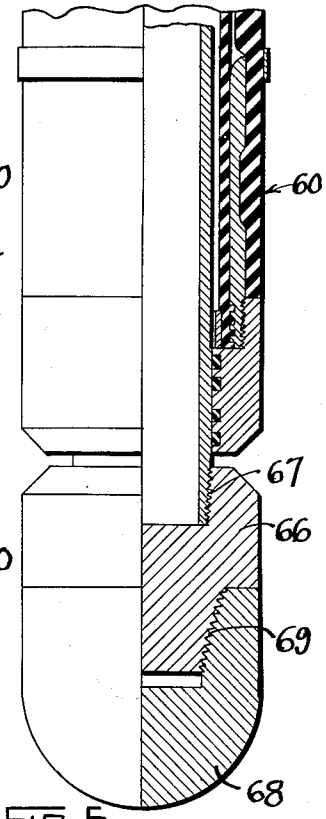


Fig 5

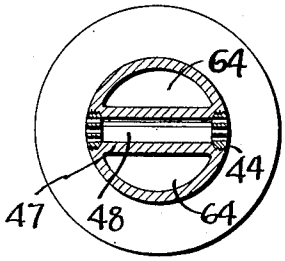


Fig 6

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FORMATION TESTING TOOL

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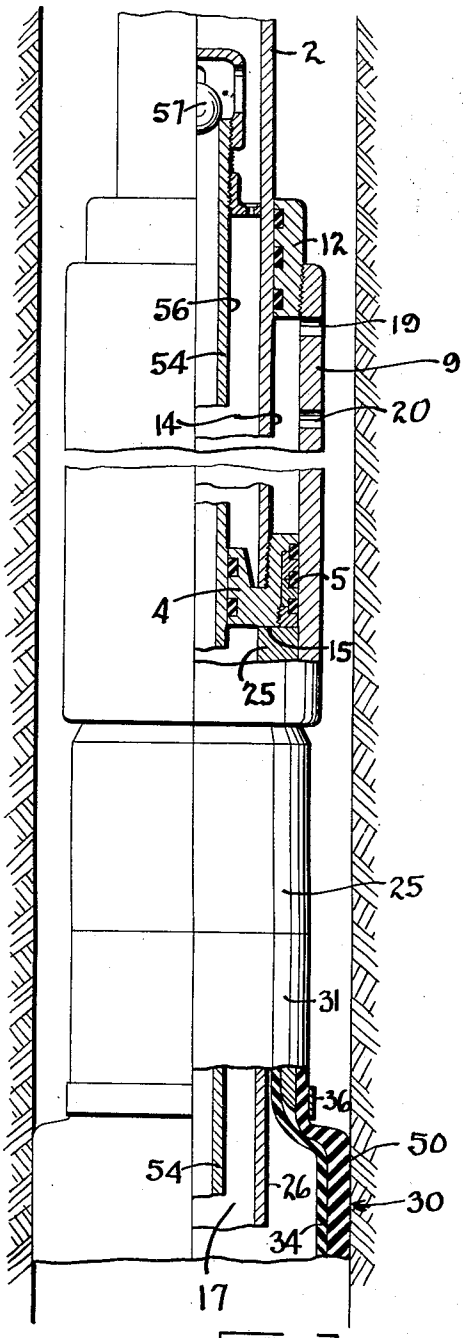


