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Aug. 17, 1943. P. H. GRANGER 2,326,940

OIL WELL TOOL

Filed March 15, 1941 2 Sheets-Sheet 1

Fig. 1.

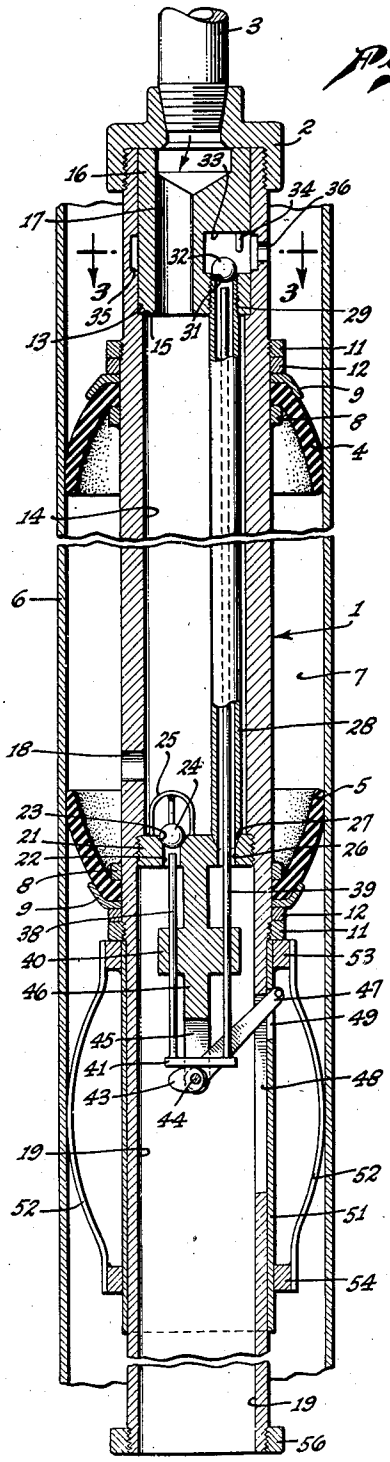
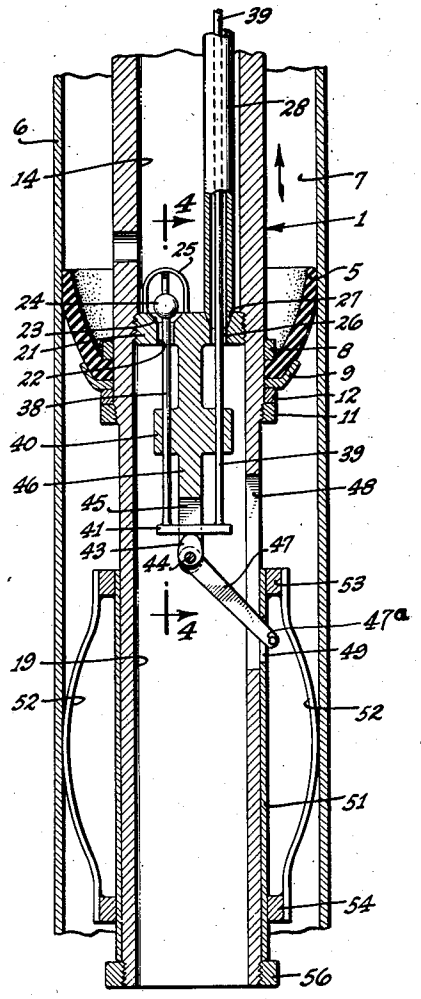


Fig. 2.



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Fig. 3.

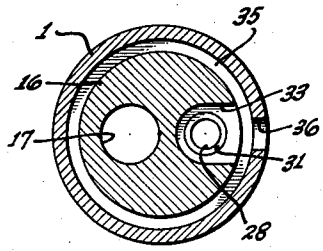


Fig. 4.

