Nov. 10, 1942. C. K. HOLT 2,301,624

TOOL FOR USE IN WELLS

Filed Aug. 19, 1940

Fig. 1.

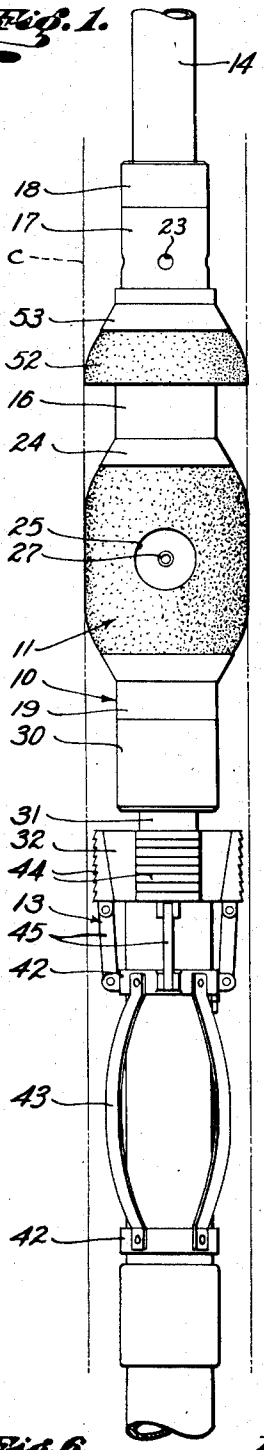


Fig. 2.

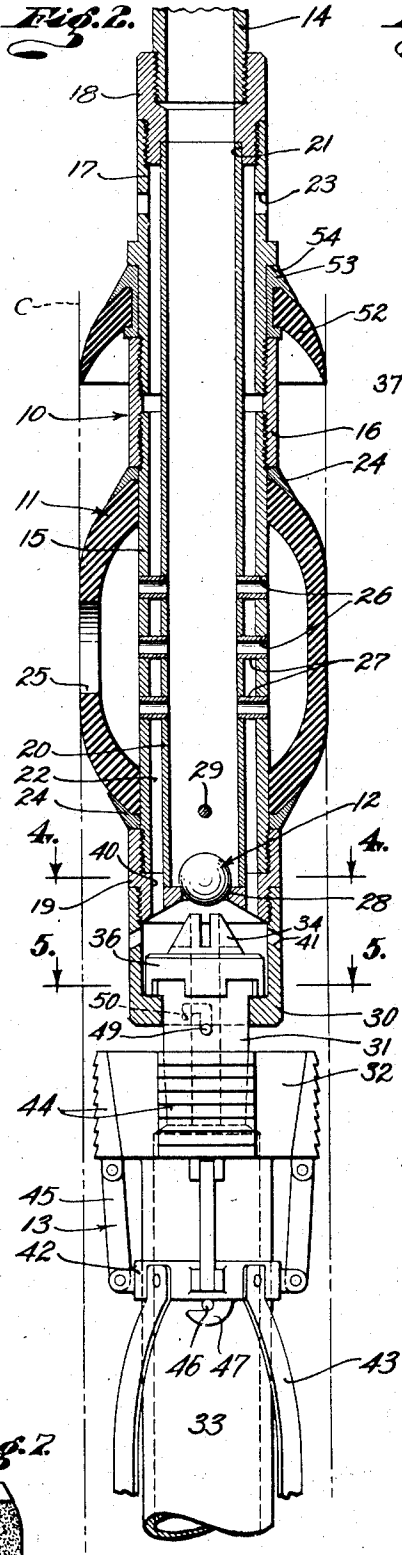


Fig. 3.