FIG 7

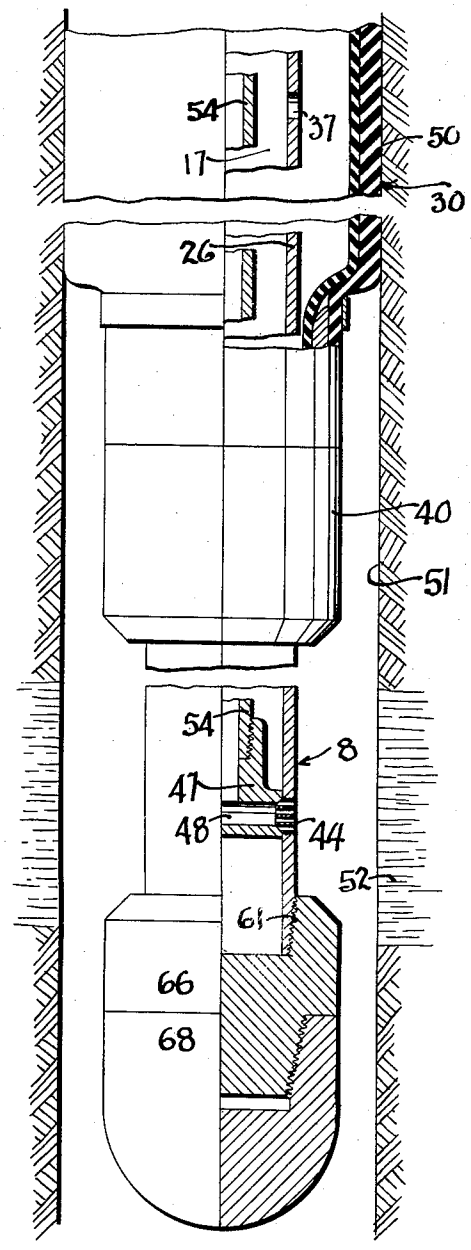


FIG 8

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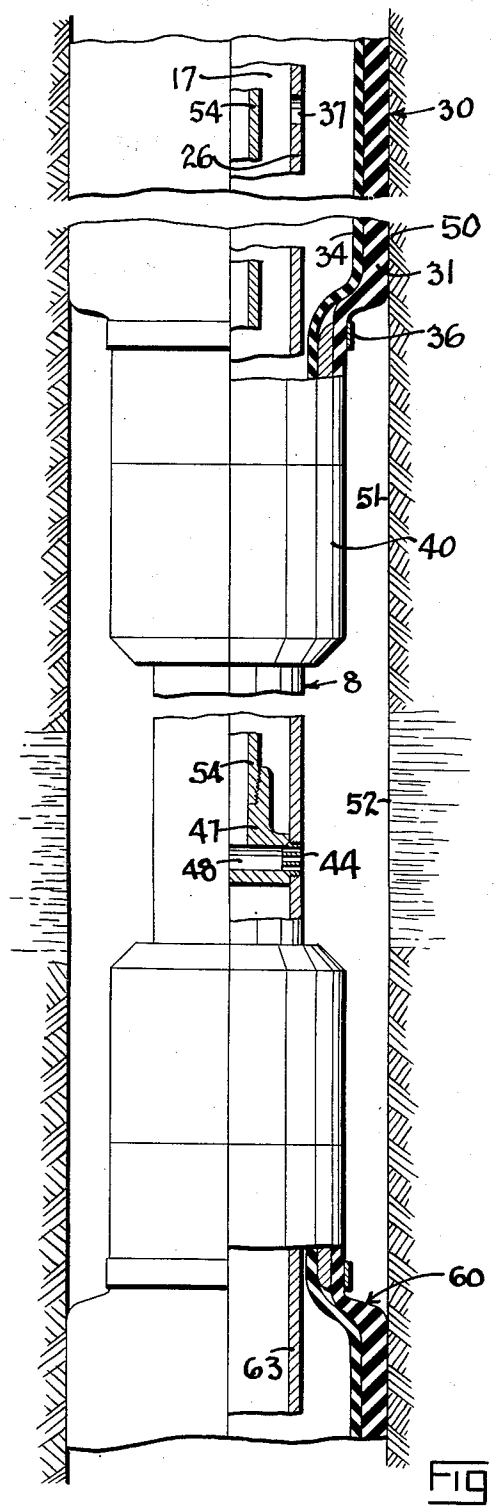


