

Aug. 1, 1961

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2,994,378

TREATMENT OF A WELL WITH THE DRILL STRING IN THE WELL

Filed March 13, 1957

2 Sheets-Sheet 1

FIG. 3a.

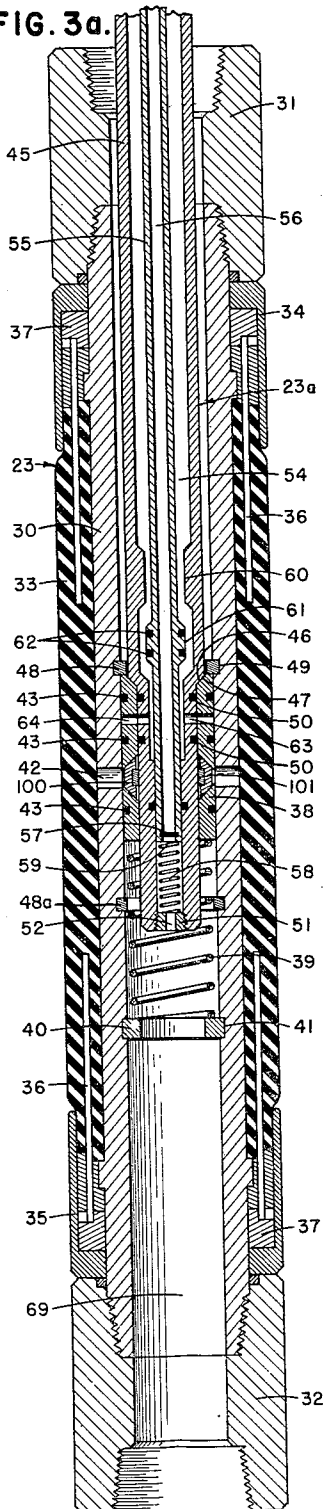


FIG. 3.

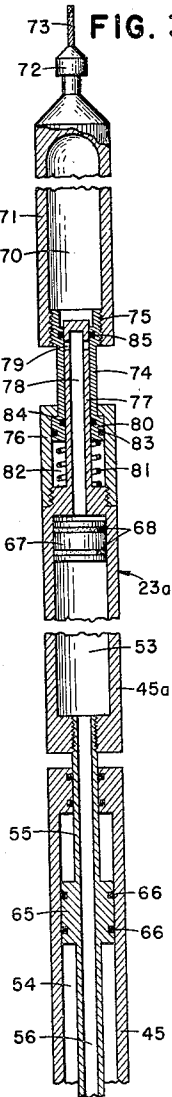


FIG. 5.

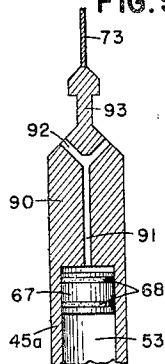


FIG. 1.

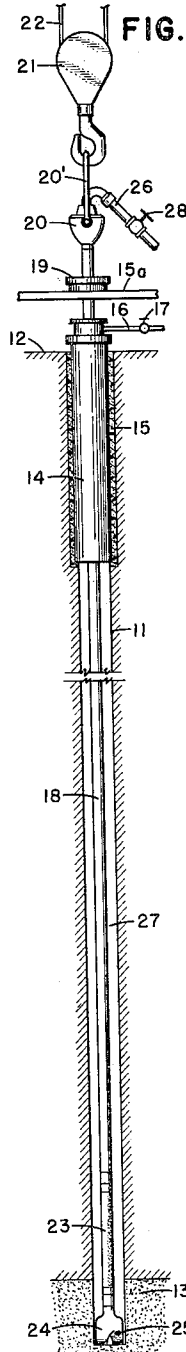
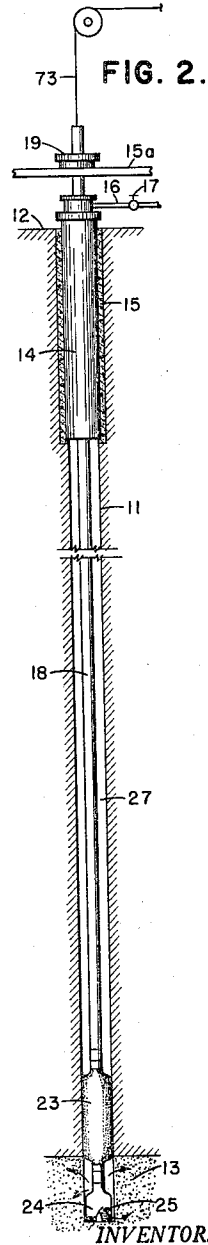


FIG. 2.



