

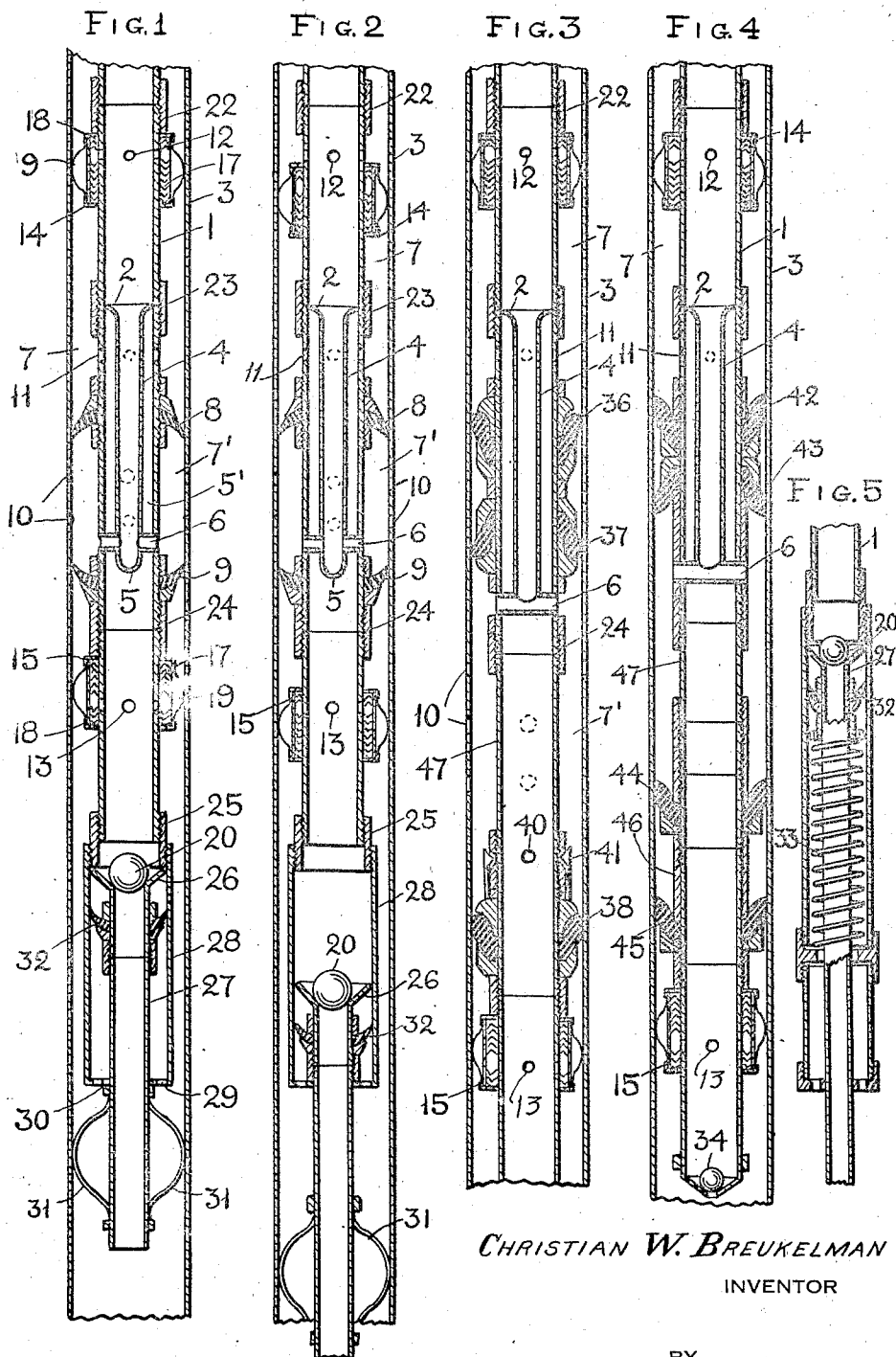
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2,426,164