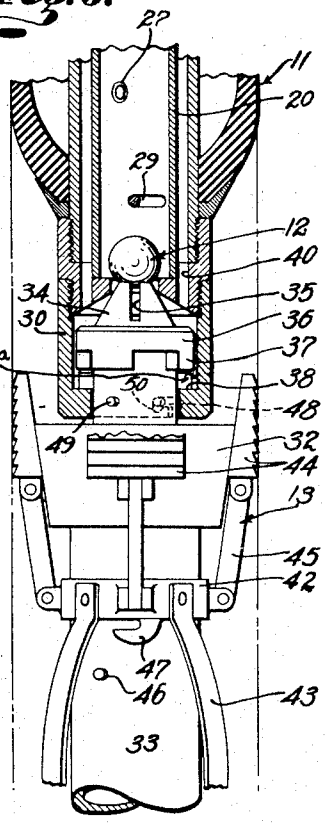


Fig. 4.

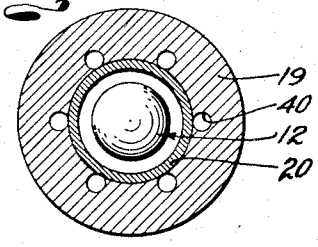


Fig. 5.

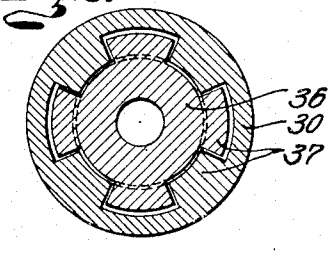


Fig. 6.

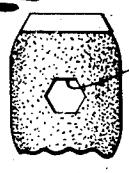
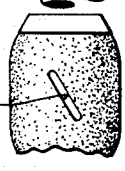


Fig. 7.



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By
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UNITED STATES PATENT OFFICE

2,301,624

TOOL FOR USE IN WELLS

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Application August 19, 1940, Serial No. 353,170

11 Claims. (Cl. 166—20)

This invention relates to a well tool and relates more particularly to a tool for discharging cement slurry, acid and other fluids in wells and adapted to be employed in locating leaks in well casings, etc. A general object of this invention is to provide an improved tool to be run into a well on a tubular well string and formed to discharge cement slurry, acid, water, or other fluid through a port or perforations in a well lining or casing.

Another object of this invention is to provide a tool of the character referred to embodying a novel fluid discharge member capable of concentrating the discharge of the cement slurry, acid, or other fluid at a selected point in the well and serving to prevent or to reduce to a minimum the escape or leakage of the fluid along the interior of the well casing or lining.

Another object of this invention is to provide a tool of the character mentioned that provides for the very accurate placement of the discharged fluid.

Another object of this invention is to provide a well tool of the character mentioned that may be run into and out of the well and moved about in the well as desired with a minimum of resistance by the fluid in the well and without producing an unwanted swabbing action.

Another object of this invention is to provide a tool of the character referred to embodying a simple, effective means which provides for the flushing or washing of the tool and the interior of the casing following the placement of the cement slurry or other fluid.

Another object of this invention is to provide a well tool of the character mentioned that is simple and easy to operate and that is not liable to become caught or cemented in the well.

A further object of this invention is to provide a well tool of the character referred to embodying a novel control for the valve which facilitates the ready washing or flushing of the tool and well casing and that allows free movement of the tool in the well.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of the invention, throughout which description reference is made to the accompanying drawing, in which:

Fig. 1 is a side elevation of the tool provided by this invention in a well lining or casing, showing the control in a released or inactive condition. Fig. 2 is an enlarged, fragmentary, longitudinol detailed sectional view of the tool with the control inactive, showing certain parts of the control in elevation. Fig. 3 is a fragmentary longitudinal detailed sectional view of a portion of the tool with the control in side elevation, showing the control active and holding the valve open. Figs. 4 and 5 are enlarged transverse detailed sectional views taken as indicated by lines 4—4 and 5—5, respectively, on Fig. 2. Figs. 6 and 7 are reduced side elevations of the packer or discharge member that is embodied in the tool illustrating different forms of discharge openings.

The well tool of the present invention may be said to comprise, generally, a body structure 10, a packer or fluid discharge member 11 on the body structure 10 adapted to receive fluid from the interior thereof, a valve 12 for controlling the circulation of fluid through the body structure 10, and a control 13 for the valve 12.