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2 Sheets-Sheet 2

FIG. 4a.

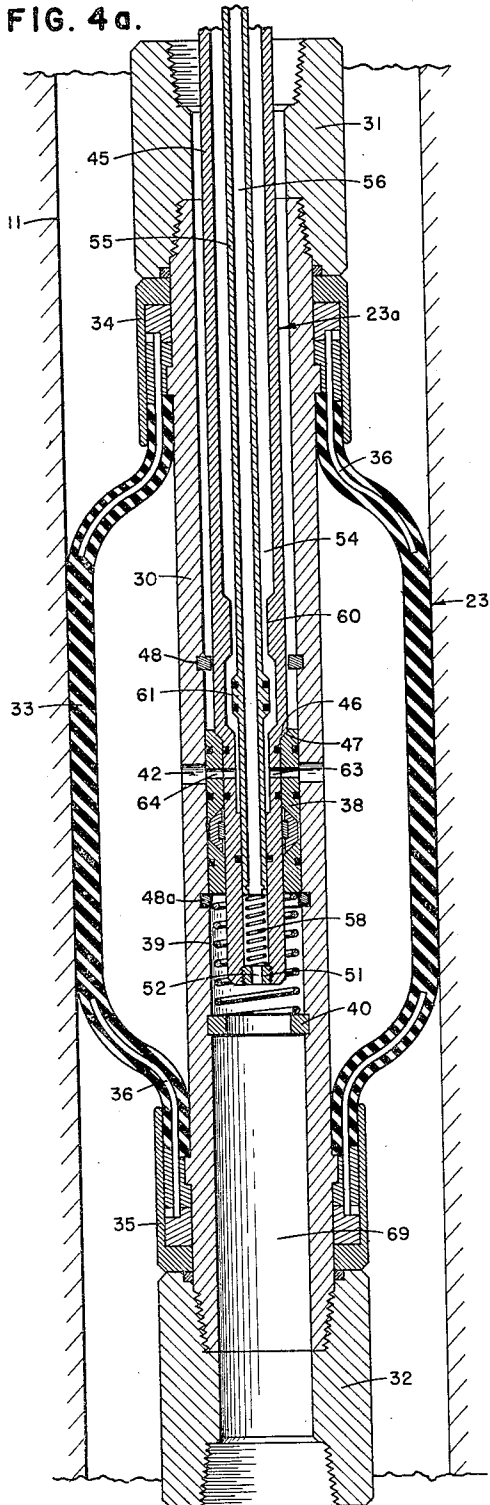
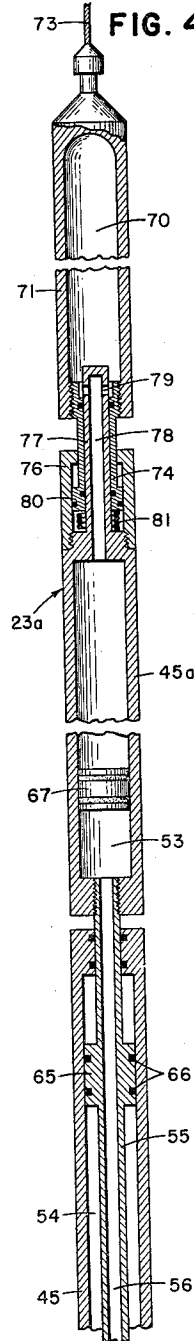


FIG. 4.



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2,994,378

TREATMENT OF A WELL WITH THE DRILL STRING IN THE WELL

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Filed Mar. 13, 1957, Ser. No. 645,722
11 Claims. (Cl. 166—72)

The present invention is directed to the treatment of a well while maintaining the drill string in the well. More particularly, the invention is concerned with the treatment of a well in which a gasiform fluid, such as air or gas, is employed as a drilling fluid. In its more specific aspects the invention is directed to apparatus for treating a well in which a gasiform fluid is employed as the drilling fluid while maintaining the drill string in the well.

The present invention may be briefly described as an apparatus for treating a well penetrating a subsurface earth interval in which a gasiform material or fluid is circulated down a hollow drill string in the well and up the annulus between the drill string and the wall of the well during the drilling operations. In the present invention the drilling operations are interrupted, the drill string is maintained in the well, and the annulus between the drill string and the wall of the well is sealed. A body of a liquid treating agent is placed in the hollow drill string and then the liquid treating reagent is introduced into the subsurface earth interval, preferably by imposing pressure on the body in the hollow drill string.