Filed Dec. 29, 1943

2 Sheets-Sheet 1



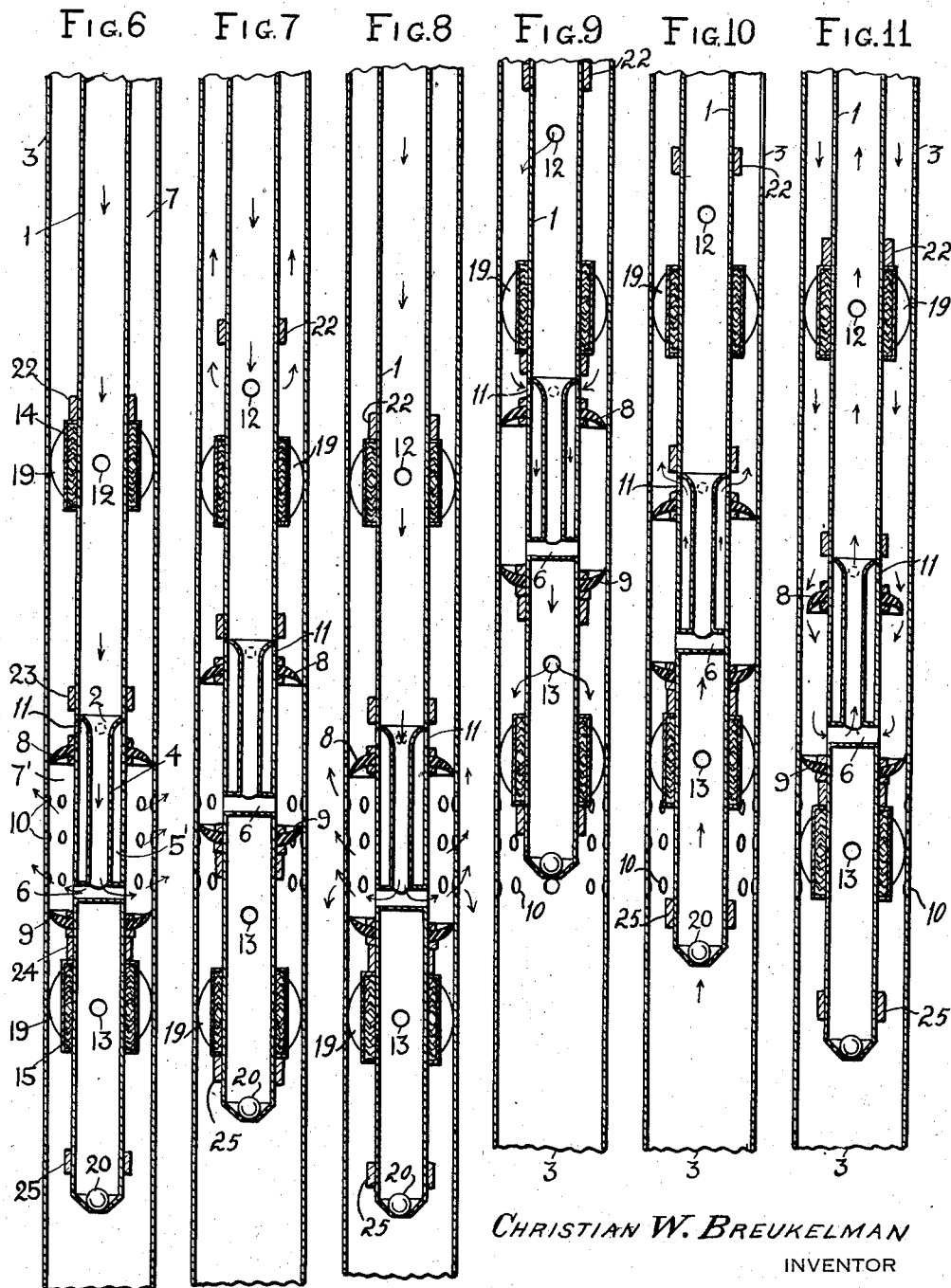
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UNITED STATES PATENT OFFICE

2,426,164

CEMENTING TOOL FOR OIL WELLS

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Application December 29, 1943, Serial No. 516,009

3 Claims. (Cl. 166—11)

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My invention relates to cementing tools for oil wells and has particular reference to tools for sealing perforations in casing pipes in oil wells.

