

July 8, 1941.

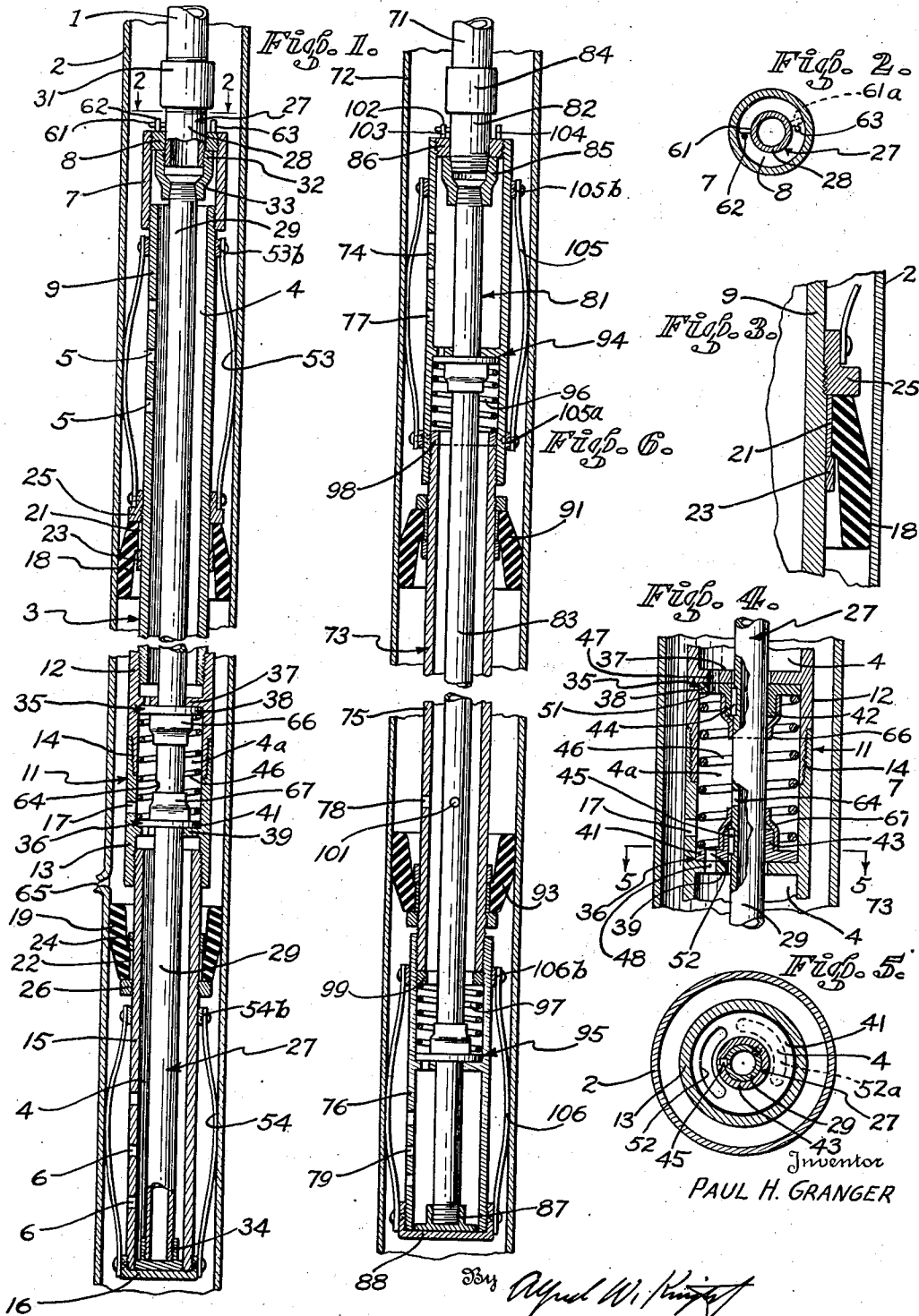
P. H. GRANGER

2,248,169

OIL WELL TOOL

Filed July 26, 1940

2 Sheets-Sheet 1



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P. H. GRANGER

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OIL WELL TOOL

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2 Sheets-Sheet 2

Fig. 7.

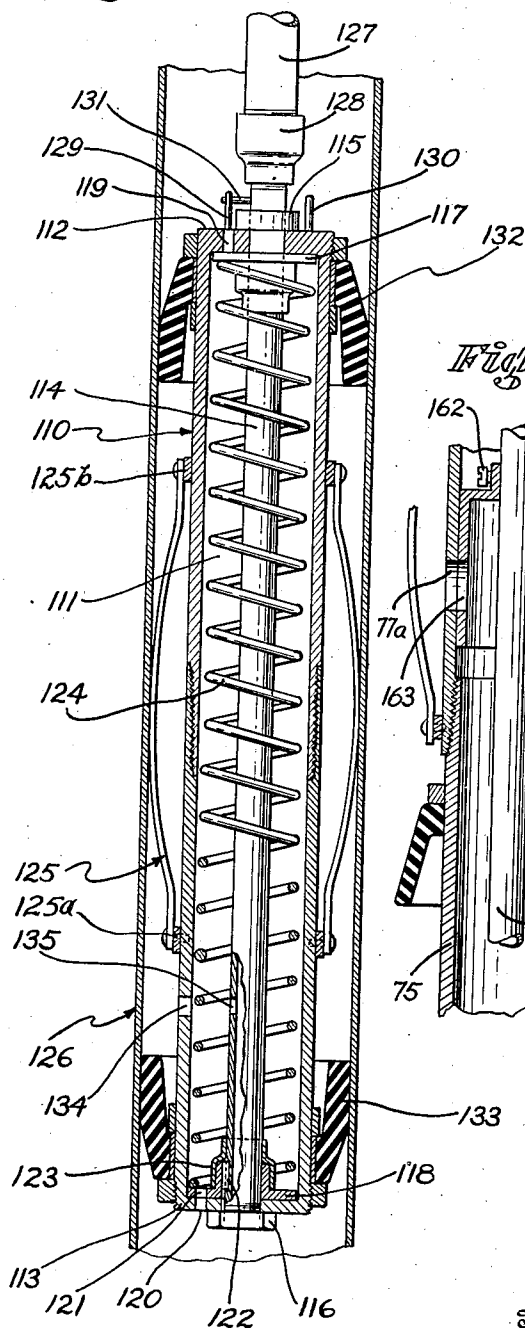


Fig. 8.