The present invention comprises apparatus useful for treating a well having a hollow drill string in the well. The particular apparatus involves a packer mandrel connected into and forming part of the drill string. An inflatable packing member is mounted on the mandrel and is adapted to seal with the wall of the well. The mandrel is provided with a port communicating with the interior of the packing member for inflating the packing member, arranged in the packer mandrel in port covering relationship is a valve member, which in its first position closes the port and in its second position opens the port. A retrievable first elongated tubular member is arranged within the drill string and the packer mandrel to engage with the valve member to move the valve member from its first position to its second position to uncover the port. The apparatus is provided with a treating fluid chamber adapted to contain fluid to treat the well and also with a chamber adapted to contain fluid to inflate the packing member. A second tubular elongated member is arranged within the first tubular member for movement from a first position to a second position to release the inflation fluid to inflate the packing member, the passageway through the second tubular elongated member fluidly communicating with the treating fluid chamber in the second tubular elongated member; the valve member and the first tubular elongated member are provided with ports adapted to be placed in correspondence with each other and with the port in the packer mandrel when the valve member is moved from a first position to a second position for inflation of the packing member by communicating fluidly with the inflation chamber. Means are provided in the passageway of the second tubular elongated member for releasing fluid from the treating fluid chamber for passage through the drill string to treat the well.

The present invention is particularly useful in well treating operations in which a gasiform material or fluid is used as the drilling fluid to circulate drill cuttings from the well. In such operations, if a zone, horizon, stratum, interval, sand, formation, or other subsurface region is

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penetrated by the drill bit which requires treatment such as to seal off water bearing formations and the like or to stimulate production, it has heretofore been necessary to fill the well bore with a liquid in order to exert pressure on the treating reagent which is to treat the subsurface interval or stratum requiring such treatment. Thereafter, it was necessary to remove the liquid from the well bore, where air or gas is employed as a drilling fluid, before resumption of the dry type of drilling operation.

It will be readily seen that the requirement of replacing the gasiform material with a liquid material throughout the whole length of the well is costly and time consuming and interrupts drilling operations for a considerable length of time. In the present invention such costly and time consuming operations are avoided by interrupting the drilling operations, sealing between the drill string and the wall of the well while maintaining the drill string in the well, and then introducing a body of liquid treating material into the hollow drill string and thereafter forcing the body of liquid treating reagent into the formation or interval to be treated by imposing pressure on the liquid body in the hollow drill string. By conducting such operations only a minimum amount of the liquid material is needed, and it can be forced substantially completely into the formation or interval to seal or treat same.

The treating reagent employed in the practice of the present invention may be a fluid cement slurry such as a conventional Portland cement or one of the modified types such as described and claimed in the Salathiel Patent No. 2,582,459. Other modified cement slurries may be employed such as oil-emulsion cements and the like.

The treating reagent may suitably be a phenol-formaldehyde resin or a urea-formaldehyde resin or other resins of the thermo-setting type.

The treating reagent may suitably be a liquid suspension of a lost circulation control material of which there are many available on the market. By way of illustration, and not by way of limitation, examples thereof include fibrous cellulosic material such as bagasse, walnut hulls, pecan hulls, shredded cellophane, mineral or vegetable fibers, animal fibers, and many other well known materials useful in controlling lost circulation.

The treating reagent may suitably be a surface active agent such as the lower aliphatic alcohols such as those having 1 to 5 carbon atoms as illustrated by butyl alcohol, and the like, sulfonates of fatty acids, soaps, diglycol stearate, aldehydes, ketones, salts of petroleum sulfonic acids, phenol sulfonates or sulfates, alkylol amine derivatives, and the like, or may be an acid either in the form of a liquid or as a gel which may be used to treat the formation or interval penetrated by the drill bit while using a gasiform material as the drilling fluid. For example, a surface active agent such as isopropyl alcohol may be employed to stimulate production to allow a particular formation to be tested. Many treating reagents for subsurface earth intervals are known which may be employed in the practice of the present invention.

The invention will be further illustrated by reference to the drawing in which:

FIG. 1 shows a well in the course of being drilled employing a gasiform fluid as the drilling fluid;

FIG. 2 is a similar showing of the well of FIG. 1 with drilling operations being interrupted and the well sealed for introduction of the treating reagent;

FIGS. 3 and 3a are sectional elevational views illustrating the apparatus of the present invention;

FIGS. 4 and 4a are views illustrating the apparatus of the present invention with the packer inflated and in position for treatment of the well; and,

FIG. 5 is a modification of the apparatus of FIG. 3.