My invention relates to cementing tools for oil wells, and has particular reference to tools for forcing cement through perforations in casing pipes and sealing them.

Perforations are sometimes provided in oil well casings within a limited vertical space, usually a few feet, to provide a passage through which cement slurry can be forced into the annulus outside the casing to prevent the movement of fluids such as gas, oil, or water behind the casing.

Similar perforations are sometimes provided for admitting oil or gas into the well, and occasionally it becomes necessary to seal such perforations as, for instance, when they lead into dry formations or formations containing salt water, etc. The usual method of sealing the perforations is by means of cement which is forced into the holes by a special tool.

Ordinary tools used for cementing holes in the casing pipes have a disadvantage in that they employ complicated valves requiring rotation of the tool, special slips, etc.

My invention has for its object to provide a cementing tool in which all the operations for opening and closing cement-admitting ports, can be effected by the simple procedure of lowering and raising the tool, the vertical movement of the tool being used to operate sliding frictional sleeves or valves for opening and closing different ports or openings.

Another object of my invention is to provide means in my tool for using the same for washing out the excess cement after completion of the cementing operation.

Still another object of my invention is to provide a single tool which can be used for cementing and washing out operations under all operating conditions, and particularly those in which it is undesirable to exert additional pressure on the well below the tool during these operations.

My invention is more fully described in the accompanying specification and drawings in which:

Fig. 1 is a fractional sectional view of a well casing with my tool in position of being lowered into a casing pipe;

Fig. 2 is a similar view of my tool after it has been slightly raised to move sliding valves for opening ports;

Fig. 3 is a fractional sectional view of a modified tool;

Fig. 4 is a similar view of another modification;

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Fig. 5 is a sectional view of a modified bottom valve;

Figs. 6 to 11 are views of a modified tool in different stages of operation.

My cementing tool consists of a tubing 1 made in several sections connected together by threaded couplings 22, 23, 24, 25.

The tubing is of a substantially smaller diameter than the inside diameter of a casing pipe 3 forming walls of a well. The tubing 1 is provided in the middle with an inner tube 4 whose upper flared-out end 2 is welded to the inner walls of the tubing 1, the lower end of the inner tube being closed at 5. Short tubes or ducts 6 connect the lower portion of the tube 4 with the annular space 7' between the tube 4 and casing 3. Sealing cups or swabs 8, 9 are placed on the tubing 1 at either side of the ducts 6. The swabs are made of an elastic material such as rubber. The cups are of a larger diameter than the casing pipe and are resiliently forced into the casing pipe, forming water-tight seal. They are placed opposite each other as shown so that they effectively resist any pressure which may be applied to the annular space 7' between them. The swabs or cups are placed at a distance of few feet from each other or substantially farther apart than the maximum distance between the extreme outer perforations or shot-holes 10 in the casing pipe.

The tubing 1 is also provided with vent holes 11 below the flared top portion of the inner tube 4, which holes are open at all times. The tubing 1 is also provided with upper vent holes or ports 12 and lower ports 13 which can be closed by sliding sleeves or valves 14 and 15 respectively, slidably mounted on tubing 1. The sleeves are of a larger diameter than the tubing 1, the annular space in the sleeves being filled with "chevron" or similar packing 17 of self-sealing type, held at the ends of the sleeves by threaded annular caps or flanges 18. Spring clamps 19 are fastened to the sleeves and frictionally engage the inner walls of the casing 3.

Springs 19 bear on the inner wall of the casing with sufficient pressure to hold the sleeves 14, 15 to which they are attached in the stationary position when tubing 1 is moved up or down, sliding through the sleeves, until one or the other of the couplings 22, 23, 24, and 25 engage the corresponding sleeve, whereupon the sleeve will be moved together with the tubing in a corresponding direction. Thus, when the tubing 1 is moved downward, sleeves 14 and 15, being engaged by the couplings 22 and 24 respectively, will be brought to their upper operative positions as

shown in Fig. 1, closing ports 12 and 13. Oil or other fluid in the well will be forced upward past a lower ball valve 20 into the tubing 1, into an annular space 5' within tubing 1 surrounding tube 4, and out through holes 11 into the annular space 7, bypassing swabs 8, 9.