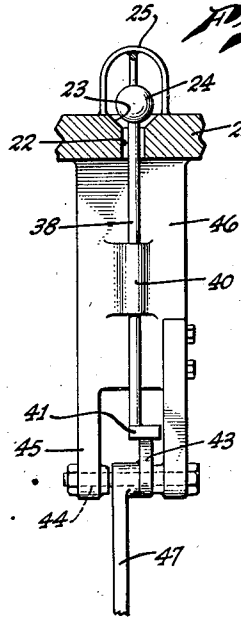
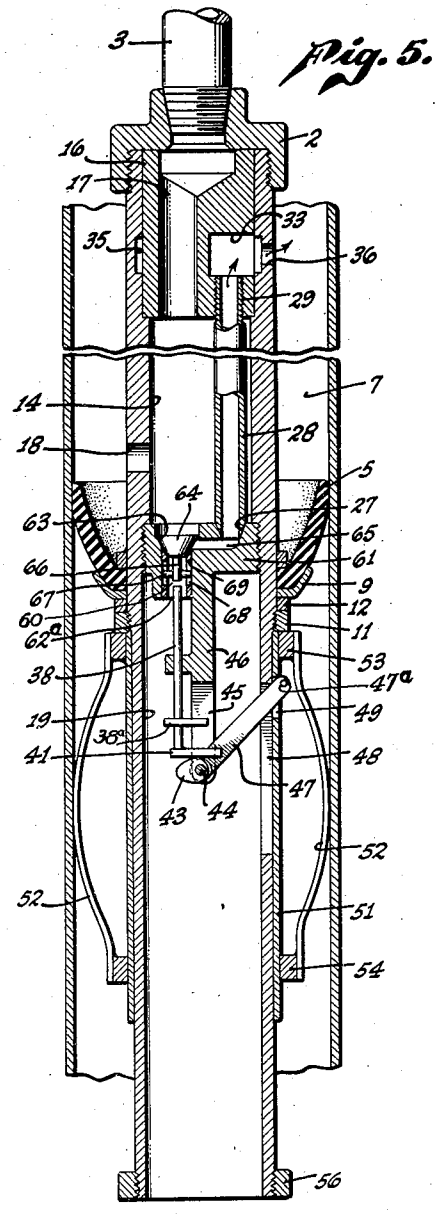


Fig. 5.



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UNITED STATES PATENT OFFICE

2,326,940

OIL WELL TOOL

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Application March 15, 1941, Serial No. 383,589

11 Claims. (Cl. 166—11)

This invention relates generally to oil well tools and, more particularly to a tool which may be used for locating leaks in well casings, 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.

Tools of this type are suspended from the tubing string and are provided with an internal passage affording communication between the tubing string and a localized zone in the casing around the tool, which zone is sealed off by vertically spaced packers carried by the tool from the spaces in the casing above and below the packers. The packing means seal tightly with the inner face of the casing and means are provided for by-passing fluids past the packing means, between the interior of the casing above and below the packing means, when the tool is moved vertically in the casing. It is particularly desirable to provide means for closing the by-pass passage when the tool is in operating position in order to carry out certain operations which will be described.

In operations attendant to locating leaks in the casing, cementing them, and flushing the tool, tubing and casing after the cementing is accomplished, or in other operations for which such tools are used, it is desirable to provide for the establishment of liquid flow through the tubing, casing or tool in various ways depending upon the particular situation. For example, in leak locating and cementing operations it is desirable to establish flow between the tubing string and only the localized zone in the casing. According to one flushing operation that is practiced, it is desirable to establish a reversed flow in the tubing and casing by forcing liquid down in the casing past the upper packing means and into the localized zone, and thence upwardly through the tubing. This operation requires that there be no communication through the tool between the localized zone in the casing and the interior of the casing below the lowermost packing means. According to another flushing procedure, it is desirable to force liquid down the tubing string and flush the interior of the tool into the interior of the casing below the lowermost packing means, this last procedure requiring a passage between the passage inside the tool and the interior of the casing below the lowermost packing means.