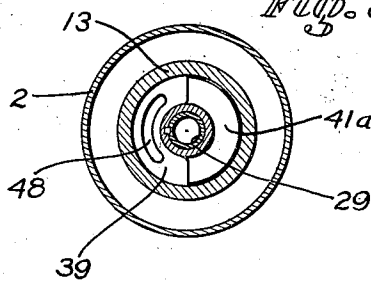


Fig. 11.

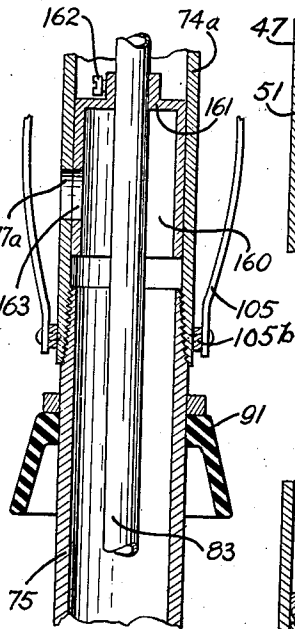


Fig. 9.

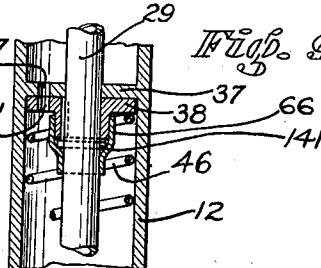
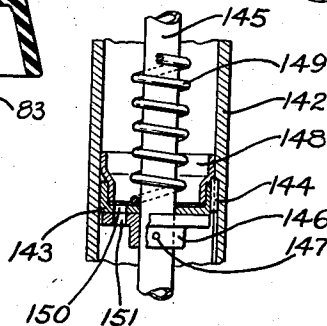


Fig. 10.



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UNITED STATES PATENT OFFICE

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OIL WELL TOOL

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Application July 26, 1940, Serial No. 347,697

17 Claims. (Cl. 166—1)

This invention relates to oil well tools and pertains more particularly to an apparatus which may be used for locating leaks in well casing, cementing such leaks, testing formations, or for other operations where it is desirable to establish fluid communication between a string of tubing and a localized portion of a well casing.

The principal object of the invention is to provide a simple, effective, rugged and easily maintained apparatus for establishing fluid communication with a localized portion of the well casing.

With apparatus of this class a localized portion of the well casing is sealed from the remaining portion of the casing by longitudinally spaced packing means which necessarily fit tightly against the walls of the casing. At the same time, it is necessary to move the apparatus to different depths in the well, and this makes it necessary to provide some means for by-passing fluids past the packing means during this movement. Otherwise, it would be necessary to force the fluids between the casing and the tight-fitting packing means, which would subject the apparatus and the casing to undue stresses.

It is further desirable to cut off this by-pass when the packing means are located on opposite sides of the desired localized portion of the well casing so that communication to this zone only is established with the surface through the tubing on which the apparatus is carried. For this purpose the apparatus is provided with valves which are controlled from the surface through relative movement of the tubing and the packing means.

It is further desirable in apparatus of this class to drain the tubing from which the apparatus is suspended in the hole of liquids as the tubing in the apparatus is raised, to avoid raising a heavy column of liquid in the tubing, and the breaking down or disjuncting of the tubing string with the tubing in a wet condition. In cementing operations it is usually necessary to displace a considerable amount of fluid present in the tubing before the cement can be brought to the tool. Unless some means is provided for by-passing this displaced fluid, it is necessary to force it out through the leak in the casing which is located between the spaced packers. This requires the expenditure of considerable energy and is sometimes difficult to accomplish.

An important object of this invention is to provide an apparatus which is movable to different depths in a well casing while suspended from the tubing and is adapted to establish fluid

communication through the tubing to a localized portion of the well casing and is provided with means for draining the tubing of fluids when it is raised in the hole and is further adapted to by-pass fluids past the localized zone in the casing when fluids are forced down the tubing.

A general object of this invention is to provide an apparatus which will effectively seal off a localized portion of the well casing and yet which is at the same time readily movable to different depths in the well casing.

Another important object of the invention is to provide an apparatus of the type described with a by-pass passage of relatively great area whereby the movement of the apparatus to different depths in the well casing is facilitated.

Another object of the invention is to provide an apparatus of the type described with improved valves which are rugged in character and positive in action.

A further object of the invention is to provide an apparatus of the class described with valve means at the opposite ends of a chamber which take advantage of the pressure within the chamber to maintain tight sealing engagement.

I accomplish the above and other objects of my invention by providing a tool having a pair of vertically spaced packing members adapted for sealing engagement with the casing along with means cooperating with the packing members, including vertically spaced valve devices, to seal off a localized zone within the casing. Means is also provided for connection to the tubing for moving the tool to different depths and to provide a passage having an opening located between the valve devices establishing fluid communication between the tubing and the localized zone. The valve devices are adapted for operation by movement of the tubing from the surface and are movable to an open position in which fluid communication is established through the localized zone and outside of the above-mentioned passage between the cased portions of the well above and below the localized zone and also from the above-mentioned opening through the valve devices to the cased portions of the well above and below the localized zone. The valve devices are also movable to a closed position shutting off communication through the localized zone between the cased portions of the well above and below the localized zone.

