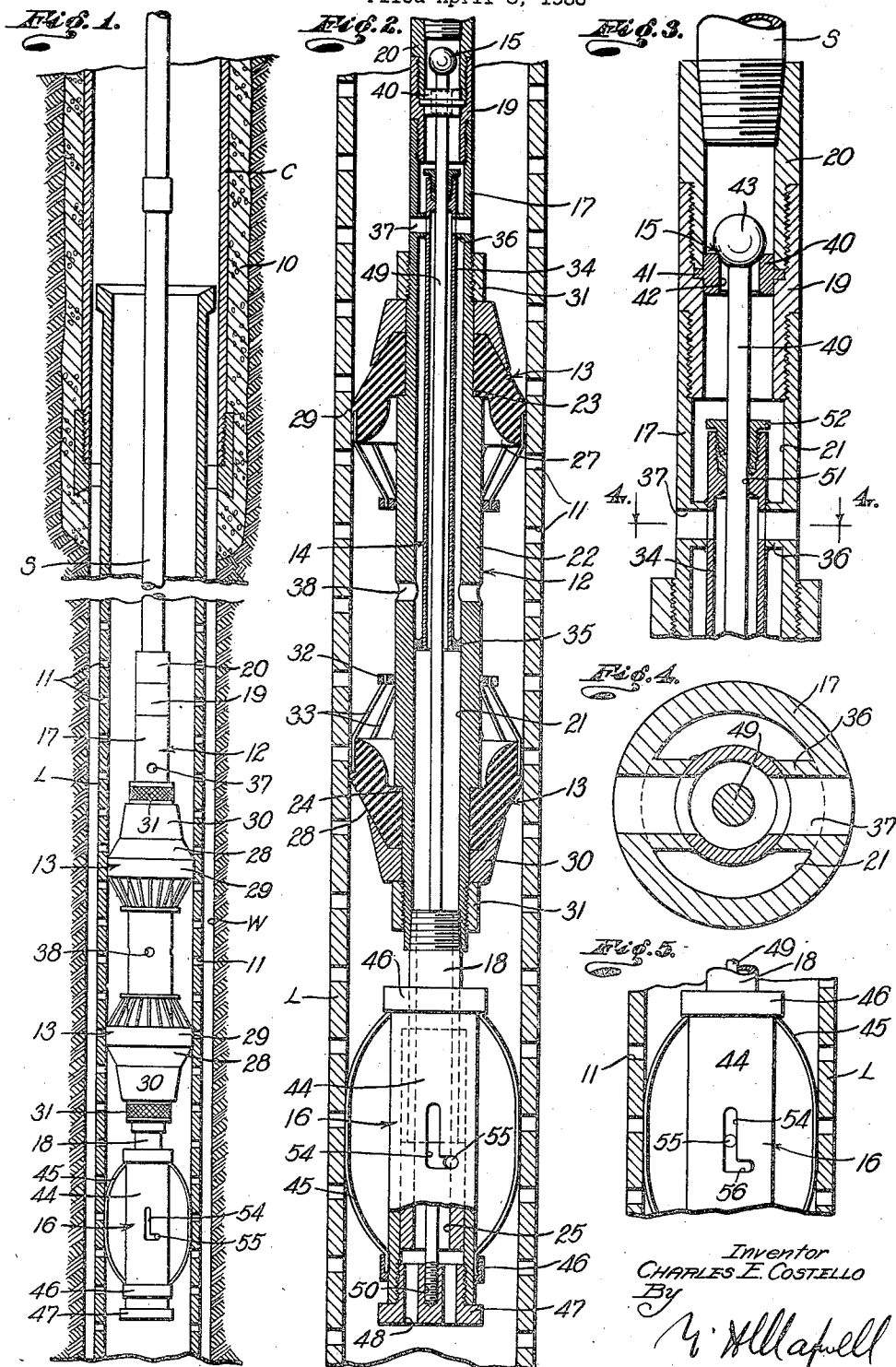


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TOOL FOR HANDLING FLUIDS IN WELLS

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TOOL FOR HANDLING FLUIDS IN WELLS

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This invention relates to a well tool and relates more particularly to a tool for handling or discharging fluids in wells. A general object of this invention is to provide a simple, practical and very effective tool of the character mentioned.