The body structure 10 mounts or carries the discharge member 11, the valve 12 and other elements, and is adapted to be secured to the lower end of a tubular well string 14 for conducting fluid into the well. The body structure 10 is a tubular assembly made up of spaced inner and outer tubular parts. In the form of the invention illustrated the body 10 includes an outer tubular section 15 provided at its upper end with a threaded on coupling 16. An upper outer section 17 is threaded in the coupling 16 to extend upwardly therefrom and a collar or sub 18 is threaded in the upper end of this section 17. The sub 18 may be threaded on the lower end of the string 14 to attach the tool to the string. A collar or sub 19 is threaded on the lower end of the main outer section 15.

The body structure 10 further includes an inner section or tube 20 within the outer sections 15 and 17. The opposite ends of the tube 20 are secured in the subs 18 and 19. As illustrated, the opposite end portions of the tube 20 may be force-fitted or welded in internal sockets 21 in the subs 18 and 19. The upper end of the tube 20 is in direct communication with the lower end of the well string 14. In accordance with the invention the tube 20 is spaced from the inner walls of the outer sections 15 and 17 to leave an annular fluid passage 22 which extends longitudinally through the body structure 10. Ports 23 are provided in the upper outer section 17 to place the upper part of the passage 20 in communication with the well or the interior of the well casing C.

The packer or discharge member 11 is carried by the body structure 10 to engage in the well lining or casing C and is formed to discharge fluid under pressure outwardly through ports, perfora-

tions, leaks or other openings in the casing. In accordance with the invention the discharge member 11 is a hollow or chambered element formed in whole or in part of a flexible resilient and expansible material such as rubber, rubber composition, synthetic rubber, or the like. The discharge member 11 is an elongate element that is generally cylindrical in a zone between its ends to fit and seal in the cylindrical well lining or casing C. The opposite end portions of the member 11 are tapered or rounded in to fit about the outer section 15 of the body structure 10. The member 11 is arranged on the section 15 to have its upper end adjacent the coupling 16 and to have its lower end adjacent the sub 19. Retaining cups 24 are provided on the section 15 to engage about and hold the end portions of the member 11. The cups 24 engage against and if desired may be secured to the coupling 16 and the sub 19. If desired the packer or discharge member 11 may be reinforced by wires, fabric, or the like, extending vertically and anchored in its end portions, or the member 11 may be plain or without reinforcement as illustrated.

One or more discharge orifices or openings 25 are provided in the member 11. The openings 25 are provided in the cylindrical intermediate portion of the member 11 and may be of any required or selected shape and size. In Figs. 1 and 2 of the drawing I have shown a round or cylindrical discharge opening 25 in the member 11. Fig. 6 of the drawing illustrates a packer or discharge member provided with a polygonal discharge opening 25^a while Fig. 7 shows a discharge opening 25^b in the form of a pitched or helical slot. The opening or openings 25 may be proportioned and shaped to discharge the required volume of fluid and to communicate with ports, slots and openings of various forms in the well casing or lining.

Means is provided to deliver fluid under pressure from the interior of the tube 20 to the interior of the member 11 to expand the member 11 and to discharge from the opening or openings 25. Pairs of aligned lateral openings 26 are provided in the tube 20 and outer body section 15 and short nipples or tubes 27 are secured in the openings 26. The tubes 27 place the interior of the tube 20 in communication with the interior of the discharge member 11. The tubes 27 may be spaced vertically and circumferentially as illustrated. The fluid discharge tubes 27 may be riveted, welded, or otherwise secured and sealed in the openings 26.