Fig 9

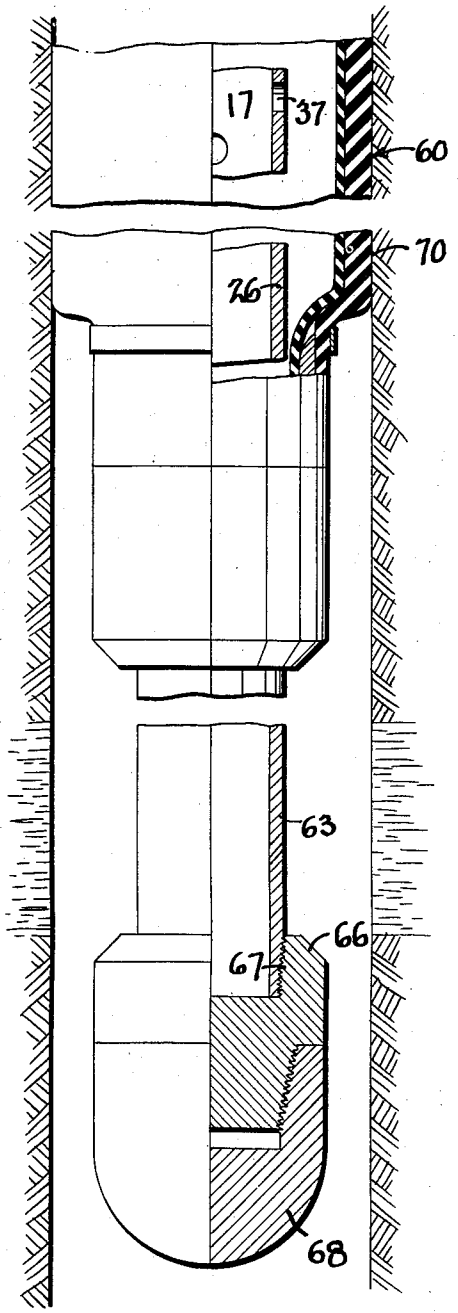


Fig 10

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Patented July 25, 1950 2,516,580

UNITED STATES PATENT OFFICE

2,516,580

FORMATION TESTING TOOL

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Application July 3, 1944, Serial No. 543,381

7 Claims. (Cl. 166—11)

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The invention relates to a formation testing tool for determining the contents and nature of a formation which has been penetrated in the drilling of a well bore.

In the deeper wells due to the tremendous pressures it has heretofore been impossible to provide a tool which would maintain a suitable seal with the walls of the well for a sufficient period of time to permit opening of the tool and the obtaining of a sample due to the fact that the means by which the seal is formed would have to exert a sufficient frictional engagement with the walls of the well bore to support the load of the column of drilling mud in the well above it.

The present invention therefore contemplates a hydraulically inflated packer which can be inflated by movement of the operating pipe relative thereto so as to inflate the packer or packers and to maintain a seal with the wall of the well bore until a sample of formation fluid can be obtained.

One of the particular features of the present invention is the simultaneous inflating of the packer and opening of the tool as a dual operation resulting from a single movement or manipulation of the operating pipe.

Another object of the invention is to provide a hydraulically inflatable packer for well formation testing tools which contracts axially as it is inflated so as to perform the dual operation of forming a seal and opening the tool by such contraction.

Still another object of the invention is to provide a formation testing tool having a packer thereon which normally covers the entry port to the tool where the packer is adapted to contract axially upon inflation to form a seal with the wall and to also open the tool.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a side elevation with certain parts in section and showing the tool as being lowered into a well bore.

Fig. 2 is a side elevation with certain parts in section and illustrating the tool as embodying two packers which have been inflated to form a seal above and below a formation to be tested.

Figs. 3, 4 and 5 are side elevations with one quarter in section which go to make up a complete tool embodying two packers.

Fig. 6 is a section taken on the line 6—6 of Fig. 4.

Figs. 7 and 8 are side elevations with one quarter in section which make up a formation testing tool embodying a single packer.

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Figs. 9 and 10 are side elevations of a formation testing tool with one quarter in section which make up a tool embodying two packers when the top of the tool shown in Fig. 7 is considered.