It is an important object of this invention to provide a tool of the class described adapted to establish liquid flow between the localized zone in the casing and the interior of the casing below the packing means and provided with valve means controllable from the surface to regulate the liquid flow whereby the tool is adapted to both of the above-mentioned flushing procedures and is also adapted to drain the tubing string as the tool is moved upwardly out of the casing.

It is a further object of the invention to provide a tool of the class described having a by-pass passage establishing liquid flow between the casing spaces above and below the packing means in order to permit ready vertical movement of the tool in the casing, and having valve means controlling liquid flow in the by-pass, which may be closed automatically by liquid pressure when the tool is flushed by reversed circulation as above described.

Another object of the invention is to provide a tool of the class described having a by-pass passage for well liquid and pressure-operated valve means for the passage which is adapted to be automatically opened by fluid pressure when the tool moves down in the casing and which is positively opened by upward movement of the tool with respect to the casing, the valve means being open when the tool is in motion up or down.

A further object of my invention is to provide a tool of the class described with a main vertical passage and valve means regulating liquid flow through the passage, the valve means being automatically opened by upward movement of the tool with respect to the casing whereby liquid in the tubing string is automatically drained back into the well as the tubing is removed from the well.

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

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

My invention will be better understood from the ensuing description taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical section of a preferred form of my tool showing it in place in the casing;

Fig. 2 is a fragmentary vertical section of the lower portion thereof showing the valve-operating mechanism in valve-opening position;

Fig. 3 is a sectional detail taken along line 3—3 in Fig. 1;

Fig. 4 is a fragmentary section and elevation taken along line 4—4 in Fig. 2; and

Fig. 5 is a fragmentary vertical section of a modified form of tool.

Referring to Figs. 1 to 3 of the drawings, and particularly to Fig. 1, the tool is shown as comprising a vertically elongated body member 1, preferably cylindrical, provided with a reducing coupling 2, to which it is threadedly secured at its upper end, for threadedly receiving the lower end of tubing string 3 from which the tool is suspended. The tool is further provided

with vertically spaced packing means, such as upper and lower packers 4 and 5 of rubber or the like, packers 4 and 5 face inwardly toward one another and are adapted to sealingly engage the inner face of the casing indicated at 6 to seal off between them a localized zone 7 around body 1 and inside the casing, this zone being cut off from fluid flow with the spaces in the casing above and below the packers. It is also within the scope of my invention to use four packers on the tool, adding an outwardly facing packer above and below each of packers 4 and 5, as is used in leak-locating tools.

The packers may be secured to the tool in any suitable manner. For example, the lowermost packer 5 may be held between a ring 8 secured to the body 1 as by welding and a conical metal follower 9 which is forced against the packer by pressure transmitted from a nut 11 threaded to the body. A suitable washer 12 may be provided between the nut 11 and the follower 9. The upper packer 4 is shown held in place by similar construction.

The upper portion of the body 1 is counterbored at 13 to a diameter greater than the diameter of chamber 14 in the central portion of the body, to provide a shoulder 15. A head member 16 slides with a close fit into the bore 13 and is held tightly against shoulder 15 by coupling 2. The head member 16 is provided with a liquid passage 17 establishing communication between the interior of the tubing string 3 and the interior 14 of the body. Body 1 is further provided with a passage 18, in the form of an aperture in the body wall, establishing communication between the zone 7 in the casing and the interior chamber 14 of the body.

The lower portion of the body is bored at 19 to a diameter which is somewhat greater than the diameter of the central bore 14 and is threaded at its upper end in order to receive valve block 21 which closes chamber 14 at its lower end. Block 21 is provided with substantially vertically extending passages 22 and 26 which both open at their lower ends to bore 19 and the space within the casing below the packing means. Passage 22 opens at its upper end to chamber 14, and has valve seat 23 at its upper end on which a ball check 24 is adapted to rest to close this passage. A suitable ball cage 25 is provided for preventing undue travel of the ball when it is lifted from its seat as will be described subsequently.