Another object of this invention is to provide a device that is operable to clean the perforations of a liner in a well and to remove mud, sand, wax, etc., from about the liner to free the same for removal from the well or for the better production of the well fluid.

Another object of this invention is to provide a tool of the character mentioned to be connected with a tubular well string, conducting water or other fluid under pressure, and that operates to discharge the fluid through perforations in the well lining at a given or selected place in the well.

Another object of this invention is to provide a tool of the character mentioned embodying novel and effective valve means for preventing the discharge or loss of the cleaning fluid from the tubular operating string when additional sections or stands of pipe or tubing are added to the said string as the device is being operated in the liner.

Another object of this invention is to provide a tool of the character mentioned that is under the full control of the operator at all times.

A further object of this invention is to provide a tool of the character mentioned that is such that cleaning fluid under high pressures may be forced out through the perforations of the liner to clean the same and to clear away accumulations of material from about the liner.

A still further object of this invention is to provide a tool of the character mentioned embodying a novel means for by-passing the fluid standing in the casing and liner around or past the sealing elements whereby the tool may be readily run into and out of the casing and liner.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application 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 position to be operated in a well liner showing a portion of the well and its casing and liner in vertical cross section. Fig. 2 is an enlarged longitudinal detailed sectional view of the tool in operating position in the liner showing a portion of the tailpiece in elevation and illustrating the valve in the open position. Fig. 3

is an enlarged fragmentary longitudinal detailed sectional view of the upper portion of the tool showing the valve in the closed position. Fig. 4 is an enlarged transverse detailed sectional view taken as indicated by line 4—4 on Fig. 3, and Fig. 5 is an enlarged fragmentary side elevation of the tailpiece with the parts in the positions where the valve is closed or is being closed and showing a portion of the liner in longitudinal cross section.

The device provided by the present invention is adapted for employment under numerous operating conditions. In the drawing I have shown a typical preferred form of the invention in the operating position in a tubular liner L in an oil well or gas well. The liner L illustrated is one specific form of lining or casing for a well. The tool of the invention is not limited for use in this particular type of well lining or casing but is adapted to be operated in the other well known forms of well linings and casings and it is to be understood that the invention is not to be construed as restricted to the specific form or application of the invention illustrated and about to be described.

In Fig. 1 of the drawing I have illustrated a portion of a typical oil or gas well W having a water string or casing C set in cement 10 in the usual manner. The well W extends downwardly beyond the set casing C and a liner L is arranged in the open lower portion of the well. The liner L is an elongate tubular structure whose upper end is open to the interior of the casing C. Spaced perforations 11 are provided in the wall of the liner L to admit the well fluid. The liner L is spaced from the wall of the well W to leave an open annular space which surrounds the liner. After extended production the perforations 11 of the liner may become clogged with accumulations of sand, wax, etc., and in many instances sand and other solid matter tightly packs in the annular space about the liner L to reduce or stop the production of the well fluid into the liner. In some instances it is desirable or necessary to remove the liner L from the well W to deepen the well or carry on other operations. These and similar circumstances often make it necessary to flush out the perforations 11 or to remove the accumulated material from about the liner L.

The tool of the present invention may be said to comprise, generally, a tubular body 12 to be connected with the lower end of an operating string S, packing elements or cups 13 carried by the body 12 to slidably seal with the interior of the liner L, means 14 for by-passing fluid past or around the packing cups 13, a valve 15 for

controlling the passage of fluid under pressure from the string S to the space between the sealing cups 13 and a control 16 for the valve 15.