Figs. 3, 4 and 5 show the sectional view of the tool embodying two packers wherein the operating pipe 2 is shown and it is understood that such pipe extends to the surface. This pipe is threaded at 3 at its lower end and has affixed thereon a piston or head 4 which carries suitable packing or sealing members 5 on its outer periphery which are held in position by a retainer ring 6. This piston is arranged for sliding movement inside of the formation testing tool 7 which is made up of a housing 8. This housing is in turn made up of a number of parts including the cylindrical upper end 9 which forms a reservoir or chamber 10. This cylinder is threaded at 11 and carries a sealing collar 12 having the packing 13 to form a seal with the periphery 14 of the operating pipe. The piston 4 is arranged for sliding movement inside of the cylinder 9 and when a liquid is disposed in the chamber or reservoir 10 it seems obvious that it will be exposed to the lower surface 15 of the piston so that if the operating pipe 2 is moved relative to the tool 7 and the housing 8 that the liquid will be forced downwardly from the reservoir 10 into the chamber 17 inside of the housing.

In order to permit breathing inside of the cylinder 9 when the piston moves the ports 19 and 20 have been in the cylinder provided. When the tool is being lowered into the well bore as seen in Fig. 1 the weight of the tool 7 will rest upon the upper shoulder 22 of the piston due to the gland or collar 12 seating thereon. The port 20 allows equalizing of any pressure inside and outside of the housing.

Figs. 3 and 4 show the housing 8 as including a coupling 25 which is threaded at 24 to the lower end of the cylinder and also to the upper end of the mandrel 26.

A relief valve 27 is shown as positioned in the side of the coupling 25 and is controlled by a spring 28 which will be of a strength or size to determine the maximum differential pressure which can exist between the inside chamber 17 and the outside of the tool so that no excessive pressure can be applied by movement of the piston 4 because if the pressure in the chamber 17 exceeds that on the outside of the valve 27 by the

amount controlled by the spring 28 then the valve will open. This is merely a safety feature.

The collar 25 serves as a support for the packer construction 30 which may be of a type which is suitable to withstand tremendous pressures when it is inflated in a well bore..

A particular type of packer which has been found satisfactory to withstand high pressures is shown, described and claimed in my copending application Serial No. 473,928, filed January 29, 1943, for Hydraulic Inflatable Packer and Assembly for Testing and Treating Well Formations, which is now copending herewith as a continuing application, Serial No. 65,843, filed December 17, 1948, and the packer 30 is merely illustrative of the packer in my copending application. The packer is here shown as embodying an outer layer of resilient material 31 which is supported upon a sleeve 32 threaded at 33 to the inside of the coupling 25. In order to provide a seal and prevent escape of liquid between the sleeve 32 and the resilient material 31 an inner sealing liner 34 has been provided which extends inside of the sleeve 32 and has its upper end held in position by a retainer collar 35.

An outer ring 36 is positioned where the bulge or enlargement of the packer occurs as it is inflated and tends to retain the outer resilient portion 31 in position to prevent it from becoming loosened or shearing over the end of the inner portions.

The housing or mandrel 26 has a port 37 therein leading from the chamber 17 to the area inside of the packer 30.

The lower end 38 of the packer has a combination collar and sleeve valve 40 affixed thereto in the same manner that the coupling 25 is affixed to the packer. This valve 40, however, is arranged for sliding movement on the periphery 41 of the housing or mandrel 26 and a plurality of packings 42 prevent leakage of fluid from the packer.

It seems obvious that when the operating pipe 2 is lowered that pressure will be applied to the liquid in the chamber 10 as soon as the piston 4 covers the opening 20 and that any further lowering of the weight of the drill stem or operating pipe 2 relative to the tool will cause the piston to move further and force the liquid into the chamber 17 and thence through the port 37 to inflate the packer.