The valve 12 controls the lower end of the tube 20, serving to close the lower end of the tube when fluid is to be discharged from the member 11. In accordance with the broader aspects of the invention any selected form of valve may be provided to control the lower end of the tube 20. In the case illustrated the valve 12 is a ball valve engaging downwardly against a seat 28 at the lower end of the inner tube 20. The seat 28 may be formed on or secured to the sub 19. A pin 29 may be arranged transversely through the tube 20 above the valve 12 to prevent upward loss or displacement of the valve. When the valve 12 is engaged on its seat 28 fluid under pressure delivered to the tube 20 by the string 14 is obliged to discharge through the tubes 27 to the member 11 for final discharge from the opening or openings 25.

The control 13 is provided to govern the valve 12 to facilitate the easy movement and operation of the tool in the well and to provide for the washing or flushing of the tool and the interior of the well lining or casing C. The control 13 is arranged at the lower end of the body structure 10 and includes a hollow cage or cap 30 threaded on the lower end of the sub 19 and a mandrel 31 shiftably entering the cap. The mandrel 31 extends downwardly from the cap 30 and carries a cone 32. A stem or pipe 33 is secured to the cone 32 and extends downwardly therefrom. The mandrel 31 and the cone 32 are preferably tubular to place the pipe 33 in communication with the interior of the cap 30. The upper end of the mandrel 31 is provided with a frusto-conical or tapered lifting part 34 for lifting the valve 12 from its seat 28. The valve lifting part 34 preferably has transverse slots or notches 35 to permit the passage of fluid into the mandrel 31 when the valve 12 is open. An enlargement or crown 36 is provided on the mandrel 31 within the cap 30. The crown 36 and the cap 30 are provided with disengageable lugs 37 and 37^a respectively. The lugs 37 on the crown 36 are engageable with an upwardly facing shoulder 38 in the cap 30 to support or suspend the mandrel 31 and the parts thereon from the body structure 10. With the lugs 37 of the crown 36 engaged on the shoulder 38 the lugs of the crown and cap 30 are in mesh as illustrated in Figs. 2 and 5 of the drawing, so that the body structure 10 and mandrel 31 are connected against relative turning. When the lugs 37 and 37^a are out of mesh or disengaged, as illustrated in Fig. 3 of the drawing, the lifting part 34 supports the valve 12 above its seat 28 so that the interior of the cap 30 is in communication with the interior of the tube 20. The sub 19 is ported to put the interior of the cap 30 in communication with the passage 22. Spaced vertical ports 40 are provided in the sub 19 and extend downwardly from the end of the passage 22 to the interior of the cap 30. If desired, lateral ports 41 may be provided in the wall of the cap 30 to put the interior of the cap in communication with the wall or casing C below the discharge member 11.

The control 13 further includes a gripping mechanism or slip mechanism for engaging in the well lining or casing C. This slip mechanism includes a pair of vertically spaced rings or sleeves 42 shiftably engaged on the pipe 33 below the cone 32. Spaced outwardly bowed springs 43 extend between and connect the sleeves 42. The springs 43 are formed to frictionally engage in the lining or casing C to resist movement of the sleeves 42 in the well. A set of gripping slips 44 is connected with the upper sleeve 42 and cooperates with the cone 32. Links or reins 45 are pivotally connected with the lower ends of the slips 44 and with the upper sleeve 42 to couple the slips 44 with the spring sleeve 42. The surface of the cone 32 slopes downwardly and inwardly so that downward movement of the mandrel 31 and cone 32 with respect to the slips 44 actuates the slips outwardly into gripping cooperation with the interior of the casing C.

Releasable latch means is provided to control the slips 44. This latch means may comprise a pin 46 projecting from the pipe 33 below the cone 32 and a hook-like latch 47 on the upper spring sleeve 42 cooperating with the pin 46. The latch 47 is engageable with the pin 46 to hold the slips 44 in their inactive or retracted positions illustrated in Figs. 1 and 2 of the drawing. The pin 46 is releasable from the latch 47 by partially turning the mandrel 31 and then moving the mandrel down. As described above,

the lugs 37 and 37a of the crown 36 and cap 30 are adapted to mesh for the transmission of rotation or turning from the body structure 10 to the mandrel 31 and when the lugs 37 and 37a are in mesh the string 14 may be turned and then lowered to release the pin 46 from the latch 47. During this operation the springs 43 engaged in the casing C resist movement of the sleeves 42 so that the latch 47 remains stationary when the pin 46 is disengaged from it. The frictional engagement of the springs 43 in the casing C further serves to hold the slips 44 against movement when the cone 32 is moved downwardly to expand the slips against the interior of the casing. The engagement of the slips 44 in the lining or casing C operates to hold the mandrel 31 against further downward movement so that the body structure 10 may be moved downwardly to cause opening of the valve 12.

