

March 10, 1953

J. LYNES

2,630,864

WELL FORMATION TOOL

Filed Oct. 19, 1944

4 Sheets-Sheet 1

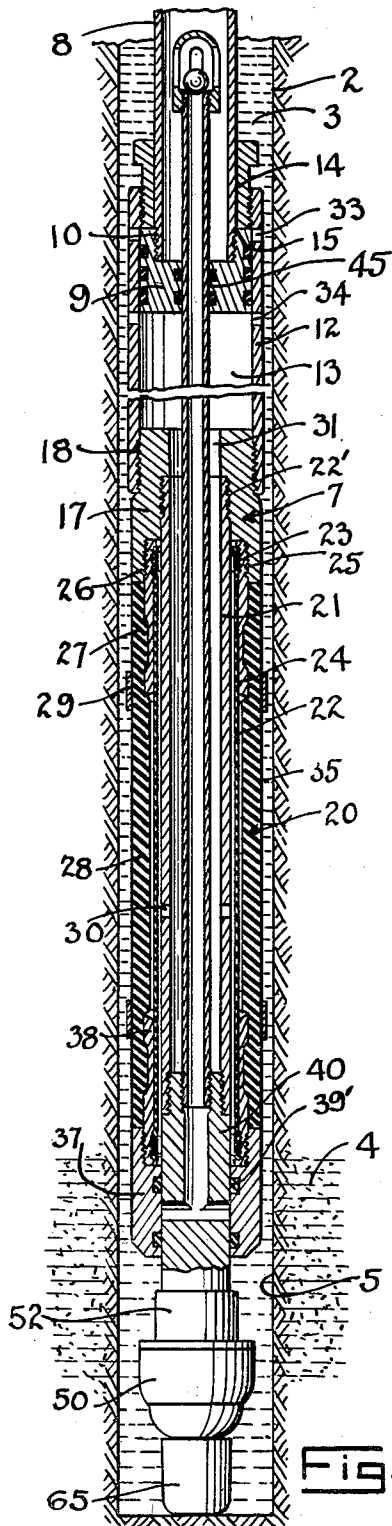


Fig. 1.

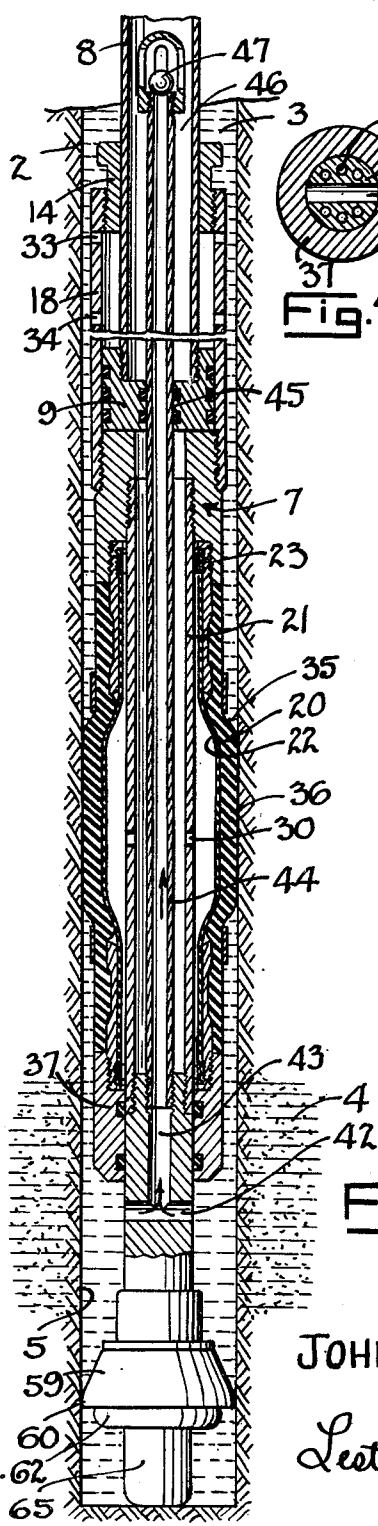


Fig. 2.