Referring now to the drawing in which identical numerals will be employed to designate identical parts, and particularly to FIGS. 1 and 2, numeral 11 designates a well drilled from the surface of the earth 12 to penetrate an earth interval 13 which is to be treated. A surface casing 14 has been placed to line a portion of the wall of the well and has been cemented in place with cement 15. The surface casing extends below the derrick floor 15a. The surface casing is provided with a fluid return line 16 controlled by a valve 17. A drill string 18 is arranged in the well 11 and extends through a rotary table 19 on the derrick floor 15a and is supported by the usual swivel 20, bails 20' and hoisting assembly 21 suspended by lines 22 from the derrick, not shown. The drill string 18 is provided with a packing assembly generally indicated by the numeral 23 which is arranged in and forms a part of the drill string 18. On the lower end of the drill string is a drill bit 24 which may be of a roller or cutter type or may be one of the fishtail type. The drill bit 24 is provided with eyes or fluid circulation ports 25. A hose 26 provides fluid introduced into the drill string 18 for circulation of cuttings from the well through the annulus 27 and outwardly by way of line 16 controlled by valve 17. The hose 26 may suitably be controlled with a valve 28 to interrupt the flow of the gasiform fluid when it is desired to treat the well with a treating reagent. Likewise, line 16 may be closed by operating valve 17.

In accordance with FIG. 1 the well is shown with drilling operations being conducted and with the gasiform fluid being introduced through hose 26 down the hollow drill string 18 and out the eyes 25 and then up the annulus 27 and thence flowing from the casing by line 16.

In FIG. 2 drilling operations have been terminated and the swivel 20 has been disconnected from the drill string 18. The assembly 23a (shown in FIGS. 3 and 3a), which comprises a packer inflating assembly and well treating apparatus, has been lowered into the drill string 18 by means of wire line 73 to inflate the packer 23. Liquid treating reagent is introduced from the hollow drill string through the eyes 25 into the formation 13 as indicated by the arrows, the annulus 27 being sealed off by the packing member 23. After the treating operation has been concluded such as to shut off water invasion from zone 13 by introduction of a sealing material therein, the packer 23 may be deflated by removal of the assembly 23a. The swivel 20 is connected to the drill string 18 and circulation of gas resumed with valves 28 and 17 opened. Drilling operations with drill bit 24 are continued with operation of the rotary table 19.

Referring now to FIG. 3 and 3a, the packing assembly generally indicated by the numeral 23 comprises a packer mandrel 30 which is connected into the drill string 18 on each end by coupling or connecting means 31 and 32. Connected to the mandrel 30 is an inflatable packing member 33, the packing member being connected to the mandrel 30 by means of collars 34 and 35. The packing member 33 is suitably reinforced on each end by reinforcing means such as metallic rods or other members 36 which are rigidly connected to ring members 37 on each end of the packing member 33.

Arranged within the packing mandrel 30 is a sleeve member 38 which is biased into a first position by biasing or urging means illustrated by a helical coil spring 39 maintained in the mandrel 30 by an annular member 40 arranged within a recess 41, the lower end of the spring 39 resting on the member 40 while its upper end is in contact with the sleeve 38. In its first or upper position the sleeve 38 covers the ports 42 in mandrel 30 and prevents the packing member 33 from being inflated. It is to be noted that the sleeve 38 is suitably sealed with the mandrel 30 by means of a plurality of sealing means or rings 43.

Arranged retrievably within the packing mandrel 30 and the drill string 18 is packer inflating and well treating

assembly 23a, which comprises a first tubular elongated member 45 which is adapted to engage by a shoulder 46 with a corresponding shoulder 47 of the sleeve 38. It is to be noted that the shoulders 46 and 47 provide corresponding tapered surfaces for engagement. It is to be further noted that the sleeve 38 is retained in position against upward movement by an annular member 48 which is arranged in a recess 49 in the packer mandrel 30 while downward movement against the spring 39 is limited by ring 48a. When the sleeve 38 is in the down position, ports 63, 64, and 42 are aligned for fluid passage from chamber 54.

A seal between the sleeve 38 and the tubular elongated member 45 is provided by a plurality of sealing means 50 arranged in the first tubular elongated member 45.