The body 12 is provided to carry the various parts of the tool and to conduct fluid as will be presently described. In practice the body 12 is an elongate structure or assembly proportioned to be received in the liner L with substantial clearance. In the form of the invention illustrated the body 12 includes an upper section 17 and a lower section 18. The upper section 17 has its upper end connected with the operating string S. In the case illustrated the upper end of the body section 17 is connected with the string S by a joint or coupling having two threadedly connected members 19 and 20. The member 19 is shown threaded in the upper end of the section 17 and the member 20 is threaded on the lower end of the string S. The body section 17 has a central longitudinal opening or passage 21 extending through it from one end to the other. The intermediate portion 22 of the body section 17 is enlarged in diameter to present an upwardly facing annular shoulder 23 and a similar downwardly facing shoulder 24. The lower body section 18 is provided to carry certain parts of the control 16 and is connected with the lower end of the section 17. In practice the section 18 may be threaded in the lower portion of the passage 21. The section 18 has a central longitudinal opening 25 extending through it from one end to the other and forming a continuation of the passage 21.

The packing elements or sealing cups 13 are carried by the body 12 to seal with the internal surface of the liner L and to define a limited chamber or space that is adapted to receive fluid under pressure to flow outwardly through the perforations 11 and to clear accumulated material from about the liner L. In the preferred construction the elements or cups 13 are carried by the body section 17 and are spaced apart vertically or longitudinally. While the cups 13 may be varied considerably in type and construction without departing from the invention, it is preferred to employ sealing elements or cups that are expanded or operated by fluid pressure in the space between them. The cups 13 may be formed of rubber or a suitable resilient elastic composition that is unaffected by the fluid encountered in the well and employed to clean the liner L. The elements or cups 13 are annular and surround the body section 17. The upper cup 13 has a flat lower surface seated downwardly against the shoulder 23 and the lower cup 13 has a similar upwardly seated surface engaging against the body shoulder 24. The opposing ends or sides 27 of the cups 13 are recessed or concaved so that a fluid pressure acting against them expands or actuates the cups outwardly against the internal wall of the liner L. The outer sides or ends of the cups 13, that is, the non-opposing ends 28 of the cups are preferably tapered or frusto-conical. The cups 13 are provided with cylindrical peripheral surfaces 29 for slidably sealing with the internal surface of the liner L.

Thimbles 30 surround the body section 17 and engage about or partially confine the frusto-conical ends 28 of the cups 13. Nuts 31 may be threaded on the body section 17 to hold the thimbles 30 in position where they maintain the cups 13 in position and in tight engagement with their respective shoulders 23 and 24. Metal rings 32 surround the intermediate portion 22 of the section 17 with suitable clearance and wires 33

extend between the rings 32 and the adjacent cups 13. The wires 33 are secured to the rings 32 and have portions embedded in the peripheral parts of the cups 13 to strengthen the cups, to eliminate distortion of the cups and to prevent the peripheral parts of the cups from being injured and broken.

The means 14 for by-passing fluid past or around the spaced cups 13 facilitates the easy movement or passage of the tool up and down in the casing C and the liner L. The means 14 operates to allow fluid standing in the liner L to pass or flow around or past the spaced cups 13 when the tool is moved longitudinally in the liner. In accordance with the invention the means 14 includes a tube 34 arranged longitudinally in the body passage 21. The tube 34 has substantial clearance with the wall of the passage 21 so that fluid may flow downwardly through the passage around the tube. The upper end of the tube 34 is spaced below the upper end of the body section 17 and the lower end of the tube 34 is preferably spaced a substantial distance above the lower end of the section 17. The upper end of the tube 34 is maintained out of communication with the passage 21 in the manner to be hereinafter described. The lower end of the tube 34 is open or in communication with the passage 21.

A partition or ring 35 surrounds the lower portion of the tube 34 and closes the lower end of the annular space surrounding the tube 34. In practice the ring 35 may be welded to the tube 34 and the wall of the passage 21. The upper portion of the tube 34 is in communication with the well or the interior of the liner L. Radial tubes or conduits 36 are provided on the body section 17 and extend inwardly to have their openings 37 in communication with the interior of the tube 34. In practice the conduits 36 may be tubular parts formed on the body section 17 and secured to the tube 34. The openings 37 extend outwardly from the interior of the tube 34 to the exterior of the section 17 to communicate with the interior of the liner L. The openings 37 are spaced between the joint member 19 and the upper nut 31. As described above, the lower end of the tube 34 is open to the portion of the passage 21 below the partition ring 35. The lower end of the opening 25 in the lower body section 18 is in communication with the interior of the liner L so that the opening 25 and the lower portion of the body passage 21 maintain the lower end of the tube 34 in communication with the well or the interior of the liner L.