It will be seen from the drawings that the three passages 17, 14 and 22 combine to form a continuous main passage establishing liquid communication between tubing 3 and the casing space below the packing means, since bore 19 is open at all times to this lower casing space and is in effect a part thereof. With the addition of passage 18, the above passage also communicates with zone 7. Valve means, in the form of ball 24 and its seat, are in this combined passage to open and close the passage and regulate liquid flow therein.

Passage 26 is conically flared at its upper end at 27 to receive the lower end of the substantially vertically extending conduit 28 in substantially fluid tight engagement. Conduit 28 is threaded at its upper end at 29 into the head member 16 and is provided at its upper end with a suitable valve seat 31 for reception of a ball check 32 which is adapted to shut off fluid communication downward through conduit 28 when the check is on the valve seat.

The head member 16 is provided with a valve chamber 33 of sufficient size to allow necessary movement of the ball check 32 to open the passage, and suitable means, such as one or more pins 34, may be provided for retaining the ball in the chamber. Chamber 33 opens at one side to an annular recess 35 (see Fig. 3) which is in fluid communication with the interior of the casing above upper packer 4 through passage 36 in the wall of the body 1.

Conduit 28 lies within chamber 14 and the first main liquid passage described. Conduit 28, with valve chamber 33 and port 36 at its upper end and passage 26 at its lower end, forms a second liquid passage through body 1. This second passage is a by-pass establishing liquid communication with the casing spaces above and below the packing means. Valve means, in the form of ball 32 and its seat 31, are in the by-pass passage to open and close the passage and regulate liquid flow therethrough.

Upon downward movement of the tool through the casing, the excess of fluid pressure from below forces ball check 32 from its seat so that liquid in the well may by-pass the tool by flowing from the space in the casing below lower packer 5 upwardly through the lower bore 19, tube 28, and passage 36 to the space in the casing above upper packer 4. The ball 24 can also rise and permit upward flow in passage 22, but it may or may not leave its seat 23 depending upon whether the pressure acting upwardly on the check in passage 22 is greater than the pressure acting downwardly on the check from chamber 14.

It will be seen that if an effort is made to move the tool upwardly in the casing, the fluid flow through by-pass tube 28 is reversed and the check 32 is moved by liquid pressure against seat 31 to close the passage and no by-passing action is obtained. Also, check 24 seals against its seat 23 to close the passage 22 and prevent drainage of the tubing string 3. It is extremely important that the tubing string be drained as the tool is lifted from the hole, since draining the string eliminates lifting a large quantity of liquid and breaking down a tubing string full of liquid. Therefore, there are provided means which are controllable from the surface of the ground for opening passages 22 and 28 so that the tool may be moved upwardly in the casing while liquids by-pass past the packers and drain from the tubing string. Such means is preferably controlled by relative movement of the tubing string and casing and more preferably controlled by upward movement of the tubing string with respect to the casing.

As one example of valve-operating means which I may employ, I provide push rods 38 and 39 extending respectively into the passages 22 and 28 and adapted upon upward movement to engage and lift ball checks 24 and 32 from their respective seats to open their associated passages. The push rods are also movable to a lowered position in which they are out of contact with the checks to allow them to operate in accordance with the hydraulic forces imposed thereon.