The packer, as a matter of fact includes in its internal construction helically wound wires which expand radially when the pressure is applied with a consequent axial construction so that the collar 40 tends to slide upwardly along the housing or mandrel 26.

Fig. 4 shows an entry port 44 as being provided in the mandrel or housing 26 by having the perforated button 45 threaded at 46 into the mandrel. This button also serves to center and hold in position a fitting 47 which is in the nature of a pipe T in that it has the cross passage 48 and the vertical passage 49 therein. A similar button 45 is disposed diametrically from the button shown in Fig. 4 so that the fitting is suitably anchored.

This port 44 is so located that when the packer is inflated and the collar 40 moved upwardly that the port will be uncovered as seen in Fig. 2 where the upper packer 30 has been inflated.

The inflating operation caused by lowering of the drill stem therefore accomplishes a dual function in that it inflates the packer and forms a seal as at 50 with the wall 51 of the well bore and it also causes the sleeve valve 40 to uncover the port 44 so as to open the tool to a productive formation such as 52 seen in Fig. 2, which formation is to be tested.

In order that the sample fluid entering the port 44 will not be contaminated with the actuating liquid inside of the reservoir 10 and chamber 17 a sampling pipe 54 is threaded at 55 into the fitting 47 and this sample tube or pipe 54 extends upwardly through the housing through the central opening 56 in the piston 4 and into the operating pipe 2 where a one-way check valve 57 prevents the escape of any of the sample from the operating pipe. A spider 58 tends to center the tube in the operating pipe 2. This sample tube remains stationary with the housing of the tool and the piston 4 slides around it.

It will be understood that the operating pipe and the tool are empty and closed as the tool is lowered into the well bore and the only liquid inside the tool will be that in the reservoir 10 and chamber 17.

A simple and economical operation for inflating the packer and opening the tool by one manipulation of the pipe 2 has been provided. As soon as a sample has been received it is only necessary to pick up on the operating pipe 2 to raise the piston 4 whereupon the external pressure in the well bore will cause deflation of the packers by forcing the actuating liquid to return through the port 37 into the chamber 17 and reservoir 10.

Figs. 4 and 5 show the housing 8 and the mandrel 26 as having a second packer 60 threaded at 61 thereto. The chamber 17 extends into this lower portion of the housing inside of the mandrel 63 which is similar to the mandrel 26. The mandrel 26 is open at each side of the fitting 47 to provide the passages 64 as seen in Fig. 6.

The lower end of the housing 8 as illustrated by the mandrel 63 is closed with a coupling 66 threaded at 67 thereon and a rounded shoe 68 may be threaded at 69 thereon so as to guide the tool in its lowering movement into the well.

While Figs. 3, 4 and 5 illustrate a tool having two packers so as to form a seal at 50 with the upper packer and a second seal at 70 with the lower packer as seen in Fig. 2 it seems obvious that a single packer such as the packer 30 may be used if it is so desired and Figs. 7 and 8 illustrate such a tool where the coupling 66 and the guide plug 68 have been connected to the thread 61 directly below the port 44. In this manner when the seal 50 is formed the entire lower end of the well bore will be open to the tool whereas when the combination of two packers shown in Figs. 3 to 5 is utilized then any particular formation may be isolated by providing both the seals 50 and 70.

The tool may be set for testing operation at any elevation in the well bore by use of a tail pipe connected between the guide plug 68 and the coupling 66 of sufficient length so that the guide plug may rest upon the bottom of the well and serve to support the weight of the tool itself and allow the operating pipe and piston to move downwardly sufficient to expand the packer to create a frictional engagement with the wall of the well.

If more than one test is to be made the tool may be supported by an expandable plug designed to contact the wall of the well and fastened to the bottom of the tool, this plug is closed at the lower end as the tool is lowered into the well bore in order to open the mouth of the plug it is necessary to engage the trip piston in the mouth of

the plug with the bottom of the well, when the plug is used as a supporting member of the tool the test must be made as the tool is moved upward as it will be impossible to lower the tool after the mouth of the supporting plug has been opened, the supporting plug is constructed of an expandable material such as rubber and heavily reinforced with wires and springs.