After the tool is placed in position, the next operation consists in forcing the fluid out of the space 7' between the swabs 8, 9. This is accomplished by pumping water into the tubing 1 for determining the "break-down" pressure, or pressure at which the liquid begins to flow into the holes 10. Ports 12 are closed during this operation. The tubing, as far down as the top of the tool, is then filled or partly filled with cement slurry. The tubing for this purpose is slightly raised, just sufficiently to open ports 12. Slurry is then pumped down the tubing, the return circulation passing through ports 12 into the annular space 7 in the casing pipe. It should be noted that the port 12 must be opened, to avoid having to pump all of the fluid in the tubing ahead of the cement through holes 10 into the formation. The position of sleeve 15 during this operation is as a rule immaterial, but port 13 can be closed if desired and port 12 opened by suitable movements of the tool.

The next operation is the pressure or squeeze cementing. The tubing 1 is lowered, closing the ports 12. Slurry is pumped into the tubing under pressure, forcing it through the inner tube 4 and through ducts 6 into the space 7' between the swabs 8, 9. Under continuous break-down pressure, cement slurry is forced from the space 7' and through shot holes 10 into the space outside the casing. The pressure is held until no back flow is observed, i. e., until cement is sufficiently set. In some instances, as in multiple-stage cementing, valved cementing ports are inserted in, and form part of the casing pipe at pre-selected points. These valves prevent back-flow of cement slurry, and the tool can be withdrawn immediately after the cement is placed behind the casing.

It should be noted that the movement of sliding sleeve valves 14 and 15 is limited by the couplings 22, 23 which limit movement of the sleeve 14, and 24, 25 which limit movement of the sleeve 15. The upper ports 12 are closer to the upper coupling 22 than the lower ports 13 are to the coupling 24 so that it is possible to raise the tubing 1 just enough to uncover the upper ports 12 without uncovering the lower ports 13.

The ball 20 is supported in a cup-shaped expanded upper end 26 of a tube 27, sliding in a tubular casing 28 supported at the lower end of the tubing 1. The upward movement of the tube 27 is limited by the coupling 25 to which the casing 28 is attached, the downward movement being limited by a flange 29 with a central opening for the tube 27 and also holes 30 therein. The depending end of the tube 27 is provided with springs 31 frictionally engaging the inner wall of the casing pipe 3. A sealing cup-shaped member or swab 32 is fitted on tube 27 below the cup 26, preventing fluids in the tubing 1 from penetrating below the tool.

As shown in Fig. 1, the tube 27 with the ball valve 20 is brought to the top of the casing 28 by the downward movement of the tool because of the friction of the springs 31 against the walls of the casing pipe 3. The tube 27 is lowered again relative to the tubing when the tool is raised for opening the port 13, and that no suction or swabbing is produced below the tool during this operation. The valve 15 uncovers the ports 13

thereby equalizing pressure at both sides of the swabs 8, 9 and preventing formation of vacuum or suction under the tool. Port 12 offers no problem when raising the tool, because port 11 is always open. If port 13 is closed, when the tool is raised, swab 9 comes into action, fluid pressure is exerted on ball 20 through ports 11, tube 27 must then move down in casing 28, and swabbing action is prevented while port 13 is being uncovered.

A retrieving spring may be provided for the tube 27 as shown in Fig. 5 so as to keep the valve 20 raised except when the tool is being withdrawn from the casing pipe.

Upon completion of the cementing operation, the excess cement is washed out from the inside of the tool. The tool for this purpose is raised above the perforations 10 (or above any, still higher, perforations, to avoid loss of washing fluid), the upward movement of the tool will leave valves 14 and 15 resting on the couplings 23 and 25 respectively, uncovering ports 12 and 13 respectively. These ports must be closed for the washing operation, and this can be accomplished by lowering the tool just enough to bring the ports 12, 13 under the respective valves 14, 15. Water is then pumped down the casing pipe, past upper or inverted swab 8, through the openings 6 and up the inner tube 4 into the tubing 1. Since both ports 12 and 13 are closed during this operation, no pressure will be exerted on the well below the tool. It should be noted that duct 6 is placed as far as possible from swab 8, so that the maximum washing of annulus 7' is effected.