Referring to Figs. 1, 2 and 4, the push rods 38 and 39 extend upwardly through guide 40, and are connected at their lower ends to cross head 41 which rides on eccentric cam 43, the cross head being a follower for the cam. Cam 43 is rotatably mounted on shaft 44 which is a bolt mounted in yoke 45 at the lower end of depending support 46 carried by the valve block 21. A

lever arm 47 is secured to cam 43 and rotatably mounted on the shaft 44 in order to rotate the cam and is adapted for movement to a raised position as indicated in Fig. 1 in which the push rods are moved to their lower positions, out of contact with the ball checks. When lever 47 is in the lowered position, as indicated in Fig. 2, the push rods are raised to lift the ball checks from their seats and open the valves. Pin 47a in the end of lever 47 prevents the lever from accidentally falling inwardly through slot 49, and it is removable to permit disassembly of the tool. Of course, any other suitable type of valve-operating means may be used, such as an eccentric and strap or a lever directly lifting the cross head.

In order to actuate the valve-operating means described, the arm 47 passes through a vertically extending slot 48 in the lower portion of body 1 and a relatively short slot 49 in sleeve 51 which is mounted for limited vertical sliding movement on the exterior of body 1. Sleeve 51 is provided with suitable means for frictionally engaging the interior of the casing, such as a plurality of vertically extending bow springs 52. Springs 52 are secured at their upper ends to ring 53 which is fixed on the sleeve, and are secured at their lower ends to ring 54 which is slidably mounted on the sleeve. Nut 56 is threaded onto the end of body 1 to limit normal downward travel of the sleeve on the body.

With the foregoing description of the construction of a preferred embodiment of my invention in mind, its operation will now be described. When the tool is lowered down inside the casing of an oil well, the frictional engagement of bow springs 52 with the inner face of the casing 6 resists movement of the bow springs with respect to the casing. This frictional drag causes sleeve 51 to slide upwardly on the tool body until further motion is stopped by engagement of ring 53 with nut 11, as shown in Fig. 1. Movement of sleeve 51 upwardly on the body actuates the valve-operating mechanism by raising lever 47 to its uppermost position, occupied in Fig. 1. At this time, push rods 38 and 39 are lowered and check valves 24 and 32 rest on their seats. At some point in its descent within the casing the tool encounters liquid in the well. This liquid in the space below lower packer 5 creates a pressure on the underside of valves 24 and 32 which is in excess of the pressure on the upper side of these valves, assuming that tube 3 is not full of liquid. The excess of pressure lifts either or both of the check valves off their seats and causes the well liquid either to by-pass the tool by going into by-pass conduit 28 and out port 36, thus reaching the casing space above packer 4, or to fill the tool and rise within the interior of tubing 3. Ordinarily liquid would fill both spaces, but by maintaining a sufficient column of liquid in the tubing, an excess of pressure may be maintained on the valve 24 to keep the valve closed.

During cementing, testing, or flushing operations, which are described later, fluid pressure is applied to the upperside of either or both of the check valves. Because of the construction of these check valves, they are responsive to fluid pressure differentials and when the excess pressure is in chamber 14 or 33, it is in a direction to move the associated valve toward its seat and the valve under pressure closes the associated passage through the tool. Consequently, although the valves automatically open in response to excess fluid pressure from below the tool tending to open them during descent of a tool in the casing, the valves automatically close during cement operations and the like because the excess pressure is on the other side of the valve.

When tubing 3 is withdrawn from the casing, bow springs 52 again resist movement relative to casing 6 because of the frictional engagement of the springs with the casing. Consequently, during the initial upward movement of the tool, sleeve 51 remains stationary while the tool moves upwardly with respect to the casing and the sleeve until the bottom of the sleeve engages nut 56 which lifts the sleeve with the casing. The relative upward movement of the tool with respect to the sleeve and casing moves lever 47 of the valve-operating means to the lowered position shown in Fig. 2. Movement of this lever rotates eccentric 43 to lift cross head 41 and push rods 38 and 39 upwardly. The push rods engage balls 24 and 32, lifting them from their seats to open the fluid passages through the tool. Liquid communication is now reestablished between the casing spaces above and below the packing means and between the tubing and tool chamber 14 and the casing space below the packing means. As the tool is moved up within the casing, liquid in the casing above the tool can by-pass downwardly through the tool, while liquid in the tubing can drain into the space below the tool. By provision of mechanical valve-operating means which is actuated by upward movement of the body relative to the casing, the check valves are positively opened against any excess liquid pressure tending to close them, and they remain open during the ascent of the tool in the casing to permit free passage of liquid back into the lower portion of the well.