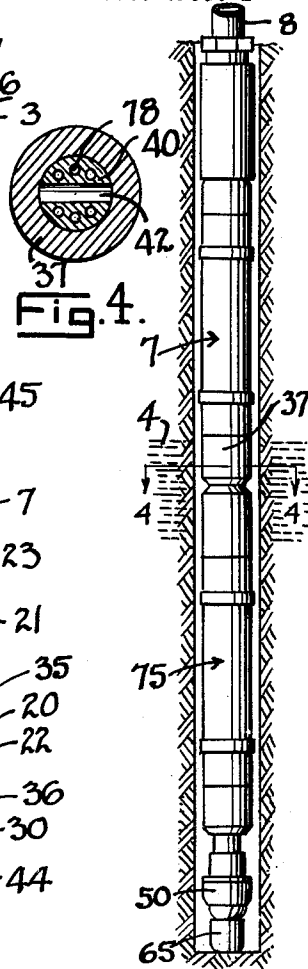


Fig. 3.

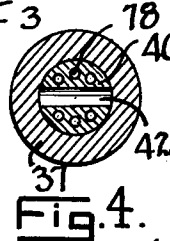


Fig. 4.

Inventor
JOHN LYNES.

Lester B. Clarke.
Attorney

March 10, 1953

J. LYNES

2,630,864

WELL FORMATION TOOL

Filed Oct. 19, 1944

4 Sheets-Sheet 2

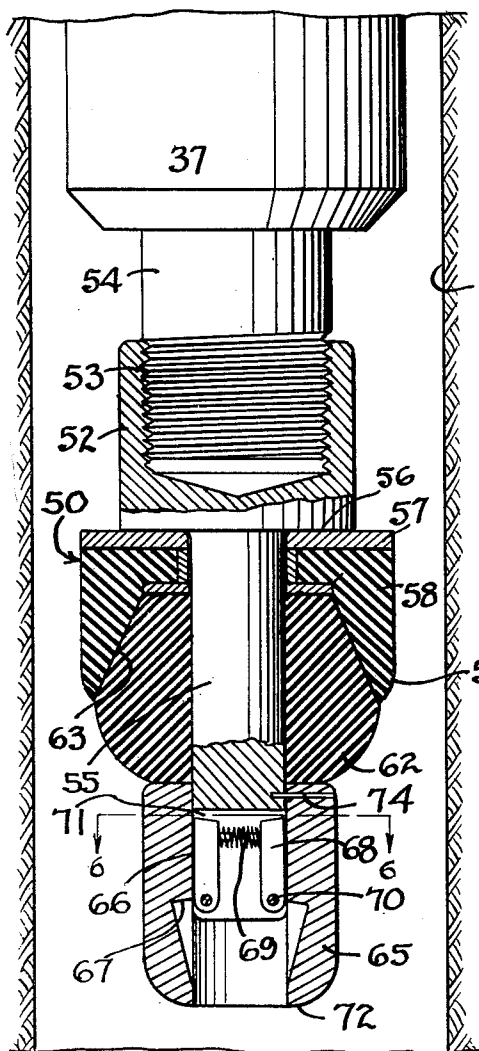


Fig. 5.

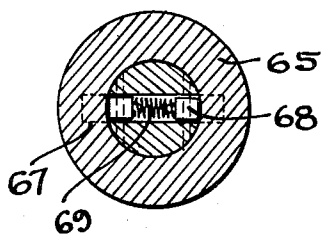


Fig. 6.