The sliding tube 27 materially facilitates operation of the device, making it easy to pull the tool even out of deep holes.

If desired, if open formations exist below the tool, and there is no objection to slight swabbing or suction action while opening the ports 13, the sliding valve tube 27 may be dispensed with and a standing valve 34, Fig. 4, may be used.

The tool can be also used for circulating a liquid down the tubing 1 and up the casing 3, without exerting pressure on the well below the tubing. The tool for this purpose is lowered to close the ports 12 and 13 by the valves 14 and 15, then raised sufficiently to close the ports 13 but not 12, as shown in Fig. 2. This is possible because the port 13 is located at a greater distance from the coupling 24 than the port 12 from the coupling 22 so that a small upward displacement of the tubing 1 is sufficient for uncovering the port 12 while leaving the port 13 still closed. The ports 13 being closed, no liquid can penetrate into the space under the swab 9, the return liquid flowing up the casing 3.

If it is desired to wash out excess cement from between the swabs 8 and 9, and then circulate it out up the casing 3, it is necessary first of all to close ports 12 and 13 and pump down the casing and up the tubing past swab 8 by a method already described. Then, when the cement has been brought into the lower part of the tubing 1, port 12 is opened as described in the previous paragraph, leaving port 13 closed, and the cement is displaced up the casing 3 by pumping down the tubing.

My tool can also replace two cement retainers, one below the shot holes as a bridge plug, and the other above for squeeze cementing.

My tool can be used for various other purposes, such as acidizing oil wells, injecting chemicals under pressure, or for perforation washing.

A modified tool is shown in Fig. 3, specially

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adapted for high pressure cementing. It is provided with two swabs 36, 37 at the top, facing in the opposite directions and of a heavy pressure type. A similar heavy pressure swab 38 is placed below cementing region 7'. Ports 40 are also provided with flapper valves 41 for washing out the excess cement. Water or other liquid for this purpose is pumped down the casing annulus 7, through the upper port 11, into the tubing 1, out the valved ports 41, into the cementing region 7', and back through ports 6 and tubing 4 and 1. The valve 41 may be dispensed with for medium pressures as shown in Fig. 4, using more flexible swabs 42, 43, 44 and 45.

The ports 46 are located between the lower swabs 44, 45 without any valves.

Distance between the upper and lower swabs can be adjusted by inserting pieces 47 of varying length between the couplings in the tubing in the cementing region.

A modified tool is shown in Figs. 6 to 11. In this tool the ports 12 and 13 are at the same distance from the collars 22 and 24 but the distance between the upper collars 23 and 22 is considerably greater than the distance between the lower collars 24 and 25.

Position of the tool during its being lowered into the well is shown in Fig. 6. The valves 14 and 15 are moved upward, resting against the collars 22 and 24 respectively, closing both ports. When the tool is lowered to a point in which the holes 10 in the casing 3 are placed between the swabs 8 and 9, the breakdown pressure is determined by pumping a liquid through the inner tube 1 and noting the pressure at which the liquid begins to flow into the formation through the holes 10. The tool is then raised as shown in Fig. 7 to uncover the port 12. Enough of the cement solution is then pumped into the inner tube for driving the liquid ahead of the solution upward through the port 12 and through the annular space in the casing 3. The tool is now ready for cementing operation. It is lowered again as shown in Fig. 8 for closing the ports, and more cement is pumped into the inner tube 1 forcing the cement at the breakdown pressure into the formation through the holes 10 between the swabs.

Upon completion of the cementing operation the tool is raised above the cemented area as shown in Fig. 9.

During this raising operation the liquid from above the tool flows downward through the ports 12, 11, space 5', and port 13 so that no vacuum is formed under the tool.

For washing out the cement from the tool, the latter is lowered as shown in Fig. 10 for closing the valves. The lowering is possible without creating pressure under the tool because the liquid from under the tool flows upward through the ball valve at the bottom and through the open ports 11. With both ports 12 and 13 closed as shown in Fig. 11, and with the swabs 8 and 9 above the cemented area, a liquid is pumped into the outer annular space 7, pressure of the liquid causing the upper swab 8 to collapse, admitting the liquid into the space between the swabs, from which it flows upward through the tubes 6, 4 and 1. The upper swab acts as a valve in this case, being of a convex shape.