During downward movement of the tool through the liner L fluid is free to flow upwardly through the opening 25, the lower portion of the passage 21 and the tube 34 to discharge from the openings 37 above the upper sealing cup 13. During upward movement of the tool through the liner L fluid is free to flow down through the opening 37, the tube 34, the lower portion of the passage 21 and the opening 25 to discharge into the liner below the lower cup 13. Thus the means 14 provides for the free passage of fluid around or past the pair of sealing cups 13 when the tool is moved through the liner.

It will be observed that the upper end of the body passage 21 is open to and is adapted to receive fluid from the operating string S and is adapted to conduct such fluid downwardly to the partition ring 35. Two or more circumferentially spaced discharge openings 38 are provided in the wall of the intermediate portion 22 of the body section 17. The openings 38 are

spaced above the partition ring 35 and are substantially midway between the sealing cups 13. The discharge openings 38 are provided to discharge fluid under pressure from the passage 21 into the space between the spaced cups 13 so that the fluid under pressure may flush the perforations 11 in the liner and may flow up in the well about the liner to remove accumulations of material from the liner.

The valve 15 is provided to control the flow of cleaning fluid through or into the passage 21. The valve 15 is adapted to close the passage 21 to positively cut off the flow of the flushing fluid from the string S to the openings 38. In accordance with the broader principles of the invention any suitable type of valve may be employed as the control valve 15. In the typical construction illustrated, the valve 15 includes an annular valve seat 40 having a flange 41 clamped between faces or shoulders on the coupling members 19 and 20. The seat 40 has the usual central longitudinal opening 42. The valve 15 further includes a ball 43 adapted to seal downwardly against the seat 40. When the valve 43 is raised from its seat 40 fluid is free to flow downwardly from the string S through the passage 21 to discharge from the openings 38. When the valve ball 43 is closed the flow is stopped.

The control 16 for the valve 15 is operable by manipulation of the operating string S to affect opening and closing of the valve 15 at the will of the operator. The control 16 includes a tailpiece carried by the lower body section 18. The tailpiece comprises a sleeve 44 shiftable and turnable on the body section 18 and outwardly bowed leaf springs 45 carried by the sleeve 44 for frictionally cooperating with the interior of the liner L to resist movement of the sleeve. Collars 46 may be provided on the tailpiece sleeve 44 to connect the ends of the springs 45 with the sleeve. A plug 47 is threaded in the lower end of the tailpiece sleeve 44 beyond or below the lower end of the body section 18. The plug 47 has longitudinal openings 48 placing the opening 25 and the interior of the sleeve 44 in communication with the well or the interior of the liner L.

The control 16 further includes a rod or stem 49 connected with the tailpiece sleeve 44 and operatively associated with the ball 43 of the valve 15. The stem 49 is arranged longitudinally in the body 12 to extend through the opening 25, the lower part of the passage 21 and the tube 34. The lower end of the stem 49 is secured to the plug 47. In practice the lower portion of the stem may be threaded in an opening 50 in the plug 47. In accordance with the invention the stem 49 is proportioned to extend through the opening 25, the passage 21 and the tube 34 with substantial clearance. The valve stem 49 extends upwardly through an opening 51 in the upper end of the tube 34 and a packing gland 52 is carried by the tube to seal about the stem. The valve stem 49 extends into or through the opening 42 in the valve seat 40 to cooperate with or to connect with the ball 43. The valve ball 43 may or may not be connected to the upper end of the stem 49. In the present instance it may be assumed that the ball 43 is secured to the stem 49.