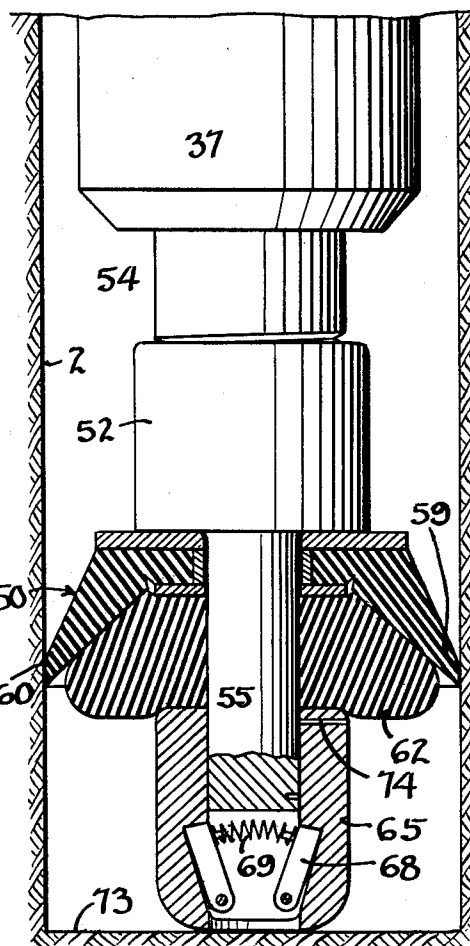


Fig. 7.

INVENTOR.
JOHN LYNES.
BY
Lester B. Clark.
ATTORNEY.