Further objects and advantages of the invention will either be specifically brought out in the ensuing description or will be apparent therefrom.

The accompanying drawings illustrate embodiments of my invention and referring thereto:

Fig. 1 is a partly sectional elevation of a preferred form of apparatus according to my invention;

Fig. 2 is a section along line 2—2 in Fig. 1;

Fig. 3 is a reproduction of a portion of Fig. 1 on a larger scale;

Fig. 4 is a reproduction of a part of Fig. 1 on a larger scale illustrating the construction of my preferred form of valve mechanism in greater detail;

Fig. 5 is a transverse sectional view taken along line 5—5 in Fig. 4;

Fig. 6 is a partly sectional elevation of a modified form of the invention;

Fig. 7 is a partly sectional elevation of a further modified form of the invention;

Fig. 8 is a transverse partly sectional view of a modified form of valve member;

Fig. 9 is a longitudinal section of a portion of my apparatus illustrating an alternative arrangement for mounting the valve members;

Fig. 10 is a partly sectional elevation illustrating a further modified valve arrangement; and

Fig. 11 is a partly sectional elevational view of a portion of my device embodying a sleeve valve.

Referring to Figs. 1-5 of the drawings, my invention will be seen to comprise a device secured to or adapted to be secured to the lower end of a string of tubing 1 for insertion into a well casing 2. The device is shown as comprising an outer conduit means 3 forming a vertically elongated body member which will be generally referred to as a "tubular" or other member throughout the specification and claims even though it is preferably made up of a plurality of sections which may be of different diameter. The body member 3 forms a longitudinally extending chamber 4 and is provided with one or more openings at 5 and at 6 which are longitudinally spaced from one another and establish fluid communication between the inside of the chamber 4 and the inside of the casing 2 which is located outwardly of the member 3.

For convenience in assembly and for other reasons which will appear as the description proceeds, the body member 3 is formed from a plurality of tubular sections of different diameters. Thus the body member 3 comprises a relatively short upper collar 7 threadedly receiving an internal sleeve 8 at its upper end. Threaded within the lower end of the collar 7 is a tubular member 9 of reduced diameter and provided with the openings 5. The lower end of the upper section 9 is threaded into the upper end of an intermediate section 11 of increased diameter which is shown formed with an upper section 12 and a lower section 13 joined at 14. A lower section 15, which may be of the same diameter as the upper section 9 and which is provided with the openings 6, is shown threadedly secured to the interior of the section 13 and is provided with a cap 16 at the lower end thereof forming the lower wall of the chamber 4.

The intermediate section 11 and preferably the lower section 13 thereof is provided with an opening 17 establishing fluid communication between the inside and outside of the chamber 4 and the inside of the casing 2. Packing means such as flexible rubber packing cups 18 and 19 are provided at longitudinally spaced positions

on opposite sides of the opening 17 and are shown facing said opening so that an increased pressure within the casing in the localized zone between the packing means will tend to force the packing cups outwardly to increase their sealing engagement with the inside of the casing.

The packing cups 18 and 19 may be of a commercial variety which are formed about metal sleeves 21 and 22 respectively which encircle the sections 9 and 15 respectively and abut against collars 23 and 24 suitably secured to the respective sections and located between the packing members. Collars 25 and 26 threadedly engaging the respective members 9 and 15 are provided for holding the packers 18 and 19 in tight engagement with the collars 23 and 24.

A vertically elongated inner tubular member 27 extends into the chamber 4 from its upper end through the collar 8 and is adapted to rotate with respect to said collar. The tubular member 27 is spaced from the chamber 4 throughout its length in order that the desired fluid communication between the openings 5, 6 and 17 in the tubular body member 3 may be maintained. Although the tubular member 27 may be of the same diameter throughout its length, I prefer to make the upper portion 28 thereof which extends through the collar 8 of larger diameter than the lower portion 29 thereof which extends into the chamber 4 and is located in the passage between the openings 5, 6 and 17. The upper portion 28 is conveniently of the same diameter as the tubing 1 so that it may be attached thereto by means of a conventional tubing collar 31.

It is preferred to support the tubular member 3 from the tubing 1 at a position adjacent the upper end of the tubular member. For that reason the tubular member is supported from the collar 8 by means of a flange 32 threadedly engaging the lower end of the section 28 and forming the upper portion of a reducing coupling 33 for coupling the sections 28 and 29 together. Suitable means is also provided for preventing upward movement of the tubular body member 3 with respect to the tubular member 27. Such means may comprise a flanged cap member 34 secured to and closing the lower end of the member 27 and resting against the inside of the cap member 16 located at the lower end of the section 15.

Valve means controlled by rotation of the member 27 with respect to the body member 3 is provided within the chamber 4 intermediate the openings 5 and 6 and is adapted to open and close communication between the openings 5 and 6 through the chamber 4. In the preferred embodiment of my invention as illustrated in Figs. 1-5 and as more particularly illustrated in Figs. 1, 4, and 5, the valve means is located in the central section 11 between the packers 18 and 19.

Referring to said last-mentioned figures and particularly to Figs. 4 and 5, the valve means is shown as comprising a pair of vertically spaced valves 35 and 36 located within the chamber 4 and associated with the sections 12 and 13 respectively and located on opposite sides of the opening 17 in the central section. The upper valve means 35 is shown as comprising a pair of relatively rotatable members 37 and 38, the member 37 being carried by the inside of the upper intermediate section 12 and the member 38 being carried by the tubular member 29. The lower valve means 36 is shown comprising a

similar pair of members 39 and 41 which are carried by the members 13 and 29 respectively.