The control 16 for governing the valve 15 further includes a releasable latch means for connecting the tailpiece sleeve 44 and the body 12 against relative movement. An L-slot 54 is provided in the tailpiece sleeve 44. A lug or pin

55 is provided on the body section 18 to cooperate with the slot 54. The lateral arm or branch 56 of the slot 54 extends rearwardly from the lower end of the slot relative to the right hand direction of rotation. When the pin 55 is in the slot branch 56 the sleeve 44 and the body 12 are held against relative longitudinal movement by the cooperation of the pin with said branch. Upon turning of the body 12 to the right by manipulation of the string S the pin 55 is brought into the vertical portion of the slot 54 so that the body may be moved vertically with respect to the sleeve 44. During such manipulations or operations the springs 45 serve to resist movement of the sleeve 44. The plug 47 may cooperate with the lower end of the body section 18 to limit relative longitudinal movement between the body 12 and the tailpiece sleeve 44 in one direction and the upper end of the valve ball 43 may cooperate with the seat 40 to limit such relative movement in the other direction. While the pin 55 cooperating with the slot 54 may limit relative longitudinal movement between the body 12 and the sleeve 44 the above described arrangement for performing this function is preferred as it relieves the pin 55 of substantial strains.

In operation the tool is connected with the lower end of the operating string S and is run into the well on the string. The pin 55 may be in the branch 56 of the slot 54 when the tool is run into the well. When the pin 55 is in the slot branch 56 the valve 15 is in its open condition as illustrated in Fig. 2 of the drawing. The string S may be lowered until the tool enters the liner L. During the movement of the tool downwardly in the liner L fluid is free to flow upwardly through the openings 48, the opening 25, the lower part of the passage 21 and the tube 34 to discharge from the openings 37. When the tool has reached a position in the liner L water, cleaning fluid or other fluid under pressure may be passed downwardly through the string S. This fluid flows past the ball 43, through the opening 42 and the passage 21 to discharge from the opening 38. The water or fluid may be pumped downwardly under substantial pressure and this fluid under high pressure admitted to the interior of the liner L between the spaced cups 13 serves to operate or expand the cups so that their peripheries effectively seal with the interior of the liner. The fluid under pressure discharged from the openings 38 passes out through the adjacent perforations 11 to clear the same of accumulated matter and passes upwardly in the well W around the liner L and may return to the interior of the liner through the perforations 11 above the upper cup 13. The tool may be slowly lowered through the liner L as the cleaning fluid is pumped downwardly through the string S. Thus the fluid under pressure discharged from the openings 38 cleans the perforations 11 and clears accumulated sand, etc., from about the liner L as the tool moves downwardly through the liner from its upper position.

If the liner L is of substantial length it may be necessary to add a stand or stands of pipe or tubing to the upper end of the string S to permit the continued downward movement of the tool through the liner. When an additional section or stand of pipe or tubing is to be added to the string S the upper end of the string must be disconnected from the hose or conduit delivering the cleaning fluid to the string from the pumps. Before breaking this connection at the

ground surface the valve 15 is closed to prevent the cleaning fluid in the string S from discharging at the tool and running away in a "thief" sand.

5 To close the valve 15 the string S is first turned to the right to move the pin 55 into the major vertical portion of the slot 54. During this turning of the string S the springs 45 resist movement of the sleeve 44. The string S is then moved upwardly and the pin 55 moves up through the slot 10 54 during this movement. Upward movement of the string S with respect to the tailpiece sleeve 44 moves the seat 40 up against the valve ball 43, the ball being supported by the sleeve 44 through 15 the medium of the stem 49 and the plug 47. This closes the lower end of the string S and prevents the loss of the fluid in the string through the openings 38. The pump connection at the upper end of the string S may then be broken and the 20 additional section or stand of pipe or tubing added to the string S. When the connection of the additional stand or section of the string S with the pump hose conduit has been completed the string S is lowered to open the valve 15. During 25 this downward movement of the string S the pin 55 moves downwardly through the slot 54 and the body 12 moves downwardly with respect to the tailpiece sleeve 44 so that the seat 40 is moved downwardly away from the ball 43. As described 30 above the ball 43 is carried by the tailpiece sleeve 44 through the medium of the stem 49 and the plug 47 and the springs 45 resist the downward movement of the sleeve 44 so that the ball may remain stationary or substantially stationary during 35 the downward movement of the seat 40 as just described. When the pin 55 has reached its lowermost position the string S may be turned to the left to move the pin into the lateral branch 56 of the slot 54 to latch the valve ball 43 in the open 40 position. After the valve 15 has been opened the fluid may be pumped downwardly through the string S to discharge from the openings 38 to flush the perforations 11 and clear the accumulated material from about the liner.