The control 13 further includes a releasable latch means for latching or holding the mandrel 31 in the position where the valve 12 is open so that the tool may be freely moved through the well with the slips 44 retracted and with the valve 12 open. This releasable latch means serves to couple the mandrel 31 to the cap 30 when the mandrel is in its raised position relative to the body structure 10. Inverted L-shaped slots 48 are provided in the cap 30 and pins 49 on the mandrel 31 cooperate with the slots. As shown in Fig. 2 of the drawing, the pins 49 are normally or initially in the vertical arms of the slots 48. When the body structure 10 is moved downwardly to release the pin 46 from the latch 47 and to actuate the slips 44 the pins 49 are received in the upper parts of the slots 48. Accordingly, when the slips 44 are actuated and the valve 12 is open, as shown in Fig. 3, the pins 49 may be in the upper parts of the slots 48. If it is desired to latch the valve 12 opened the body structure 10 is turned, while the slips 44 remain set, to move the pins 49 into the lateral arms of the slots 48. The lateral arms of the slots 48 have depressed seats 50 for receiving the pins 49. The seats 50 serve to releasably retain the pins 49 in the lateral arms of the slots 48 so that the mandrel 31 is latched in its raised position to hold the valve 12 open. With the pins 49 engaged in the seats 50 the body structure 10 may be raised to release the slips 44 and turned to re-engage the pin 46 with the latch 47. The pins 49 remain engaged in the seats 50 when the slips are retracted and the pin 46 is re-engaged with the latch 47. With the valve 12 held open by the co-operation of the pins 49 in the slots 48 the tool may be moved up and down in the well while discharging fluid to flush the interior of the casing C and may be freely withdrawn from the well with little or no resistance offered by the fluid in the well.

If desired, the tool may be provided with a swab element or sealing element 52 for preventing the excessive leakage of the delivered cement slurry or other fluid upwardly in the casing C above the discharge member 11. The swab element or sealing element 50 may be supported by a tubular carrier 53 clamped between the coupling 16 and a shoulder 54 on the upper body section 17. The swab element or sealing element 52 is preferably a flexible resilient member of inverted cup shape. The element 52 is adapted to seal outwardly against the interior of the casing C.

In the use or operation of the tool provided by this invention the body structure 10 may be secured to the lower end of a well string 14 intended to deliver fluid into the well. The tool is preferably run into the well on the string 14 in the condition illustrated in Figs. 1 and 2 of the drawing with the slips 44 retracted and the pin 46 engaged in the latch 47. The valve 12 is free to open if the tool encounters a column of standing fluid in the casing C and such fluid does not interfere with the free lowering of the tool through the casing. The tool is lowered and positioned to bring the opening or openings 25 to points where they may deliver the fluid to openings or ports in the casing C. When the tool has been positioned in this manner the fluid to be introduced into the well is passed or pumped down through the string 14. This fluid flows down through the tube 20 and passes through the tubes 27 into the interior of the discharge member 11. The fluid under pressure in the member 11 expands the member so that its intermediate cylindrical part effectively seals with the inner surface of the casing C. If the opening 25 or any one of the openings 25 is in communication with the port in the casing C the fluid under pressure is free to discharge into the well around the casing. If, on the other hand, the opening or openings 25 are out of register with the port or ports in the casing C the fluid cannot discharge from the member 11 and the operator at the ground surface is made aware of the incorrect positioning of the tool by the back pressure developed in the pump handling the fluid. If such a back pressure develops the string 14 may be moved up or down to bring the opening or openings 25 into communication with the port or ports in the casing C. The necessary or desired quantity of fluid may be pumped down through the string 14 to discharge through the opening or openings 25 and the port or ports in the casing C into the well around the casing. The fluid thus discharged into the well around the casing C may be cement slurry, acid, water, or any other fluid. The valve 12 is in the closed position during the placement of the fluid and prevents the discharge of fluid into the cap 30. The expanded discharge member 11 effectively seals with the casing C around the opening or openings 25 to prevent any substantial leakage of fluid into the casing. In the event that fluid leaks into the casing C above the member 11 it is prevented from flowing upwardly through the casing by the sealing element 52.