The members 37 and 39 are each in the form of partitions providing annular faces for cooperating to form a tight sealing fit with the cooperating faces of the valve members 38 and 41. The members 38 and 41 are provided with portions 42 and 43 which extend toward one another along the tubular member 29. The members 38 and 41 are constrained for rotation with the member 29 and are preferably also capable of some longitudinal movement with respect to the member 29. To accomplish this, the members 38 and 41 are keyed to the tubular member 29 by means of longitudinally extending keys 44 and 45. The portions 42 and 43 and the adjacent portions of the tubular member 29 are appropriately splined for this purpose. The valve members 38 and 41 are spring-pressed outwardly against the members 37 and 39 by means of a compression spring 46 which is preferably of substantially the same diameter as the inside of the intermediate section 11 and preferably bears against the outer edges of the members 38 and 41.

The members 37 and 39 are provided with valve apertures 47 and 48 which preferably take the form of arcuate slots extending about 120° about the circumference of these members. The members 38 and 41 provide means for closing or opening the apertures 47 and 48; for opening the apertures 47 and 48 they are also provided with apertures of substantially the same size and shape as the apertures in the members 37 and 39 and are adapted to mate therewith. The apertures in the members 38 and 41 are designated as 51 and 52 respectively.

The members 38 and 41 are adapted, in one rotative position of the tubular member 27 with respect to the body 3, to establish fluid communication through the chamber 4 between the openings 5 and 6 outside of the passage provided by the inner tubular member 27 which has an opening 64 providing communication between the last-mentioned passage and the portion of the chamber 4 between the valves, and in another rotative position of the members 27 and 3, to break this fluid communication. In this last mentioned rotative position of the valves, the by-pass passage between cased portions of the well above and below the spaced packers which was present when the valves were open, is completely closed off from the passage through the inner tubular member 26 at positions below the lower valve and above the upper valve. With the example illustrated, a rotation of approximately 120° will either make or break this fluid communication. To enable such relative rotation, the member 3 is provided with means for engaging the inner walls of the casing 2 to prevent rotation of said member, said means consisting, for example, of bow springs 53 and 54 secured to said member 3, for example through the agency of the threaded collar 25 and the cap member 16, and adapted to frictionally engage the walls of the casing so as to resist rotation of the member 3 while permitting rotation of the member 27.

For ease in determining the position of the valves from the surface, means is also provided for limiting the relative rotation of the members 27 and 3. Such means may comprise a pin 61 projecting outwardly from the member 28 and adapted to engage pins 62 and 63 extending upwardly from the sleeve 8 and limiting the relative rotation to around 180°. Thus when the pin

61 is in engagement with the pin 62 the valves are open and all of the apertures are in line with one another. With the pin 61 engaging the pin 63, as indicated in dot-dash lines at 61a, the valves are closed, and communication between the openings 5 and 6 is broken. In Fig. 5 the slot 52 is shown at 52a in dot-dash lines, corresponding to the position taken by the pin at 61a, in which position this slot is out of line with slot 48 and the valve 36 is closed.

When the valves 35 and 36 are closed, a portion 4a of the chamber 4 located between the valves is isolated from the rest of the chamber. This chamber 4a is in fluid communication through the opening 17 with the localized portion of the casing 2 located between the passage means 18 and 19. The tubular member 27 is provided with an opening 64 located within the chamber 4a by means of which fluid communication between the localized portion of the casing and the surface of the ground may be had through the tubing 1.

Although my apparatus is useful in any operation in which it is necessary to establish fluid communication through the tubing to a localized portion of the casing, for brevity it will be described in connection with the locating and cementing of openings such as leaks in a well casing. The apparatus is lowered into the well casing on the end of the tubing 1. During descent the valves 35 and 36 are maintained open, which means that the tubing 1 has been given a counter-clockwise rotation to bring the pin 61 into engagement with the pin 62. Fluids in the well are by-passed past the packing means 18 and 19 by passing through the chambers 4 from the openings 6 through the valves 36 and 35 and out through the openings 5. It is to be understood that the passage between the packers through the valves may be considered as a pair of by-pass passages. Thus it may be considered as one by-pass passage establishing communication between the exterior of the tool above the upper packing member and the exterior of the tool between the packing members; and another by-pass passage establishing communication between the exterior of the tool below the lower packing member and the exterior of the tool between the packing members.

As the depth at which the leak is thought to be located is reached, the descent of the tool is stopped and the tubing 1 is rotated clockwise for about 180° until the pin 61 strikes the pin 63. This closes the valves 35 and 36 and places the localized zone of the casing between the packing means in communication with the tubing only through the openings 17 and 64. An attempt may then be made to force fluid down the tubing 1 under pressure. If it is not possible to readily accomplish this, it may be assumed that there is no leak in the casing in the localized zone between the packing means. If it is readily accomplished, a leak is indicated in this localized zone. If no leak is found the apparatus may be moved up or down the hole in the manner previously described and the above process of locating leaks may be repeated.

Assuming now that a leak such as indicated at 65 has been located between the packing means, the valves are preferably opened by rotating the tubing with respect to the outer tubular member to bring the pin 62 into contact with the pin 61 and to provide a by-pass through the chamber. The desired quantity of cement slurry

is then introduced into the upper end of the tubing and is forced downwardly.

The fluid present in the tubing below the cement slurry flows through the chamber and out through the valves on opposite sides of the packing means as it is displaced by the slurry. When the cement has reached the level of the tool, and preferably when it has reached a position only slightly above the opening 64, as may be indicated by any one of a number of tell-tale devices now available on the market or determined by knowledge of the amount of fluid displaced from the tubing below the cement and of the length of the tubing string, the tubing is rotated with respect to the member 3 to bring the pin 61 into engagement with the pin 63 and close the valves 35 and 36.