45 The above operations may be continued until the entire liner L has been cleaned. It is believed that it will be understood how the tool may be operated to thoroughly clean all the perforations 11 of the liner and clear all accumulations of sand, etc., from about the liner L. When the liner 50 L has been cleaned and cleared of accumulated material the tool may be withdrawn from the well W by the string S. The cleaning of the perforations 11 and the cleaning of accumulated sand, etc., from about the liner may materially increase 55 the production of the well, that is, it may allow the well fluids from the earth formation to more readily enter the liner. Further, the cleaning of accumulated sand, etc., from about the liner 60 may free or assist in freeing the liner so that it may be easily pulled or removed from the well. This is of great importance when it becomes necessary to pull a liner from a well that has remained in the well for a substantial period. Sand, 65 etc., accumulating about a liner often makes the removal of the liner difficult, if not impossible, and in some instances prevents deepening of the well and similar operations. The fluid under high pressure discharged from the openings 38 at a 70 point between the spaced cups 13 discharges from the perforations 11 and flows upwardly about the liner to effectively loosen and remove accumulated sand from about the liner. This, of course, frees the liner so that it may be readily pulled or with- 75 drawn from the well.

Having described only a typical preferred form and application 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 5 those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A tool adapted to be operated on a tubular well string and adapted to operate in a well lining 10 or casing, the tool comprising, a body to be secured to said string, spaced packing elements carried by the body to seal with the interior of the casing, the body having a passage to conduct fluid from the string to the interior of the casing 15 between said elements, valve means for controlling said passage opened and closed by longitudinal movement of the string, and means for locking the valve means open releasable by turning of the string. 20

2. A tool adapted to be operated on a tubular well string and adapted to enter a well liner, the tool comprising, a body to be rigidly secured to said string, spaced packing elements carried by the body to seal with the interior of the liner, the 25 body having a passage to conduct fluid from the string to the interior of the liner between said elements, friction means engageable with the liner to have its movement resisted by the liner, the body and friction means being related for relative movement, and a valve for controlling said 30 passage comprising two parts, one a seat, the other a closure for engaging the seat, one valve part being secured to the body, the other valve part being secured to the friction means whereby the 35 valve is controllable by manipulation of the string.

3. A tool adapted to be operated on a tubular well string and adapted to enter a well casing, the tool comprising, a body to be secured to said 40 string to move therewith and having a passage to receive fluid from the string and adapted to discharge into the casing, sealing means on the body located at opposite sides of the point of discharge of the said passage to slidably seal with 45 the interior of the casing, a valve for controlling fluid flow through the passage, and a control operable by manipulation of the string to open and close the valve.

4. A tool adapted to be operated on a tubular 50 well string and adapted to enter a well lining, the tool comprising, a body to be secured to said string to be rigid therewith and having a passage to receive fluid from the string and discharging 55 into the well lining, sealing elements carried by the body to slidably seal with the interior of the lining above and below the point of discharge of the passage, friction means shiftable carried by the body and engageable with the lining to have 60 its movement resisted by the lining, a valve to control the passage, means operable by manipulation of the string to effect opening and closing of the valve including a stem carried by the friction means and extending through the passage 65 to operatively connect with the valve, and means for by-passing fluid past the sealing elements when the tool is moved longitudinally in the lining.

5. A tool adapted to be operated on a tubular well string and adapted to enter a perforated liner 70 in a well, the tool comprising, a body to be secured to said string and having a passage to receive fluid from the string and discharging into the liner, sealing elements carried by the body to slidably seal with the interior of the liner 75

above and below the point of discharge of the passage, a valve to control the passage, means operable by manipulation of the string to effect opening and closing of the valve, and means for by-passing fluid past the sealing elements when the tool is moved longitudinally in the liner, the last mentioned means including a tube in said passage, and means placing the tube in communication with the interior of the liner above and below the said sealing elements.