Following the placement of the cement slurry, acid, or other fluid, it may be desired to flush out the tool and the casing C. To prepare the tool for this flushing operation the string 14 is turned a short distance and is lowered. This disengages the pin 46 from the latch 47 and actuates the slips 44 as described above. With further lowering of the string 14 the cone 32 actuates the slips 44 and the slips hold the mandrel 31 and associated parts against further downward movement. Downward movement of the body structure 10 and string 14 following the setting of the slips 44 brings the valve 12 against the upper end of the part 34, and the valve is freed from its seat. Water or other flushing fluid is then pumped down through the string 14 to pass the valve 12 and enter the cap 30. This flushing fluid is free to flow upwardly through the passage 22 to discharge from the ports 23 to flush the casing C. The fluid delivered to the cap 30 may also pass down through the mandrel 31 and pipe 33 and may

pass through the ports 41. Thus the washing or flushing fluid is adapted to flush clean both the upper and lower portions of the tool and the parts of the casing C above and below the packing element or discharge member 11. The washing operation may clear the tool and the casing of excess cement, acid, or the like.

When the above operations have been completed the tool may be withdrawn from the well or may be moved to another location in the well for further operation. Assuming that the slips 44 are set or expanded, as above described, the tool is readily conditioned for free movement through the well for withdrawal or for movement to a new location by turning the string 14 to bring the seats 50 of the slots 48 into receiving relation to the pins 49. The string 14 is then raised to release the slips 44 and is turned a slight distance to re-engage the pin 46 with the latch 47. This latches the slips 44 in their retracted positions while the pins 49 remain engaged in the seats 50. With the parts in this condition the tool may be readily moved either up or down in the well while discharging circulation fluid or flushing fluid down through the string 14. The discharge of the cleaning or flushing fluid from the tool while moving the tool in the well assures a full cleaning of the interior of the casing C. With the valve 12 latched open as above described, the tool may be freely withdrawn from the well or moved to a new location for further operation.

In the above detailed description of the operation it was considered that the tool was operated in a well casing, liner, or other lining element. It is to be understood that the tool is not restricted to this particular use. The fluid placement tool of the invention is suitable for use in an open well or a portion of a well without casing, for example, it may be used in squeeze jobs around shoes, for installing bottom hole plugs under pressure, for cementing around casing strings under pressure where leaks may be present, and for many other purposes.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A tool for placing fluid in a well and adapted for use on a tubular well string comprising a fluid discharge member for engaging in the well and having at least one lateral discharge opening for discharging fluid, a body structure to be secured to said string and carrying said member, the body structure having a first passage leading from the string to the member so that fluid from the string may be discharged from said discharge opening and having a second passage leading from the first passage to the interior of the well lining, and a valve normally closing said second passage from the first passage and adapted to be opened by manipulation of the string.

2. A tool for placing fluid in a well and adapted for use on a tubular well string comprising a fluid discharge member for engaging in the well and having at least one lateral discharge opening, a body structure to be secured to said string and carrying said member, the body structure having a first passage leading from the string to the member so that fluid from the string may be discharged from said discharge opening and having a second passage leading from the first passage to the interior of the well lining, a valve governing communication between said passages, and a control operable by manipulation of the string for causing opening and closing of the valve.