The pumping of the cement is then continued and it passes from the tubing out through the openings 64 and 17, then out through the casing through the opening 75 to cement the opening and the formation therearound. After a sufficient quantity of cement has been forced through the opening 65, the cement remaining within the tool, as within the tubular member 27, the chamber 4a and the space between the opening 17 and the lower packing member 19, may be flushed out in accordance with any one of a number of methods.

For example, with the valves 35 and 36 closed, the fluid flow through the tubing 1 may be reversed, as by forcing liquid down through the casing 2 around the tubing 1, past the packing member 18, and thence through the openings 17 and 64, and out through the tubing. This flushing procedure is disclosed in greater detail and claimed in my copending application Ser. No. 395,370, filed May 27, 1941. The upper packing member 18 will readily move away from the wall of the casing in response to excess fluid pressure from above.

After the tool has been sufficiently flushed out, the tubing may be rotated to open the valves 35 and 36 and the tool may then be moved to any desired depth or out of the hole. Movement of the tool with the valves open will also tend to clean the chamber 4a of any cement. Obviously the valves 35 and 36 may be opened as soon as the cementing operation is completed, and the tool may be moved to a different depth and away from the cemented opening before the flushing operation is performed. During such movement of the tool a certain amount of initial flushing will be accomplished. It should be noted that when the tool is removed from the hole with the valves open, the liquid in the tubing will drain out and the tubing string may be broken down in a dry condition. Furthermore, it is not necessary to lift a wet string to the surface.

It should be noted that when the valves 35 and 36 are closed and the chamber 4a is under pressure, as when fluids are being forced down the tubing 1, the members 38 and 41, being located on the sides of their respective coacting members toward the zone between the packers, are forced outwardly against the members 37 and 39 in tight sealing engagement therewith. When the pressure within the chamber 4a is released, the spring 46 maintains the members 38 and 41 in light frictional engagement with the members 37 and 39 whereby only a small force is required to rotate the member 27 with respect to the member 3.

In view of the fact that some clearance is

required between the members 38 and 41 and the tubular member 29, I prefer to provide a flexible gasket forming a fluid seal between the tubular member 29 and each of the members 38 and 41. Such gaskets may conveniently take the form of rubber sleeves 66 and 67 which are placed under tension about the tubular member 29 and over the portions 42 and 43 of the members 38 and 41.

In Fig. 6 I have illustrated another form of my invention. The apparatus is shown suspended from a string of tubing 71 within a casing 72 and may comprise a vertically elongated outer body member 73 made up with upper, intermediate and lower tubular sections 74, 75 and 76, respectively. Each of these sections is provided with one or more openings, as at 77, 78 and 79, respectively.

The apparatus is further provided with an inner vertically elongated member such as a tubular member 81 extending into the chamber formed by the body member 73 and comprising an upper section 82 and a lower section 83. The upper section 82 is connected by means of a collar 84 to the tubing 71 from which the apparatus is suspended. The lower section 83 is connected to the upper section 82 through the agency of coupling 85 located within the chamber formed by the member 73, and the upper portion of this coupling bears against the inner face of a sleeve 86 threadedly engaging the interior of the upper section 74 of the tubular body member.

The lower end of the tubular member 81 is closed by means of a flanged cap which bears against a cap 88 carried by the lower end of the bottom section 76 of the tubular body member. Thus the tubular member 81 is prevented from moving longitudinally with respect to the body member 73 by the members 85 and 87 which bear outwardly against the members 86 and 88 respectively.

It will be noted that in this form of my invention the intermediate section 75 is of smaller diameter than the outer sections 74 and 76. Also in the form of the invention longitudinally spaced packing means 91 and 93 are carried by the intermediate section. The packing means may be the same as illustrated in Fig. 3 and may be attached to the tool in the same manner. The packing means are located on opposite sides of the opening 78 and between the openings 77 and 79.

The apparatus is further provided with valves 94 and 95 which may be constructed in the same manner as valves 35 and 36 illustrated in Figs. 1, 4 and 5 and are located on opposite sides of the opening 78 and between the openings 77 and 79. In this form of my invention the valves are located in the upper and lower sections 74 and 76 and outwardly of the packing means 91 and 93.

The valve means in this form of my invention also may be spring-pressed against their seats, but since the valves are separated by a considerable distance separate springs 96 and 97 are used and they may bear inwardly against sleeves 98 and 99 provided for this purpose. The tubular member 83 is further provided with an opening 101 located between the valves 94 and 95 and adapted to establish communication through the opening 78 to the localized portion of the casing sealed off between the packing means 91 and 93.

Means, such as an outwardly extending pin 102 on the section 82 and cooperating upwardly

extending pins 103 and 104 carried by the sleeve 86, are provided for limiting relative rotation of the tubular member 81 and the body member 73. Bow spring means 105 and 106 are provided on the upper and lower ends of the tubular body member for engaging the walls of the casing 72 for resisting rotation of this member with respect to the casing.

Operation of this form of the invention is substantially the same as that described in connection with Fig. 1. With one rotative position of the tubing with respect to the body member, for example with the stop pin 102 engaging the pin 103, the valves 94 and 95 are opened. This provides communication between the openings 79 and 77 for the purpose of by-passing fluids past the packing means 91 and 93 when the tool is moved longitudinally of the casing. When the tubing is rotated sufficiently with respect to the body member, for example to a position with the stop pin 102 in engagement with the pin 104, the valves 94 and 95 are closed and communication between the openings 77 and 79 is broken. Communication can then be established through the tubing 71 and the openings 101 and 78 to only the localized zone of the well casing located between the packing means 91 and 93.