March 10, 1953

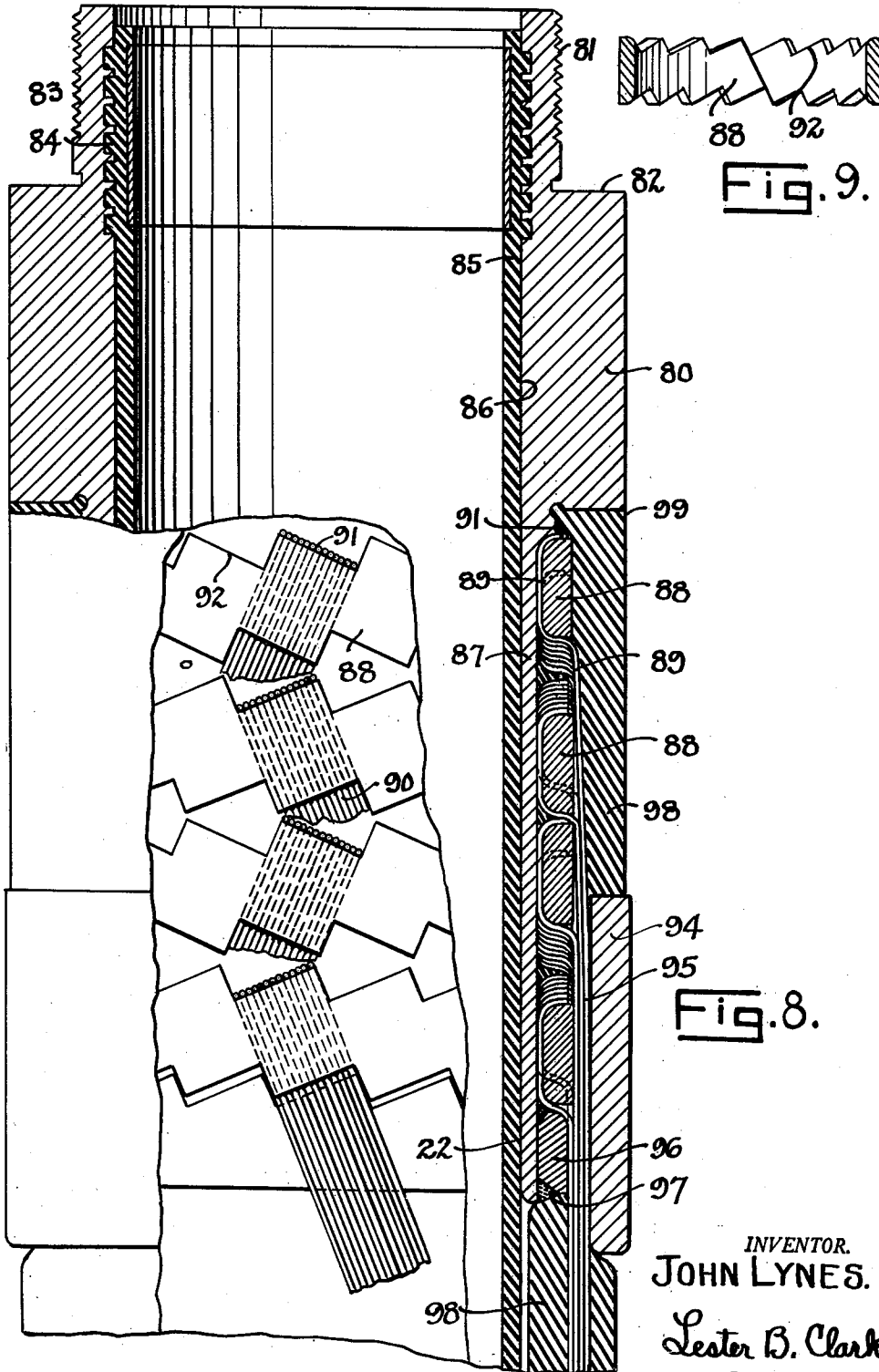
J. LYNES

2,630,864

WELL FORMATION TOOL

Filed Oct. 19, 1944

4 Sheets-Sheet 3



INVENTOR.
JOHN LYNES.

Lester B. Clark.
ATTORNEY.

UNITED STATES PATENT OFFICE

2,630,864

WELL FORMATION TOOL

John Lynes, Houston, Tex., assignor to Lynes, Inc.,
a corporation of Texas

Application October 19, 1944, Serial No. 559,338

1 Claim. (Cl. 166—10)

1

The invention relates to a tool for manipulation in a well bore with a view of testing, treating, cementing, or accomplishing other operations where a seal is to be provided in the well.

The invention relates generally to the subject matter disclosed in my prior copending application Serial No. 543,381, filed for a Formation Testing Tool, filed July 3, 1944, now Patent No. 2,516,580, granted July 25, 1950.

It is one of the objects of the present invention to provide a well tool which can be set at any desired elevation in the well bore so as to provide a seal in the well bore while opening the tool to a formation below the seal thus formed.

Still another object of the invention is to provide a tool which when once tripped can thereafter be set for operation an indefinite number of times as it is raised in the well bore.

Still another object of the invention is to provide a positioning cup construction for use with a well tool so as to temporarily hold the tool at the desired elevation in the well to permit the setting of a hydraulic packer to anchor the tool against movement and to form a seal with the well bore.

Still another object of the invention is to provide a positioning cup which will automatically engage the wall of the well bore when the tool to which it is connected is lowered so as to permit a setting of a packer which is also carried by the tool.

It is also an object of the invention to provide a hydraulically inflatable packer for wells which will withstand tremendous pressure due to the particular arrangement of the reinforcing material in the packer sleeve.

Still another object of the invention is to provide a packer reinforcing assembly wherein reinforcing strands are woven in a helical path to permit radial expansion and longitudinal contraction of the packer under pressure.

A still further object of the invention is to provide a high pressure hydraulic packer wherein a single reinforcing strand of material is woven back and forth in a helical path from end to end of the packer.

Still another object of the invention is to provide a reinforcing assembly for hydraulic packers wherein a reinforcing strand is anchored at the ends of the packer and imbedded in resilient material so as to reinforce the material against the pressure encountered.

Still another object of the invention is to provide a plurality of laminated layers of reinforcing strands where each layer constitutes a single

2

strand for the reinforcing of a packer construction.

Still another object of the invention is to provide an anchoring means on packer heads in order to retain the reinforcing strands utilized in the manufacture of a hydraulic packer.

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 vertical sectional view of the tool being lowered into a well bore and about to be manipulated so as to set it in sealing position.

Fig. 2 is a section of the tool of Fig. 1 where the seal has been set by manipulation of the tool in engagement with the well bottom.