A modified form of the invention is disclosed in Fig. 5. This form of the invention operates in the same manner as described and differs in construction from the form shown in Figs. 1 to 4 only in the construction and arrangement of the valve means and the liquid passages in the valve block. In general, the two main liquid passages through the tool are joined for a portion of their length within the valve block so that a single opening in the block is common to both passages, thus making it possible for one valve to control liquid flow in both passages. More particularly, valve block 21 of Fig. 1 is replaced by valve block 61 which has a single vertically extending liquid passage 62 opening at its lower end 62a into bore 19 and the well space below the packing means. This vertical liquid passage 62 is provided at its upper end with a conical valve seat 63 with which cooperates a poppet type check valve 64 to control liquid flow through the passage. Passage 62 has a horizontal branch 65 which communicates with by-pass conduit 28. Branch passage 65 is so located with respect to valve 64 that liquid flow through passage 65 is stopped when valve 64 is closed.

From this construction it will be seen that the main liquid passage through the tool affording communication between tubing 3 by way of chamber 14 with the casing space below the packing means, and also the by-pass passage 28, both open to bore 19 through the lower end 62a of the same passage in valve block 61. However, valve 64 is responsive to fluid pressure in the same manner as the ball check valves described since it is opened by an excess of liquid pressure in the casing below the packers, and closed by an excess of pressure in chamber 14.

The valve 64 is shown provided with a depending stem portion 66 having a horizontal pin 67 therethrough for engaging suitable guides 68 in the sides of the passage 62. Suitable stop means 69 are provided at the upper ends of the guides for arresting the upward movement of the valve. The push rod 38 is normally spaced from the lower end of the valve stem 66 when the arm 47 is in its raised position and is adapted to engage the lower end of the valve stem to raise the valve 64 from its seat when the arm 47 is in its lowered position. Push rod 38 carries a plate 38a that spans the distance between the legs of fork 45 and prevents the rod from turning and moving cross head 41 off cam 43.

It is preferable that the valve-operating mechanism be actuated by upward movement of the tool with respect to the casing although it will be understood that the mechanism may be modified to operate upon relative rotation of the tool with respect to the casing. It will also be seen that in the form of the invention illustrated in Fig. 1, both of the check valves may be located at the same level and on the valve block 21, instead of at different levels as shown. The exact type and location of the valves are not limited to those shown.

The tool may be used to locate leaks in the casing by attaching it to the tubing string and running it down the casing to various possible locations of leaks. The excess fluid pressure below the tool reaches the valves through the passages 22 and 26, and raises the check valves to allow liquid to by-pass around the packers and also to flow into bore 14. At any desired level liquid may be pumped down the tubing string 3 causing the check 24 to seat and close the passage 22. If there is no leak, no liquid will escape, and the pressure rises until the pump stalls. The tool is then run on down the hole to another position, and the procedure repeated until a location is found at which the pump continues to operate. This indicates that the packers are on opposite sides of a leak or other opening in the casing, since liquid from the tubing string passes out of passage 14 through the passage 18 into the zone 7, and then out through the casing into the formation.

The leak may be cemented by pumping cement down the tubing string and out through the passage 18 into the hole in the casing. It is preferable that the passage 18 be located closely adjacent block 21 and the lower packing cup 5 so that there is little tendency for cement to accumulate in and around the tool.