A somewhat more compact arrangement embodying my invention is illustrated in Fig. 7. The apparatus is shown as comprising a tubular body member 110 forming a chamber 111 which is closed at its ends by upper and lower partitions 112 and 113. A tubular support member 114 extends through the partitions 112 and 113 and through the central portion of the chamber 111, being spaced from the interior of the body member 110 to provide for fluid flow through the chamber 111. The tubular member 114 is prevented from moving longitudinally with respect to the body member 110 by means of a collar 115 which is secured to the member 114 and is adapted to bear downwardly against the upper face of the partition 112 and a cap 116 which closes the end of the tubular member and is adapted to bear upwardly against the bottom face of the lower partition 113.

The tubular member 114 is adapted for rotation with respect to the body member 112 and is provided with valve members 117 and 118 adapted to respectively bear upwardly and downwardly against the respective lower and upper faces of the partitions 112 and 113. The valve members 117 and 118 are adapted to close apertures 119 and 120 of the respective valve members for one relative rotative position of the members 110 and 114 and to open these apertures for another rotative position.

The valves may be the same as those described in connection with Figs. 1-6 and since they both may be the same, only the lower valve is illustrated in detail. It is shown provided with an aperture 121 which is adapted to align with the aperture 120 when the valve is open. The valve 118 is suitably keyed as at 122 to the tubular member 114 and a suitable resilient gasket such as a flexible rubber sleeve 123 is shown in sealing engagement with the valve 118 and the tubular member 114. The valves 117 and 118 are preferably mounted for some longitudinal movement with respect to the member 114, and suitable means such as a compression spring 124 is provided to press these valves upwardly and downwardly against the respective lower and upper faces of partitions 112 and 113. Ob-

viously two springs may be used, as shown in Fig. 6, in place of the single spring 124.

Suitable means, such as bow springs 125, secured to the outside of the tubular body member 110 and adapted to engage the inner wall of casing 126 is provided for resisting rotative movement of the body member 110 with respect to the casing 126 and thereby facilitating rotative movement of the tubular member 114 with respect to the body member. As with previously illustrated embodiments of the invention, the inner tubular member is shown suspended from the lower end of a string of tubing 127 by means of a suitable coupling 128.

Suitable means such as upwardly extending pins 129 and 130 carried on the upper partition 112, and a radially extending pin 131 extending from the tubular member 114, is provided for limiting the relative rotating movement of the body member and the inner tubular member whereby the open and closed positions of the valves may be readily obtained by rotating the tubing string 127 at the surface of the ground.

With this embodiment of my invention I have shown spaced packers 132 and 133 located near the ends of the tubular body member 110 and on opposite sides of the bow springs 125. The packers 132 and 133 may be the same as described in connection with Figs. 1 and 3 and are adapted to sealingly engage the inner wall of the casing 126 to seal off a localized portion or vertically extending zone of the casing therebetween. Located between the packers and preferably near the lowermost packer is an opening 134 in the wall of the member 110 providing fluid communication between the space sealed off between the packers and the interior of the chamber 111. An opening 135 preferably located at about the same level as the opening 134 is also provided in the tubular member 114 so that fluid communication may be established through the tubing 127 through the openings 135 and 134 to the localized portion of the casing located between the packers 132 and 133. This form of my invention may be operated in the same way as the forms described in connection with Figs. 1-6.

Although I have shown the same types of valves in the embodiment of my invention illustrated in Figs. 1-7, it should be understood that the valve structure may be modified considerably without departing from the spirit and scope of this invention. For example, a valve member such as shown at 21 in Fig. 5 need not be provided with an arcuate slot as shown therein, but may comprise only a partial plate as shown at 41a in Fig. 8, of sufficient size to close the aperture such as the arcuate slot 48 in the partition 39. The construction of the apparatus may be otherwise the same as illustrated in Figs. 1-7.

As previously stated, the valve members are preferably capable of some longitudinal movement with respect to the inner tubular member. In Fig. 9 the structure of the upper valve such as illustrated in Figs. 1 and 4 has been modified to provide a definite limit to the longitudinal movement of the valve member with respect to the tubular member 29. For this purpose a pin 141 is shown extending through the tubular member 29 and radially thereof to engage the lower portion of the valve 38 to prevent this valve from moving more than a short distance from the partition 37.

In this connection it may be stated that when means such as the pin 141 is used to positively

prevent the valve from moving more than a very small distance from the partition, the spring means such as the spring 46 may be omitted. Pressure within the chamber between the valves will tend to hold them in close engagement with the partition. At the same time, the resilient gasket 66 tends to bias the valve toward the partition.

In the previously described examples of my invention the partitions in the tubular body member have been shown fixed thereto and the valve members have been slidably mounted on the inner tubular member. In Fig. 10 an arrangement is illustrated in which a tubular body member 142 is provided with a partition 143 which is keyed as at 144 to the interior of the body member and is slidably movable longitudinally therein. An inner tubular member 145 is shown extending through the body member 142 and through the partition 143 and is provided with a valve member 146 which is suitably secured thereto as by means of a pin 147. Suitable means such as a flexible rubber sleeve 148 in engagement with the interior of the body member 142 and the partition 143 is provided to give a flexible fluid seal between the partition and the body member.

A construction for a lower valve member is illustrated in Fig. 10 and an upper valve member may be constructed in exactly the same manner. The construction of the remainder of the apparatus may be otherwise the same as that illustrated in Figs. 1-6. Spring means 149 comparable to the spring means 46 of Fig. 1 or 97 of Fig. 6 is provided for pressing the partition into engagement with the valve 146. The partition 143 is shown provided with an aperture 150 which is adapted to coact with a suitable aperture 151 in the valve 146 to provide an open position for the valve. The aperture 150 is closed by the member 146 upon relative rotation of the members 142 and 145.