6. A tool adapted to be operated on a tubular well string and adapted to enter a perforated liner in a well, the tool comprising, a body to be secured to said string, spaced packing elements carried by the body to seal with the interior of the liner, the body having a passage to conduct fluid from the string to the interior of the liner between said elements, a valve for controlling said passage, and a control for the valve operable by manipulation of the string, said control comprising a tailpiece shiftable carried by the body and yielding frictionally engaging the interior of the liner, and a connection between the tailpiece and the valve.

7. A tool adapted to be operated on a tubular well string and adapted to enter a perforated liner in a well, the tool comprising, a body to be secured to said string, spaced packing elements carried by the body to seal with the interior of the liner, the body having a passage to conduct fluid from the string to the interior of the liner between said elements, a valve for controlling said passage, and a control for the valve operable by manipulation of the string, said control comprising a sleeve shiftable on the body, springs on the sleeve adapted to frictionally engage the interior of the liner to resist movement of the sleeve, and a member carried by the sleeve and associated with the valve to open and close the same upon longitudinal movement of the body with respect to the sleeve.

8. A tool adapted to be operated on a tubular well string and adapted to enter a perforated liner in a well, the tool comprising, a body to be secured to said string, spaced packing elements carried by the body to seal with the interior of the liner, the body having a passage to conduct fluid from the string to the interior of the liner between said elements, a valve for controlling said passage, and a control for the valve operable by manipulation of the string, said control comprising a sleeve shiftable on the body, springs on the sleeve adapted to frictionally engage the interior of the liner to resist movement of the sleeve, a member carried by the sleeve and associated with the valve to open and close the same upon longitudinal movement of the body with respect to the sleeve, and releasable means for latching the body and sleeve together against relative longitudinal movement.

9. A device for use on a tubular well string and adapted to clean accumulated material from a perforated liner in a well, the device including an elongate body to be secured to the string and adapted to enter the liner in the well, the body having a longitudinal opening to receive fluid under pressure from the string and having lateral outlets to discharge said fluid into the liner, opposed sealing cups carried by the body to seal with the liner above and below the outlets, a valve in the body controlling the opening, a sleeve

shiftable on the body, spring means on the sleeve frictionally cooperating with the interior of the liner to resist movement of the sleeve, a stem carried by the sleeve and extending through the opening to open and close the valve upon movement of the body relative to the sleeve, and means carried by the body for by-passing fluid to and from the interior of the liner past the sealing elements.

10. A tool for use on a tubular well string and adapted to operate in a well casing or lining comprising a body to be secured to the lower end of the string and having a passage to receive fluid under pressure from the string and to discharge into the lining, packing means on the body to seal with the interior of the lining above and below the point of discharge of the passage, means for by-passing fluid around the packing means when the tool is moved through the lining including a tube extending through the passage and communicating with the lining, a valve element adapted to close the passage against the down flow of fluid, friction means shiftable carried by the body and engageable with the lining to have its movement resisted thereby, a stem carried by the friction means and extending through the passage and tube to connect with the valve element whereby the valve element is controllable by movement of the body relative to the friction means, and packing means sealing about the stem to prevent the leakage of fluid between the passage and tube.

11. A tool for use on a tubular well string and adapted to operate in a well casing or lining comprising a body to be secured to the lower end of the string and having a passage to receive fluid under pressure from the string and to discharge into the lining, packing means on the body to seal with the interior of the lining above and below the point of discharge of the passage, friction means shiftable carried by the body and adapted to engage the lining to have its movement resisted thereby, a stem carried by the friction means and extending through the passage, a valve part on the stem operable to prevent a down flow through the passage, and a control means for holding the friction means and the body in a given relation where the valve part is open and releasable by turning of the string to allow movement of the body relative to the friction means to close the valve part.

12. A tool for use on a tubular well string and adapted to operate in a well casing or lining comprising a body to be secured to the lower end of the string and having a passage to receive fluid under pressure from the string and to discharge into the lining, packing means on the body to seal with the interior of the lining above and below the point of discharge of the passage, friction means shiftable carried by the body below the packing means engageable with the lining to have its movement resisted thereby, valve means above the packing means operable to control the passage and comprising two parts, one a seat, the other a closure engageable with the seat, one valve part being carried by the body, and a stem on the friction means extending upwardly through the passage to carry the other valve part whereby relative movement between the body and friction means controls the valve means.

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