While the structure of the tool and its method of operation have been described for use in the testing of formations it is clear that the tool may be used for treating formations by merely removing the check valve 57 so that pressure applied to the tool will discharge through the sample pipe 54. Either one or two packers may be thus used.

Broadly the invention contemplates a means and method for obtaining formation fluid samples and testing formations in a well bore particularly where the bore is filled with a column of fluid such as drilling fluid whereby the formation may be isolated by a single manipulation of the drill pipe to accomplish a lowering action thereon whereby a seal with the wall and opening of the tool are simultaneously accomplished.

What is claimed is:

1. A formation testing tool comprising an operating pipe, a piston thereon, a cylinder about said piston, a seal between the cylinder and said pipe, a hydraulically inflatable packer connected to said cylinder and adapted to be inflated by a liquid in said cylinder being forced into the packer on movement of said piston, an entry to said cylinder, a sample tube connected to said entry in said cylinder and slidably extending through said piston and into said pipe to conduct a sample into said pipe, said piston and sample tube sealing the inflating liquid in said cylinder, said packer including a lower end overlying said entry and which is slidable on said cylinder in response to the inflating pressure in the packer to uncover the entry.

2. A formation testing tool comprising a body, a hydraulically inflatable packer thereon, an entry in said body for a sample of formation fluid, an operating pipe slidable in said body, a tube extending from said entry into said pipe, a cylinder forming a part of said body, a slidable piston sealed in said cylinder and about said tube, said operating pipe being connected to said piston whereby lowering of the piston forces a liquid from said cylinder into said packer, the lower end of said packer being slidable on said body and disposed to cover said entry when the packer is deflated but slidable upon inflation to uncover said entry.

3. A formation testing tool comprising a body, a hydraulically inflatable packer thereon, means carried by said body to receive a sample, a sleeve valve forming one end of said packer, overlying said entry, and adapted for movement due to inflation of said packer to uncover said entry to admit a sample to the tool.

4. A formation testing tool comprising a body, a hydraulically inflatable packer thereon, means carried by said body to receive a sample, a sleeve valve forming one end of said packer, overlying said entry, and adapted for movement due to inflation of said packer to uncover said entry to admit a sample to the tool, and means to inflate said packer comprising a reservoir for liquid in said body, an operating pipe for the tool, and a piston in said reservoir to force liquid therefrom into said packer.

5. A formation testing tool comprising a housing, an operating pipe slidably connected thereinto, a piston on said pipe forming a seal with the inside of said housing, an inflatable packer on said housing, an opening from the interior of the housing into said packer, a liquid in the housing and adapted to be forced into said packer through said opening when said pipe and piston are lowered relative to said housing so as to inflate the packer and provide a seal with the wall of the well, one end of said packer being slidably mounted on said housing, said housing having a port which is covered by said end, but which port is opened by being uncovered upon contraction in the length of said packer due to inflation.

6. A formation and treating tool for wells including a housing, an inflatable packer thereon, a reservoir for liquid in said housing, an operating pipe slidably connected to said housing, means in the housing and movable by said pipe to force liquid into said packer, said packer being contractible upon inflation, a port into said housing, a tube fixed to said port and extending through said reservoir, and means on the packer closing said port but movable to uncover the port upon inflation of the packer so as to open said tool to discharge treating liquid or to receive a sample of the formation.

7. A well tool including an operating pipe, a housing slidably mounted on the lower end of said pipe, an inflatable packer on said housing, an opening from said housing into said packer, a liquid in said housing, piston means on said pipe in said housing and operable by said pipe to force such liquid into said packer to expand the packer to seal with the wall of the well, a sample tube extending into said housing from within said pipe and thru said piston means, a lateral entry port means connecting said tube to said housing and opening externally thereof, a lower end on said packer normally overlying said port means and slidable on said housing to uncover said entry means upon inflation of said packer.

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