Fig. 3 is a side elevation of a tool arranged for setting in the well bore where two spaced packers are arranged to isolate a formation.

Fig. 4 is a section taken on the line 4—4 of Fig. 3.

Fig. 5 is a vertical sectional view of the positioning cup in collapsed position.

Fig. 6 is a section taken on the line 6—6 of Fig. 5.

Fig. 7 is a view similar to Fig. 5 except that the positioning cup is shown as having been expanded to initially permit the setting of the packer.

Fig. 8 is a side elevation with certain parts broken away and shown in section to illustrate the manner of anchoring the reinforcing strands in the ends of the packer.

Fig. 9 shows a sectional view of one of the anchor rings.

Fig. 10 is a side elevation showing the arrangement for passing a single strand of reinforcing material from end to end of the packer in making up a layer of reinforcing material.

Fig. 11 is a section taken on the line 11—11 of Fig. 10.

Fig. 12 is a transverse sectional view through the construction of the packer, showing the plurality of laminated layers of reinforcing material enclosed in the packer sleeve.

In Fig. 1 the well bore 2 has been drilled and during the drilling operation, the flushing fluid or drilling mud 3 is present in the well.

A formation 4 has been penetrated and it is desired that some operation be performed in connection with this formation 4. Such an operation may be (1) the taking of a sample of fluid from such formation 4, (2) the treating of the formation 4 for the purpose of introducing acid or other chemicals to dissolve or treat the formation, (3) the cementing or squeezing of cement

into the formation 4 to block off the formation, or (4) the performance of some other operation in connection with this formation 4.

In view of the fact that the column of mud 3 in the well usually creates a predominate pressure upon the face of the well bore such as the exposed area 5 of the formation 4, it is desirable to seal off the well bore so as to eliminate such pressure upon the formation 4.

To accomplish the dual purpose of performing the operation on the formation and the sealing of the formation during such operation, a well tool 7 has been lowered into the well. This tool is usually manipulated by means of an operating pipe 8 which carries a piston or plunger 9 threaded at 10 to the lower end thereof. This piston or plunger is arranged for sliding movement in the pipe 12 which is hollow and thus forms a chamber 13.

To retain the pipe 12 about the plunger 9, a gland 14 is threaded into the upper end of the pipe 12.

The load of the tool 7 is thus supported upon the shoulder 15, forming the upper end of the plunger 9.

With the parts in the position shown in Fig. 1 the tool is lowered into the well bore with a view of forming a seal with the wall 2 of the well bore.

The structure of the tool 7 to accomplish this seal includes the coupling 17 threaded at 18 into the lower end of the pipe 12 and this coupling serves as the upper end of the packer assembly 20 which assembly is made up of the mandrel 21 threaded at 22' inside of the coupling 17. The foregoing parts cooperate to make up the body of the tool. Around this mandrel is arranged an internal sealing liner 22 anchored at 23 inside of the coupling 17. This liner is arranged to be forced against the packer head 24 which is threaded at 25 into the skirt portion 26 of the coupling 17 in such a manner that it will form a support for the upper end 27 of the packing sleeve 28. A retainer ring 29 confines the resilient packing sleeve 28 when pressure fluid is applied to cause its inflation. Such pressure fluid may pass from the chamber 13 through the passage 31 and into the mandrel 21 and outwardly through the mandrel openings 30 into the liner 22. The chamber 13 in turn has the openings 33 and 34 so as to allow an inflow and an outflow of fluid. When, however, the tool 7 is held stationary and the pipe 8 is lowered as soon as the plunger 9 passes the opening 34, any fluid in the chamber 13 will be trapped therein and forced through the passage 31 and out through the openings 30 and into the sleeve 22 to effect inflation of the packer as best seen in Fig. 2. In this manner the outer periphery 35 of the packing sleeve forms a seal as at 36 with the wall of the well bore.

The lower end of the packer is closed by a slide valve nipple 37, which carries the packer head 38 and serves as a support for the lower end of the packer sleeve 28 and inner liner 22. Suitable packing rings 39' form a seal with the periphery of the mandrel 21 so there can be no leakage thereby.