In all of the previously described modifications and embodiments of my invention the partitions and valve members have had radially extending cooperating faces. Although I prefer to use this type of construction, it should be obvious that other forms of valves may be used. As an example, the form of apparatus illustrated in Fig. 6 may be modified in the manner illustrated in Fig. 11. For brevity, only the upper valve structure has been illustrated in Fig. 11, and the lower valve structure may be modified accordingly.

Referring to Fig. 11, a modified form of the upper section 74 of the tubular body member is designated 74a and is provided with one or more openings 77a. The opening 77a corresponds generally to the opening 77 illustrated in Fig. 6. In place of the upper valve member 94 I have provided a sleeve 160 which is adapted to be rotated with respect to the member 74a while maintaining a close sliding fit therewith. Sleeve member 160 is provided at its upper end with a closed flange and hub member 161 which is secured to the inner tubular member 83 as by means of a set screw 162 and cooperates with the packing member to seal off the casing. The members 160 and 161 are adapted to provide a fluid seal between the members 83 and 75. The member 160 is adapted in one rotative position of the tubular member 83 with respect to the body member 75 to close the opening 77a and in another rotative position to provide free fluid communication from the opening 77a to the interior of the member 75. To provide this communication the member 116

has one or more openings 163 adapted to align with the opening 77a, as shown in Fig. 11.

The spring means used for frictional engagement with the casing may be constructed in accordance with established practice. It is customary to anchor one end of the spring means to the tool and to let the other end of the spring means slide longitudinally with respect to the tool to accommodate for different diameter casings, obstructions, or the like. Thus in Fig. 1, the ends of the springs 53 and 54 are anchored to the collar 25 and cap 16 which threadedly engage the body member 3. The other ends of the springs 53 and 54 are attached to collars 53b and 54b respectively which are slidably movable longitudinally on the body 3.

In Figs. 6 and 11 the springs 105 and 106 are respectively connected to a collar 105a which is fixedly connected to the body 73 and the cap 88 which is threaded on the body. The other ends of these springs are connected to collars 105b and 106b respectively which are slidably movable longitudinally on the body 73.

In Fig. 7 the springs 125 are attached to a collar 125a which is rigidly attached to the body 110. The upper ends of the springs 125 are attached to a collar 125b which is slidably movable longitudinally on the body 110.

My invention is obviously subject to considerable modification. Hence, I do not choose to be limited to the above described examples but rather to the scope of the appended claims.

I claim:

1. A tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, comprising: a vertically elongated inner member adapted for connection at its upper end to the tubing string and having a passage that extends downwardly from its upper end and communicates with the exterior of said member through an opening spaced from said upper end; a vertically elongated outer member which extends around and rotatably engages said inner member; two vertically spaced packing members secured to said outer member at positions respectively above and below said opening and adapted for sealing engagement with the casing and cooperating with said outer member to seal off a vertically extending zone of the casing between said packers in communication with said opening; said outer member defining a passage outside the inner member establishing communication from a position outside the tool below the lower packer and a position outside the tool above the upper packing member and communicating through said opening with the first-mentioned passage; two valve devices controlling communication through the last-mentioned passage and located respectively below and above said opening, each of said valve devices comprising two coacting valve members secured respectively to the inner and outer members and operable to open and closed positions upon relative rotation of said members.

2. A tool as set forth in claim 1, and further comprising means attached to said outer member for frictionally engaging the walls of the casing to resist rotation of said member with respect to the casing.

3. A tool as set forth in claim 1, said last-mentioned passage being completely closed off from communication with said first-mentioned passage at positions below said lower valve device and above said upper valve device.

4. A tool as set forth in claim 1, one of the

valve members of each of said valve devices comprising an apertured seat, the other one of the valve members of each of said valve devices comprising a member located on the side of its cooperating seat toward said zone and being adapted to close the aperture in said seat and to be forced into tight engagement with said seat in response to fluid pressure in said zone.

5. A tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, comprising: a vertically elongated inner member adapted for connection at its upper end to the tubing string and having a passage that extends downwardly from its upper end and communicates with the exterior of said member through an opening spaced from said upper end; a vertically elongated outer member which extends around and rotatably engages said inner member, said outer member having an opening in its side providing fluid communication between the inside of the casing and said first-named opening; two vertically spaced packing members secured to said outer member at positions respectively above and below said openings and adapted for sealing engagement with the casing and cooperating with said outer member to seal off a vertically extending zone of the casing between said packers in communication with said opening; said outer member defining a passage outside the inner member establishing communication from a position outside the tool below the lower packer and a position outside the tool above the upper packing member and communicating through said openings with the first-mentioned passage; two valve devices controlling communication through the last-mentioned passage and located respectively below and above said openings, each of said valve devices comprising two coacting valve members secured respectively to the inner and outer members and operable to open and closed positions upon relative rotation of said members.

6. A tool as set forth in claim 5, and further comprising means attached to said outer member for frictionally engaging the walls of the casing to resist rotation of said member with respect to the casing.

7. A tool as set forth in claim 5, said last-mentioned passage being completely closed off from communication with said first-mentioned passage at positions below said lower valve device and above said upper valve device.

8. In an oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, the combination which comprises: a vertically extending tool body member; two vertically spaced packing members adapted for sealing engagement with the casing and secured to said body member and cooperating with said body member to seal off a vertically extending zone of the casing therebetween; an inner vertically elongated member adapted for connection to said tubing string and extending within said tool body member and adapted for rotary movement with respect to said body member, said inner member having a passage communicating with the tubing string and an opening located within said body member providing communication between said passage and said vertically extending zone in said casing; upper and lower rotary valve means associated with said tool body member and said inner vertically elongated member and located on vertically opposite sides of said opening, said valve means being adapted in one relative rota-

tive position of said tool body member and said inner vertically elongated member to open a by-pass passage outwardly of said passage in said inner vertically elongated member between the portions of the casing above and below said vertically extending zone and being adapted in another relative rotative position of said tool body member and said inner vertically extending member to close said by-pass passage.