The lower end of the tubular elongated member is provided with an annular member 51 which is provided with a port 52 for passage of fluid therefrom.

Slidably arranged in tubular member 45 is a second tubular elongated member 55 which threadedly engages tubular member 45a at its upper end. Tubular member 45a is provided with a chamber 53 which is adapted to contain a fluid of the nature described entrapped therein at the wellhead, to treat a subsurface earth formation. An annular chamber 54 is provided in tubular elongated member 45 and is adapted to contain a compressible fluid also entrapped therein at the wellhead, for inflation of the packer 33 in a manner to be described. The tubular elongated member 55 is provided with a passageway 56 fluidly communicating with the chamber 53 and closed on its lower end by a frangible means such as a rupture disc 57. While the closure means 57 is illustrated as a frangible means or a rupture disc, suitably the closure means 57 may be a spring loaded valve which will open when pressure is imposed thereon. The second tubular elongated member 55 is urged or biased into first position by means of a biasing means or urging means illustrated by helical coil spring 58 which rests on the annular member 51 on its lower end and with its upper end contacting the lower end 59 of the tubular elongated member 55.

It is to be noted that the first tubular elongated member 45 is provided with a restricted area or sealing surface 60 which is adapted to cooperate with a sealing surface 61 of the second tubular elongated member 55 to form a seal therewith, one of the surfaces 60 or 61 being provided with sealing rings 62, which for purposes of illustration, are arranged in the surface 61. The surfaces 60 and 61 cooperate to form a valve which controls flow of fluid from the chamber 54 which is then communicated fluidly with corresponding ports 63 in the first tubular elongated member 45 and ports 64 in the sleeve 38. The valve made up of surfaces 60 and 61 is normally closed as the apparatus is being lowered and placed in position, the spring 58 bearing against the lower end of elongated member 55 and holding the surfaces 60 and 61 in sealed relationship. When the sleeve 38 is moved from its first position as shown in FIG. 3a to its second position as shown in FIG. 4a by imposing weight of the tubular elongated member 45 on the sleeve 38 to move sleeve 38 downwardly until it is stopped by ring 48a, the ports 63 and 64 are thus placed in alignment with the ports 42 and fluid may then be flowed from chamber 54 to inflate the packer 33 by the surface 61 moving out of correspondence with the surface 60 by the second tubular elongated member moving from its first position to its second position by compressing the spring 58.

A piston member 65 provided with sealing means 66 is formed on the upper end of the second tubular elongated member 55 and serves to compress the fluid in chamber 54 and force same through the ports 63, 64, and 42 to inflate the packer.

Arranged in the chamber 53 is a piston member 67 provided with sealing rings 68 which is designed to compress the liquid treating reagent in chamber 53 to force same through the passageway 56 and to rupture the disc or

open the closure member 57 to allow the treating reagent to proceed down the passageway 69 in the mandrel 30 and thence through the eyes 25 to treat the formation 13.

The piston 67 may suitably be actuated by introduction of fluid pressure in contact therewith. In this embodiment of the present invention the fluid pressure is contained in a chamber 70 formed in a body member 71 which is provided with a fishing neck 72 connected to a wire line or cable 73. The body 71 is connected to and forms part of the tubular member 45a. A suitable connecting means is a tubular member 74 which is connected to the body member 71 by mating threads 75 which is arranged within a closure member 76. The upper end 77 of the tubular member 45a has a restricted cross sectional area and is provided with a passageway 78 which is closed on its upper end. The passageway 78 communicates with the exterior surface of the member 77 by means of lateral ports 79. It is to be noted that the tubular member 74 embraces the upper end member 77 and provides for relative movement between the body member 71 and the tubular member 45a, the member 74 forming an enlarged shoulder 80 and being arranged within the closure member 76 and biased or urged upwardly by means of a spring member 81 arranged within a chamber 82 in the member 76. The shoulder 80 is suitably sealed with the closure member 76 by sealing ring 83 and with the member 77 by means of a sealing ring 84. A sealing ring 85 seals between the upper end 77 and the tubular connecting means 74.

By virtue of the slidable connection provided by means of the upper end 77 and the tubular connecting means 74, the ports 79 may be moved within the chamber 70 to allow fluid such as a gas under high pressure in chamber 70 to be exerted through the passageways 79 and 78 against the piston 67 to move it downwardly to compress the non-compressible fluid in chamber 53 and to force same through the passageway 56 and open the closure member 57 and thence through the passageway 69 to treat the formation 13 as has been described.