3. Apparatus for the placement of fluids in wells comprising a tubular well string adapted to conduct fluid into the well, a tubular body structure secured to the string to receive the fluid therefrom, a packer member on the body structure having a laterally directed discharge opening, means for maintaining the discharge opening in communication with the interior of the body structure whereby fluid may be pumped from the ground surface through the string to the discharge opening, and a valve below the packer member operable by manipulation of the string for putting the interior of the body in communication with the well.

4. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to the body structure and having at least one lateral discharge opening, the discharge member sealing with the well wall around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the interior of the well, a valve normally closing off communication between said passages, and means operable by manipulation of the string for opening the valve.

5. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to the body structure and having at least one lateral discharge opening, the discharge member sealing with the well wall around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the interior of the well above the discharge member, a valve for preventing the delivery of fluid from the first passage to the second passage, and a control carried by the body structure operable by movement of the string for opening the valve.

6. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to the body structure and having at least one lateral discharge opening, the discharge member sealing with the well wall around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the well above and below the discharge member and forming a by-pass around the discharge member, a valve for closing off communication between the passages, and means operable by movement of the string for opening the valve to permit the delivery of fluid from the string to the second passage.

7. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to

the body structure and having at least one lateral discharge opening, the discharge member sealing with the well wall around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the well, a valve for preventing the delivery of fluid from the first passage to the second passage, and means operable to hold the valve open while the string is moved in the well so that fluid may be pumped into the well to flush the same.

8. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to the body structure and having at least one lateral discharge opening for registering with ports or other openings in the well lining, the discharge member sealing with the well lining around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the interior of the well lining, a valve for preventing the delivery of fluid from the first passage to the second passage, and control means comprising a mandrel shiftable relative to the body structure and adapted to open the valve, means engageable with the well lining for holding the mandrel against movement so that the body structure may be moved to open the valve, and releasable latch means for holding the last named means against operation.

9. A tool for use on a tubular well string comprising a body structure fixed to the string, a discharge member of packing material secured to the body structure and having at least one lateral discharge opening for registering with ports or other openings in the well lining, the discharge member sealing with the well lining around the discharge opening, the body structure having a first passage leading from the string to the discharge opening whereby fluid may be passed down through the string to the discharge opening and having a second passage joining the first passage below the discharge opening and communicating with the interior of the well lining, a valve for preventing the delivery of fluid from the first passage to the second passage, and control means comprising a mandrel shiftable relative to the body structure and adapted to open the valve, means engageable with the well lining for holding the mandrel against movement so that the body structure may be moved to open the valve, latch means released by movement of the string for holding the last named means inactive, and releasable means for holding the mandrel against movement relative to the body structure in a position where the valve is open.

10. A tool for use on a tubular well string comprising a tubular section fixed to the string, a packer member on the section having a surface for sealing with the interior of the well lining and having a discharge opening in said surface for discharging fluid into ports in the well lining, a tube within the section having its upper end in communication with the string and spaced from the interior of the section to leave a fluid passage, means for putting the interior of the tube in communication with the discharge opening of the packer member so that fluid may be passed through the string to the discharge opening, means for maintaining said passage in communication with the interior of the well lining above the packer member, a valve for controlling communication between the tube and passage, and a control operable by movement of the string for opening the valve.

11. A tool for use on a tubular well string comprising a tubular section fixed to the string, a packer member on the section having a surface for sealing with the interior of the well lining and having a discharge opening in said surface for discharging fluid into ports in the well lining, a tube within the section having its upper end in communication with the string and spaced from the interior of the section to leave a fluid passage, means for putting the interior of the tube in communication with the discharge opening of the packer member so that fluid may be passed through the string to the discharge opening, means for maintaining said passage in communication with the interior of the well lining above the packer member, said section having a chamber communicating with the passage, the interior of the well below the packer member, and the tube, a valve for closing off the tube from the said chamber, and a control operable by movement of the string for opening the valve.

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