Extending through the nipple 37 is a flow connection 40 which is connected to the lower end of the mandrel 21 in such a manner that, when the pressure is applied to inflate the packer, the nipple 37 will slide upwardly to the position of Fig. 2. The flow ports 42 will thus be uncovered due to the axial contraction of the packer, which causes the raising of the nipple 37. The

flow port 42 leads into a passage 43 which has the flow tube 44 connected thereto. This flow tube passes through an opening 45 in the plunger 9 and into the chamber 46 inside of the operating pipe 8, where the check valve 47 is disposed thereon and arranged to prevent any back flow.

Such a check valve is used when the formation 4 is to be tested and a fluid sample obtained, because the upward flow of such fluid sample will lift the valve 47 and trap a sample of the fluid in the chamber 46 of the operating pipe 8. On the other hand, if pressure were being applied to the formation 4, then of course the check valve 47 would be reversed to prevent any back flow into the operating pipe from the formation where the pressure was being applied.

The construction and operation of the tool thus far described quite closely follows that disclosed in my above mentioned application for patent.

One of the novel features of the present invention is the arrangement of a positioning cup 50 which is shown in a collapsed position in Figs. 1 and 5 and in extended position in Figs. 2 and 7.

The purpose of this cup is to temporarily hold the tool at a desired elevation until the pipe 8 can be manipulated to force fluid into the packer to form a seal with the packer. The detail structure of this positioning cup is best seen in Figs. 5 and 7 and includes a coupling 52 threaded at 53 to the lower end 54 of the flow connection 40. This coupling has a stem 55 of reduced diameter extending therebelow and provides a shoulder 56 on which a plate 57 is arranged to abut. This plate 57 serves as a support for the positioning cup 58 which fits around the stem 55 and has a resilient lip 59 thereon. It is intended that this lip 59 may be moved outwardly so as to engage the face of the well bore as at 60 in Fig. 7. A plug 62 having a tapered face 63 is shown in Fig. 5 as being fitted inside of the inverted cup 58. Arranged around the stem 55 is the latch collar 65, having an opening 66 therein to slide on the stem 55. This collar has the notches 67 arranged to receive the latch pins 68 which are normally urged outwardly by a spring 69, these pins being pivoted at 70 in the cross slot 71 in the lower end of the stem.

Normally the parts are in the position shown in Fig. 5, but when the tool is lowered so that the bottom 72 of the collar 65 abuts an obstruction 73, such as the bottom of the well, the stem 55 will slide downwardly due to the resilient nature of the cup 58 and the plug 62 so as to force the parts to the position of Fig. 7. This downward movement of the stem 55 shears a retainer pin 74 which normally prevents such action and as the movement is completed, the latch arms 68 will snap into the notches 67 and prevent return of the parts to the collapsed position.

Further movement of the operating pipe 8 now causes the plunger 9 to move down into the chamber 13 and inflate the packer.

The desired operation can now be performed because the ports 42 will have been opened as seen in Fig. 2.

This positioning cup is of particular advantage where the tool is to be used a number of times on one run into the well bore because after the positioning cup has been set as seen in Fig. 7, upward movement on the operating pipe will cause the lip 59 to slide along the surface 2 of the well bore so long as the tool is being moved upwardly.

When it is desired to take an additional test or to perform a second or third operation, a slight

5

lowering movement by the operating pipe 8 will cause the lips 59 of the cup to grip against the wall of the well and stop the downward movement of the lower portion of the tool. In this manner the plunger 9 will force liquid into the packer to form a seal so that this positioning cup serves as an initial anchoring device to permit the setting of the packer.

It seems obvious that if a sampling operation is being performed, that the sample can be withdrawn from the operating pipe 8 by a swab or in any desired manner and if a treating operation is being performed, of course the ports 42 will be covered every time the pipe 8 is raised to relieve the pressure on the inside of the packer, which permits the packer to automatically collapse due to its inherent resiliency.