Referring to FIG. 5, it will be seen that the upper end of the tubular member 45a has been modified to provide a relatively solid member 90 having a passageway 91 communicating with the exterior surface thereof by means of lateral passageways 92, the upper end 90 of the modified tubular elongated member 45 being provided with a fishing neck 93 connected to the cable or wire line 73. In this embodiment gaseous pressure in the drill stem 18 may be exerted on the piston 67 and serve to force the non-compressible fluid in chamber 53 through the passageways 56 and 69 out through the eyes 25 of the drill bit 24 to treat the formation 13.

It is believed that the foregoing description taken with the drawing illustrates the utility and advantages of the present invention.

When it is desired to treat a particular formation, stratum, or interval, and the like, the drilling operations as set out in FIG. 1 are interrupted. Thereafter, the assembly 23a, either the embodiment of FIGS. 3 and 3a or FIG. 5, is lowered in through the drill stem 18 to engage the surfaces 46 and 47. The tubular elongated member 45 has arranged within it the second tubular elongated member 55. Weight is set down on the tubular elongated member 45 which causes the spring member 39 to depress and to move the sleeve 38 downwardly until ring 43a stops further movement and thus places the ports 63 and 64 into alignment with the ports 42 as shown in FIGS. 4 and 4a. The tubular elongated member 55 then is moved downwardly by weight compressing the spring 53 which moves the surface 61 out of correspondence with the surface 60 which causes the fluid in the chamber 54 to be compressed by the piston 65 and forces same through the aligned ports 63, 64, and 42 to inflate the packer 33 and to seal with the wall 11 of the well. Thereafter by relative movement of the member 71 and the member 45a by setting down on or slacking

off of the wire line 73, the piston 67 forces a formation treating fluid in chamber 53, which was entrapped therein at the wellhead, through the passageway 56 under pressure, opening the closure member 57, and forcing the treating liquid into the formation. After the formation has been suitably treated such as by introduction of a sealing material, the tubular elongated member and its attendant structure may be lifted from the packer mandrel 30 which causes the sleeve valve member 38 to resume its first position. The check valve member 100 which is held in place by a ring member 101 is then forced open by the pressure inflating the packing member 33, allowing same to be deflated and to resume the position shown in FIGS. 1 and 3a. Thereafter, drilling operations may be resumed.

It will be clear to the skilled workman that the operations as illustrated before and described with respect to the several figures of the drawing may be repeated as many times as necessary when required by the drilling bit penetrating a formation which requires such treating.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and to secure by Letters Patent is:

1. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a valve member provided with a port and movably mounted and normally arranged in a first position in said packer mandrel in mandrel port closing relationship, a retrievable first elongated member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the valve member to move said valve member from its first position to a second position to align the valve port and the first elongated member port with said mandrel port, said first elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, a second elongated member movably arranged within said first elongated member, said second elongated member being provided with a second chamber adapted to contain fluid to treat said well, normally closed valve means formed within said first chamber by sealingly coengageable surfaces on said first and second elongated members for confining said inflation fluid in said first chamber, said second elongated member being movable from a first position closing said valve means to a second position to open said valve means and place said first chamber in fluid communication with, and being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second elongated member being provided with a passageway for fluidly communicating said second chamber with said drill string below said packing member, and means in the passageway of said second elongated member for entrapping fluid in said second chamber, said entrapping means being opened by means in said second chamber imposing fluid pressure thereon from said second chamber.

2. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably mounted and normally arranged in a first position in said packer mandrel in mandrel port closing relationship, first means in said mandrel urging said sleeve valve

member to its first position, a retrievable first elongated tubular member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member against said first urging means from its first position to a second position to align the sleeve valve member port and the first elongated member port with said mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, a second tubular elongated member movably arranged within said first tubular elongated member, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, normally closed valve means formed within said first and second tubular elongated members for confining said inflation fluid in said first chamber, second means in said first tubular elongated member urging said second tubular elongated member to a first position closing said valve means, said second tubular member being adapted for movement from its first position to a second position against said second urging means to open said valve means and place said first chamber in fluid communication with, and being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with said drill string below said packing member, and means in the passageway of said second tubular elongated member for entrapping fluid in said second chamber, said entrapping means being opened by means in said second chamber imposing fluid pressure thereon from said second chamber.

3. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably mounted and normally arranged in a first position in said packer mandrel in mandrel port closing relationship, a retrievable first elongated tubular member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first elongated member port with the mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, a second tubular elongated member movably arranged within said first tubular member, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, a normally closed second valve member formed by sealingly coengageable surfaces on said first and second tubular elongated members for confining inflation fluid in said first chamber, said second tubular elongated member being movable from a first position closing said second valve member to a second position to open said second valve member and place said first chamber in fluid communication with, and being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with said drill string below said packing member, and means in the passageway of said second tubular elongated member for entrapping fluid in said second chamber, said entrapping means being opened by means in said second chamber imposing fluid pressure thereon from said second chamber.

4. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably mounted and normally arranged in a first position in said packer mandrel in port closing relationship, a retrievable first elongated tubular member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first elongated tubular member port with said mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, said first tubular elongated member being formed to provide an internal sealing surface, a second tubular elongated member movably arranged within said first tubular member for movement from a first position to a second position, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, said second tubular elongated member being formed to provide an external sealing surface for sealing engagement with the internal sealing surface of said first tubular elongated member, said surfaces forming a second valve for controlling flow from said first chamber operable on movement of the second tubular elongated member from its first to its second position to place said first chamber in fluid communication with, and said second tubular elongated member being provided with means for forcing inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with the drill string below said packing member, and means in the passageway of said second tubular elongated member for entrapping fluid in said second chamber, said entrapping means being opened by means in said second chamber imposing fluid pressure thereon from said second chamber.

5. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably mounted and normally arranged in a first position in said packer mandrel in port closing relationship, a retrievable first elongated tubular member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first elongated tubular member port with said mandrel port, said first elongated tubular member being provided with a first chamber adapted to contain fluid to inflate said packing member, said first tubular elongated member being formed to provide an internal sealing surface, a second tubular elongated member movably arranged within said first tubular member for movement from a first position to a second position, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, means in said second chamber adapted to force fluid from said second chamber, said second tubular elongated member being formed to provide an external sealing surface for sealing engage-

ment with the internal surface of said first tubular elongated member, said surfaces forming a second valve for controlling flow from said first chamber operable on movement of the second tubular elongated member from its first to its second position to place said first chamber in fluid communication with, and said second tubular elongated member being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with the drill string below said packing member, and means in the passageway of said second tubular elongated member adapted to entrap fluid in said second chamber, said entrapping means being opened on operation of said forcing means in said second chamber.

6. Apparatus in accordance with claim 5 in which the forcing means is a piston adapted to be operated by fluid admitted into said second chamber through a conduit fluidly communicating with the exterior surface of said second tubular elongated member.

7. Apparatus in accordance with claim 5 in which the forcing means is a piston adapted to be operated by fluid admitted into said second chamber through a conduit fluidly communicating with a third chamber in said second tubular elongated member adapted to contain an actuating fluid under a pressure sufficient to operate said piston.

8. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably arranged in a first position in said packer mandrel in mandrel port closing relationship, a first elongated tubular member having a port in its wall movably and retrievably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first tubular elongated member port with said mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, said first tubular elongated member being formed to provide an internal sealing surface, a second tubular elongated member movably arranged within said first tubular member for movement from a first position to a second position, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, a third chamber and a passageway between the second and third chambers, valve means for controlling fluid flow from the third to the second chamber, a piston member in said second chamber adapted to force fluid from said second chamber, said third chamber being adapted to contain fluid to operate said piston member, said second tubular elongated member being formed to provide an external sealing surface for sealing engagement with the internal sealing surface of the first tubular elongated members, said surfaces forming a second valve for controlling flow from said second chamber operable on movement of the second tubular member from its first to its second position, to place said first chamber in fluid communication with, and said second tubular elongated member being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with said drill string below said packing member, and frangible means in the passage-

way of said second tubular elongated member adapted to entrap fluid in said second chamber, said frangible means being ruptured on operation of said piston member in said second chamber by flow of fluid from the third chamber against said piston member on opening of said valve means.

9. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and arranged in a first position in said packer mandrel in mandrel port covering relationship, a retrievable first elongated tubular member having a port in its wall and arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first tubular elongated member port with said mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, said first tubular elongated member being formed to provide an internal sealing surface, a second tubular elongated member movably arranged within said first tubular member for movement from a first position to a second position, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat the well, a third body member provided with a third chamber movably connected to the second tubular elongated member for relative movement with respect to said first tubular elongated member, the upper end of said second tubular elongated member being slidably arranged within the lower end of the third body member and forming a passageway having a closed end and a lateral port adapted to communicate fluidly with the exterior surface of said upper end and between the second and the third chambers on said relative movement to place said lateral port within said third chamber, a piston member in said second chamber adapted to force treating fluid from said second chamber, said second tubular elongated member being formed to provide an external sealing surface for sealing engagement with the internal sealing surface of the first tubular elongated member, said surfaces forming a second valve for controlling flow from said first chamber operable on movement of the second tubular elongated member from its first to its second position to place said first chamber in fluid communication with, and said second tubular elongated member being provided with means for forcing said inflation fluid through said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with said drill string below said packing member, and frangible means in the passageway of said second tubular elongated member for entrapping fluid in said first chamber, said frangible means being ruptured on operation of said piston member in said second chamber by flow of fluid from the third chamber when the lateral port is placed in the third chamber by said relative movement.

10. Apparatus for use in treating a well having a hollow drill string in the well which comprises, in combination, a hollow packer mandrel connected into and forming part of said drill string, an inflatable packing member mounted on said packer mandrel and adapted to be inflated to seal with the wall of the well, said mandrel being provided with a port communicating with the interior of said packing member for inflating said packing member, a sleeve valve member having a port in its wall and movably arranged in a first position in said packer mandrel in port covering relationship, a retrievable

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first elongated tubular member having a port in its wall and movably arranged within said drill string and said packer mandrel to engage with the upper end of said sleeve valve member to move said sleeve valve member from its first position to a second position to align the sleeve valve member port and the first tubular elongated member port with said mandrel port, said first tubular elongated member being provided with a first chamber adapted to contain fluid to inflate said packing member, said first tubular elongated member being formed to provide an internal sealing surface, a second tubular elongated member movably arranged within said first tubular member for movement from a first position to a second position, said second tubular elongated member being provided with a second chamber adapted to contain fluid to treat said well, a retrievable third body member forming a third chamber movably connected to the second tubular elongated member for relative movement with respect to said second tubular elongated member, the upper end of said second tubular elongated member being slidably arranged within the lower end of the third body member and forming a passageway having a closed end and a lateral port adapted to communicate fluidly with the exterior surface of said upper end and between the second and the third chambers on said relative movement to place said lateral port within said third chamber, a first piston member in said second chamber adapted to force treating fluid from said second chamber, said second tubular elongated member being formed to provide a second piston member on its external surface for slidable movement within the first chamber and to provide an external sealing surface spaced below the second piston member thereon for sealing engagement with the internal sealing surface of the first tubular elongated member, said sealing surfaces forming a second valve adapted for controlling flow from the first chamber on compression of fluid therein by said second piston member on movement of the second tubular elongated member from its first to its second position to place said first chamber in fluid communication with said aligned ports to inflate said packing member, said second tubular elongated member being provided with a passageway fluidly communicating said second chamber with the drill string below said packing member, and frangible means in the passageway of said second tubular elongated member for entrapping fluid in said second chamber, said frangible means being ruptured on operation of said first

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piston member in said second chamber by flow of fluid from the third chamber when the lateral port is placed in the third chamber by said relative movement.

11. For use in a hollow drill string having connected therein a hollow packer mandrel forming part of the drill string and provided with an inflatable packing member mounted on said mandrel for sealing with the wall of a well, the mandrel being provided with a normally closed valved port for inflating the packing member, apparatus which comprises a retrievable first elongated member adapted to be movably arranged within said mandrel to open said valved port, said first elongated member having a port in its wall and being provided with a first chamber adapted to contain fluid to inflate said packing member, a second elongated member movably arranged within said first elongated member, said second elongated member being provided with a second chamber adapted to contain fluid to treat said well, means formed by sealing coengageable surfaces on said first and second elongated members within said first elongated member for confining said inflation fluid in said first chamber, said first elongated member being movable from a first position to a second position to align the first elongated member port with and to open the valved port, said second elongated member being movable from a first to a second position to open said confining means, and being provided with means for forcing said inflation fluid through the aligned port to inflate said packing member, said second elongated member being provided with a passageway fluidly communicating said second chamber with said drill string below said packing member, and means in the passageway of said second elongated member for entrapping fluid in said second chamber, said entrapping means being opened by means in said second chamber imposing fluid pressure thereon from said second chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,663,545	Grable	Dec. 22, 1953
2,695,065	Baker et al.	Nov. 23, 1954
2,701,122	Grable	Feb. 1, 1955
2,760,580	Johnston	Aug. 28, 1956
2,783,026	Reistle	Feb. 26, 1957
2,784,790	Boer et al.	Mar. 12, 1957