9. A tool as set forth in claim 8, said by-pass passage being completely closed off from said first-named passage at positions below said lower valve means and above said upper valve means.

10. In an oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, the combination which comprises: two vertically spaced packing members adapted for sealing engagement with the casing; members associated with said packing members and cooperating therewith to seal off a localized vertically extending zone within the casing and defining a fluid passage extending downwardly from the upper end of the tool and communicating with the exterior of the tool at a position between said packing members and also defining a fluid by-pass passage extending from below the lower packing member to above the upper packing member and communicating at each end with the exterior of the tool, said two passages communicating with each other only at a position between said packing members; and valve means controlling communication through said by-pass passage, located respectively below and above the position of communication thereof with the first-mentioned passage, and movable to open and closed positions.

11. In an oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, the combination which comprises: two vertically spaced packing members adapted for sealing engagement with the casing; means cooperating with said packing members to seal off a localized zone within the casing between said packing members; means defining a fluid passage extending downwardly from the upper end of the tool and communicating with the exterior of the tool at a position between said packing members; means defining a by-pass passage separate from the first-mentioned passage, establishing communication between the exterior of the tool above the upper packing member and the exterior of the tool between the packing members; means defining another by-pass passage separate from said first-mentioned passage, establishing communication between the exterior of the tool below the lower packing member and the exterior of the tool between the packing members; and valve devices operable to open and close each of said by-pass passages.

12. In an oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, the combination of upper and lower means spaced vertically from one another and each including and cooperating with a packer for sealing engagement with the walls of the casing to seal off a vertically extending zone of the casing therebetween; means holding said upper and lower means in vertically spaced relation and having a passage communicating with the tubing and with an opening communicating with said zone; and valve means cooperating with said upper and lower means and operable upon relative movement

between the tubing and said upper and lower means, to an open position providing fluid communication between said zone and the cased portion of the well above and below said zone and between said opening and the cased portions of the well above and below said zone, said passage being completely cut off from communication with the cased portions of the well above and below said zone when said valves are closed.

13. In an oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, the combination that comprises: an outer conduit means having two vertically spaced packing members disposed outwardly thereof for sealing engagement with said casing; an inner conduit means extending within and spaced from the outer conduit means and relatively rotatable with respect thereto; two vertically spaced, transverse partitions disposed between said conduit means and secured to one of said conduit means, and having apertures in fluid communication with the exterior of said outer conduit means at positions respectively below the lower packing member and above the upper packing member; two valve members disposed respectively below the upper partition and above the lower partition and biased into engagement with the respective partitions, said valve members being connected to the other conduit member and constrained to rotate therewith relative to said one conduit member and movable into positions to close and open the respective apertures upon relative rotation of said conduit members; said outer conduit having an opening located between said packing members and also between said valve members; and said inner conduit means having an opening located between said valve members.

14. A tool as set forth in claim 13, and further comprising means attached to said outer conduit means for frictionally engaging the walls of the casing to resist rotation of said outer conduit member with respect to said casing.

15. An oil well tool for use in combination with a well casing and a string of tubing adapted to be moved vertically within said casing, said tool comprising: an inner portion including an inner tubular conduit means having means at its upper end for connection to the tubing string in communicating relation therewith; an outer portion supported on said inner portion in such manner as to permit relative rotation of said inner portion with respect to said outer portion, and including an outer tubular conduit means of less diameter than said casing surrounding and spaced from said inner conduit means to provide a fluid passage therebetween; means on said outer portion adapted to frictionally engage said casing in such manner as to permit vertical movement of said tool within said casing and to resist rotative movement of said outer

portion; two vertically spaced packing members secured to said outer conduit means and adapted to engage said casing to seal off a localized portion of said casing; said outer conduit means having two openings located respectively below the lower packing member and above the upper packing member; and two vertically spaced valve devices located within said fluid passage between said two openings and each comprising a valve member connected to said outer conduit means and constrained against rotative movement relative thereto and a member connected to said inner conduit means and constrained to rotate therewith into closed and open positions with respect to the other valve member; said outer conduit means having another opening located between said packing members establishing fluid communication with the portion of said fluid passage between said valve devices; and said inner conduit means having an opening located between said devices.

16. A well tool adapted to be suspended from a string of tubing for movement to different depths in a well casing, comprising: means defining the side walls of a longitudinally extending chamber having an opening in said side walls; packing means carried by said first-named means and located at longitudinally spaced positions above and below said opening and adapted to seal off a portion of said well casing therebetween; apertured members carried by said means and forming upper and lower end walls of said chamber, said apertures being adapted to provide fluid communication through said chamber between portions of the casing above and below said packing means; another member extending into said chamber through one of said apertured members and adapted for connection with said string of tubing to provide fluid communication from said tubing to the interior of said chamber and adapted for rotation with respect to said means; and other apertured members respectively spring-pressed upwardly against the inner face of the upper one of said first-named apertured members and downwardly against the inner face of the lower one of said first-named apertured members and mounted for rotation with said other member, said apertured members cooperating in one rotative position to provide said fluid communication through said chamber between said portions of the casing above and below said packing means and cooperating in another position to close said apertures and the ends of said chamber.

17. A tool as set forth in claim 16, and further comprising bow spring means secured to said first-named means for frictionally engaging the inner walls of said casing to resist rotation of said first-named means with respect to said casing.

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