Fig. 3 shows the same arrangement as disclosed in Figs. 1 and 2, except that there is an additional packer 75 so that the formation 4 intermediate the packers may be isolated and as seen in Fig. 4, the flow ports 42 may be uncovered by movement of the nipple 37 as previously described.

The flow connection 40 will have the passages 78 therein to permit actuating liquid from the chamber 13 to move in to inflate the lower packer 75.

Broadly, it is contemplated that the tool described may be used for a number of different operations, such as testing, treating, or cementing of a particular formation; that the operations may be conducted stage by stage due to the fact that the tool may be raised and reset an indefinite number of times. While the latch collar 65 has been shown as engaging the bottom 73 of the well bore, it seems obvious that any desired obstruction may be placed in the well so as to release the latch at any desired elevation. Of course the tool can be lowered to the bottom of the well bore and the positioning cup set in place and then the tool can be raised any desired distance in the well before it is set down to inflate the packer. Thus for instance, if the formation 4 were several hundred feet or any other distance from the bottom of the well bore, the positioning cup should be set and then the tool slowly raised to the elevation at which the operation was to be performed.

One of the important features of the tool is the construction of the inflatable packer. While the packer has merely been shown diagrammatically in Figs. 1 to 3 inclusive, it is of course well understood that a packer to withstand the tremendous pressures encountered in a well bore must be constructed of materials and in such a manner as to withstand pressures approximating 10,000 and 15,000 pounds per square inch. This is true because for instance in a 10,000 foot well using a drilling mud having a specific gravity of two, just roughly the static pressure due to such a column of mud would approximate more than 10,000 pounds per square inch near the bottom of the well.

If the tool were set as shown at Fig. 2, when the flow ports 42 were open and the pressure fluid in the well bore below the packer released into the operating pipe 8, the pressure in the bore below the packer might drop to just a few hundred pounds per square inch, whereas, on the expanded packer directly thereabove, the weight of the long column of mud in the well bore would have to be supported. It seems clear therefore that there might be a differential pressure across the packer approximately 10,000 lbs. per square inch.

6

One form of construction of such a packer is shown in my copending application, Serial No. 473,928, filed January 29, 1943, for Hydraulic Inflatable Packer and Assembly for Testing and Treating Well Formations, now refiled as a continuation application bearing Serial No. 65,343, filed December 17, 1948.

Figs. 8 to 12 inclusive herewith show two of the forms of packer construction which will withstand very high pressures. In Fig. 8 an enlarged detail view of the end of a packer is shown. This is somewhat different than the diagrammatic illustration of the end of the packer shown in Figs. 1 and 2 and is made up of a packer head 80, threaded at 81 externally to receive the pipe 12 at its upper end and is enlarged at 82 to form a seat for the end of such pipe. This head is internally cut away to provide a groove 83 which receives the ribs 84 of the inner liner 85, which is the same as the liner 22 of Fig. 1 but shown more in detail. This liner is arranged to abut the inner-periphery 86 of the head 80 so as to form a seal therewith when the packer is inflated. The head 80 is provided with an annular skirt 87 of reduced diameter which is arranged to receive a plurality of anchor rings 88, whereby the reinforcing wires or strands 89 are anchored in position. These anchor wires are made up in bands such as 90 seen in the center of Fig. 8, each band being made up of some ten or twelve wires, which wires, cables or strands more or less adhere together and can be applied as a unit. The anchor rings 88 are of a size so that these strands 89 may be passed therebeneath and curved over the upper edge as at 91, so as to form a single anchor to prevent the strands from being pulled loose.

There are four layers of these strands shown in Fig. 8 and each layer is held in place by its anchor ring 88. These anchor rings have inclined steps or shoulders 92 thereon. Each shoulder is being arranged to receive a band of strands. The strands are carried in a helical path around the packer so that when the packer is inflated, it will contract longitudinally and expand radially due to the helical path of these strands or wires.