The excess cement may be flushed out of the casing and the tool by forcing liquid down the casing and discharging it from the upper end of the tubing string 3. The application of fluid pressure from above to start this reverse circulation seats the check valve 32 to close the by-pass passage and collapses the upper packer 4 sufficiently to pass liquid, since it faces downwardly. The lower packer 5 maintains its sealing engagement with the casing since the fluid pressure from above tends to seal it with the casing. Thus, the liquid flows down the casing past the upper packer and into the zone 7 flushing the cement out of this zone and discharging it through the passage 18 into passage 14 of the tool, and out through the tubing string 3. Any cement lodged on the partition 21 is also flushed during this operation. Flushing and cementing procedures of this nature are disclosed and claimed in my copending application Serial No. 395,370, filed May 27, 1941.

After the flushing operation the pump may be disconnected and the tubing string hoisted upwardly to bring the tool from the hole. Upon upward movement the arm 47 is moved to its lowered position raising the checks 24 and 32 to open the passages 22 and 26, respectively. Liquid in the tubing string is thus drained through the passage 22 and suitable by-pass is provided by the passage 28.

I claim:

1. A tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, comprising: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off therebetween a localized zone within the casing; said body having a first passage therethrough opening outwardly of the body into the space in the casing below the packing means for establishing liquid communication between the tubing string and said space; said body also having means defining a second passage opening outwardly of the body into the spaces in the casing above and below the packing means; valve means for opening and closing said passages, said first passage communicating with said zone at a position above the valve means in the first passage; and valve-operating means carried by said body in position for operative engagement with said valve means and actuated by movement of the body relative to the casing to open said valve means.

2. A tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, comprising: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off therebetween a localized zone within the casing; said body having a first passage therethrough opening outwardly of the body into the space in the casing below the packing means for establishing liquid communication between the tubing string and said space; said body also having means defining a second passage opening outwardly of the body into the spaces in the casing above and below the packing means; separate valve means in each of said passages for opening and closing the associated passage; said first passage communicating with said zone at a position above the valve means in the first passage; the valve means in the second passage being operable to open said second passage in response to fluid pressure in said space in the casing below the packing means; and valve-operating means carried by said body in position for operative engagement with said valve means and actuated by movement of the body relative to the casing to open said valve means.

3. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, the combination which comprises: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off a localized zone around the body and inside the casing; means for by-passing liquid through the body and past said packing means to allow vertical movement of the tool in the casing; a passage in said body opening outwardly of said body into the space in the casing below said packing means for establishing

communication between the tubing string and said space and also communicating with the exterior of the body in said zone; valve means operable to open and close said passage, and located in the passage below the point of communication with the exterior of the body in said zone; means slidably mounted on said body for limited vertical movement and adapted to frictionally engage the walls of the casing; and valve-operating means operatively connected with said slidably mounted means actuated thereby on upward movement of said body with respect to said slidably mounted means, to open said valve means.

4. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, the combination which comprises: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off a localized zone around the body and inside the casing; a passage in the body opening outwardly of the body into the space in the casing below said packing means for establishing communication between the tubing string and said space and also communicating with the exterior of the body in said zone; means providing a by-pass passage in the body for by-passing liquid through the body and past the packing means to allow vertical movement of the tool in the casing; valve means in the by-pass passage operable to open and close the by-pass; means slidably mounted on said body for limited vertical movement and adapted to frictionally engage the walls of the casing; and valve-operating means operatively connected with said slidably mounted means and actuated thereby on upward movement of said body with respect to said slidably mounted means to open said valve means.

5. A tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, comprising: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off therebetween a localized zone within the casing; said body having a first passage therethrough opening outwardly of the body into the space in the casing below the packing means for establishing liquid communication between the tubing string and said space, and having a second passage opening outwardly of the body into the spaces in the casing above and below said packing means; separate valve means in each of said passages for opening and closing the associated passage, the valve means in the second passage being operable to open said second passage in response to liquid pressure in said space in the casing below the packing means; said first passage communicating with said zone at a position above the valve means in the first passage; and valve operating means carried by said body in position for operative engagement with said valve means and actuated by upward movement of the body relative to the casing to open said valve means.