In order to further anchor these strands or wires, a retainer collar 94 is shown as having been passed over the outer layer 95 of the wires. The anchor rings may be held against sliding movement on the skirt 87 by means of the locking collar 96 which is preferably welded at 97 in place to securely support the rings.

The resilient sleeve or covering material 98 is shown as having been vulcanized in position to enclose these strands or wires of the reinforcing material so that a packer presents a streamlined appearance where the resilient material is of the same diameter as the head 80 as indicated at 99.

One of the anchor rings 88 shows the stepped shoulders 92 as best seen in Fig. 9.

Packers generally constructed in accordance with the structure just described have been actually inflated to pressures approximating 10,000 pounds per square inch without damage.

Figs. 10 to 12 inclusive show more in detail an arrangement for the reinforcing of the packer. In this view the upper head 100 and the lower head 101 are spaced apart a considerable distance and the inner liner 22 is shown as extending between them. This liner is of course of resilient material.

In order to anchor the reinforcing strands in

an efficient manner, each of the heads 100 and 101 have been provided with a plurality of buttons or lugs 103. These are shown as arranged in circles 104 extending around the head. Four rows have been shown so that it is possible to anchor four layers of the reinforcing strand 105.

Fig. 10 shows that each layer of the reinforcing material is made up of a single strand or cable 105. This cable or strand is applied by anchoring the end 106 to one of the buttons 103 and then weaving the strand from the upper head 100 in one revolution, following a helical path around the liner 22 and passing it over the button 107 on the lower head 101. The strand is then returned and passed around the next adjacent button 108 on the upper head and thence back and forth from button to button and head to head until a complete layer of reinforcing is provided by looping the strand around each one of the buttons of the row 103. Fig. 10 shows the layer as partially formed, whereas, a transverse sectional view of a complete assembly of the whole tool is shown in Fig. 12, where the inside pipe or mandrel 21 has the innerliner 22 there against, then there is the resilient material 98 both on the inside and the outside of the four layers of reinforcing strands 89 so that it seems obvious that a rigid construction has been arranged for anchoring the reinforcing strands on the one hand while on the other hand the packer itself is resilient and very strongly reinforced.

Broadly the packer construction contemplates a packer which will withstand tremendous pressures far in excess of any other packer now known to have been constructed.

What is claimed is:

A well tool for employment on an operating pipe in a well bore and comprising a body adapted for connection to the lower end of said pipe, said body including a coupling and a tubular mandrel secured thereto, a packer connected at its upper end to said body and upon inflation slidable upwardly from its lower end upon said mandrel, there being an opening in said mandrel

for the passage of liquid into said packer for inflation thereof, piston means on said pipe above said packer and operable by said pipe to force liquid into said packer through the opening in said mandrel for inflation of the packer, a flow connection secured to the lower end of said mandrel, there being ports therein for communicating with the well bore when the packer is inflated, a flow tube connected with said flow connection and communicating with the ports therethrough, said flow tube extending upwardly through said mandrel and piston means and terminating in said operating pipe, the lower end of said packer end normally overlying the ports in said flow connection and uncovering said ports upon inflation thereof for communication of said flow tube with the well bore, an annular inverted resilient positioning cup secured to the lower end of said flow connection, a stem of reduced diameter extending from said flow connection, and thru said cup, a resilient plug around said stem and below said cup, a collar slidable on said stem and mounted below said plug, said collar movable along said stem upon contacting an obstruction therebelow to urge said plug against said cup for expansion thereof, and co-operating latching elements on said collar and said stem to latch said cup in expanded position.

JOHN LYNES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,840,379	Wrighter	Jan. 12, 1932
1,850,218	Thomas	Mar. 22, 1932
2,143,106	Freedlander	Jan. 10, 1939
2,143,746	Spang	Jan. 10, 1939
2,161,135	Chappell	June 6, 1939
2,186,230	Bald	Jan. 9, 1940
2,227,731	Lynes	Jan. 7, 1941
2,248,169	Granger	July 8, 1941
2,516,580	Lynes	July 25, 1950