6. In a tool for use in connection with a well casing and a string of tubing adapted to be moved within the casing, the combination which comprises: a vertically elongated body adapted for connection at its upper end to the tubing string; vertically spaced packing means carried by said body and adapted to seal off a localized zone around the body and inside the casing; means for by-passing liquid through the body and past said packing means to allow vertical movement of the tool in the casing; a passage in said body opening outwardly of said body into the space in the casing below said packing means for establishing communication between the tubing string and said space and also communicating with the exterior of the body in said zone; valve means operable to open and close said passage, and located in the passage below the point of communication with the exterior of the body in said zone; and valve operating means carried by said body in position for operative engagement with said valve means and actuated by upward movement of the body relative to the casing to open said valve means.

7. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, said tool having a body, vertically spaced packers adapted to seal off a zone inside the casing and around the body, and a chamber in the body communicating with the tubing string and the zone between the packers, the combination which comprises: means in the body defining a by-pass passage opening outwardly of the body into the spaces in the casing above and below the packers and defining a second passage opening outwardly of the chamber into said space in the casing below the packers; a check valve in each of said passages for controlling liquid flow through the passages, the check valves being adapted to be opened by liquid pressure in said space below the packers to permit movement of liquid through the passages as the tool descends in the casing; and valve operating means carried by said body in position for operative engagement with said check valves and actuated by upward movement of the body relative to the casing to positively open said check valves and thereby permit flow of liquid through the passages as the tool ascends in the casing.

8. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, said tool having a body, vertically spaced packers adapted to seal off a zone inside the casing and around the body, and a chamber in the body communicating with the tubing string and the zone between the packers, the combination which comprises: means in the body defining a passage opening outwardly of the body into the space in the casing below the packers and leading from the chamber to said space; valve means in said passage operable to open and close said passage; and valve operating means carried by said body in position for operative engagement with said valve means and actuated by upward movement of the body relative to the casing to open said valve means.

9. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, said tool having a body, vertically spaced packers adapted to seal off a zone inside the casing and around the body, and a chamber in the body communicating with the tubing string and the zone between the packers, the combination which comprises: means in the body defining a passage opening outwardly of the body into the space in the casing below the packers and leading from the chamber to said space; a fluid pressure operable check valve in said passage adapted to be opened by the fluid pressure in said space when such pressure exceeds the chamber pressure and to be closed when such pressure is less than the chamber pressure; means slidably mounted on the tool body and frictionally engaging the casing to re-

sist movement relative thereto; and valve-operating means carried by said body in position for operative engagement with said check valve and said slidably mounted means and actuated by upward movement of the body relative to the slidably mounted means to positively open the check valve.

10. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, said tool having a body, vertically spaced packers adapted to seal off a zone inside the casing and around the body, and a chamber in the body communicating with the tubing string and the zone between the packers, the combination which comprises: means in the body defining a by-pass passage opening outwardly of the body into the spaces in the casing above and below the packers; valve means in said passage operable to open and close said passage; and valve-operating means carried by said body in position for operative engagement with said valve means and actuated by upward movement of the body relative to the casing to open said valve means.

11. In a tool for use in combination with a well casing and a string of tubing adapted to be moved within the casing, said tool having a body, vertically spaced packers adapted to seal off a zone inside the casing and around the body, and a chamber in the body communicating with the tubing string and the zone between the packers, the combination which comprises: means in the body defining a by-pass passage opening outwardly of the body into the spaces in the casing above and below the packers; a fluid pressure operable check valve in said passage adapted to be opened by the fluid pressure in the casing in said space below the packers when such pressure exceeds the chamber pressure and closed when such pressure is less than the chamber pressure; means slidably mounted on the tool body and frictionally engaging the casing to resist movement relative thereto; and valve-operating means carried by said body in position for operative engagement with said check valve and said slidably mounted means and actuated by upward movement of the body relative to the slidably mounted means to positively open the check valve.

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