It should be noted that the packing in the valve 14 must resist pressure from within and from without the valve, while the packing in the valve 15 must resist only pressure from within the tool.

It is understood that my cementing tools for

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oil wells may be further modified without departing from the spirit of the invention, as set forth in the appended claims.

I claim as my invention:

1. A cementing tool for oil wells comprising a tubing constructed to be placed in a casing of a well, the tubing being of a substantially smaller diameter than the casing; a tubular member of a still smaller diameter within the tubing, the upper end of the tubular member communicating with the tubing and being flared-out and attached to the inner wall of the tubing, forming a seal between the tubular member and the tubing; a check valve closing the lower end of the tubing against downward flow of fluid; the lower end of the tubular member being closed to communication with the tubing; tubular ducts connecting the tubular member with the outside of the tubing; sealing swabs on the tubing above and below the outer openings of the tubular ducts, said swabs being spaced apart a distance greater than the length of that portion of the casing occupied by holes to be cemented; the tubing having permanently open ports above the sealing swabs and below the flared-out end of the tubular member, and having additional ports above and below the sealing swabs; sleeves slidably supported on the tubing for closing said additional ports; frictional members extending from the sleeves and engaging the inner wall of the casing for retaining the sleeves stationary when the tubing is moved; the said additional ports above the swabs being also above the flared-out end of the tubular member, the sleeves being adapted to close said additional ports when the tubing is moved downwardly, and to open said additional ports when the tubing is moved upwardly; an enlarged tube depending from the lower end of the tubing; a sliding tube in the enlarged tube and extending through the lower end of the enlarged tube; a sealing swab at the upper end of the sliding tube engaging the inside walls of the enlarged tube; means on the outwardly extending portion of the sliding tube for frictionally engaging the inner surface of the casing; and means to limit the movements of the sliding tube in the enlarged tube, the distance of movement of the sliding tube being comparable to the distance of movement of the tubing for opening the ports, the check valve being arranged to be opened by inwardly flowing well fluid when lowering the tool for admitting the fluid from the well into the tubing, the well fluid flowing outwardly through said permanently open ports into the casing.
2. A cementing tool for oil wells comprising a tubing constructed to be placed in a casing of a well, the tubing being of a substantially smaller diameter than the casing; a tubular member of a still smaller diameter within the tubing, the upper end of the tubular member communicating with the tubing and being flared-out and attached to the inner wall of the tubing, forming a seal between the tubular member and the tubing; tubular ducts connecting the tubular member with the outside of the tubing, sealing swabs on the tubing above and below the outer openings of the tubular ducts; said sealing swabs being spaced apart a distance corresponding to the length of that portion of the casing occupied by holes to be cemented; the tubing having permanently open ports above the sealing swabs and below the flared-out end of the tubular member, and having additional ports above and below the sealing swabs, the additional port above the swabs being

also above the flared-out end of the tubular member; sleeves slidably supported on the tubing for closing said additional ports; frictional members extending from the sleeves to the inner wall of the casing for retaining the sleeves stationary when the tubing is moved; an enlarged tube depending from the lower end of the tubing; a sliding tube in the enlarged tube and extending through the lower end of the enlarged tube; a sealing swab at the upper end of the sliding tube engaging the sides of the enlarged tube; an upwardly and downwardly closing check valve at the upper end of the sliding tube for preventing downward flow of the fluids through the tubing; frictional means on the outward extension of the sliding tube for engaging the inner surface of the casing; and means to limit the movements of the sliding tube in the enlarged tube.

3. A cementing tool for oil wells comprising a tubing constructed to be placed in a casing of a wall, the tubing being of a substantially smaller diameter than the casing; a tubular member of a still smaller diameter within the tubing, the upper end of the tubular member communicating with the tubing and being flared out and attached to the inner wall of the tubing, forming a seal between the tubular member and the tubing, tubular ducts connecting the closed end of the tubular member with the space outside of the tubing; sealing swabs on the tubing above and below the outer openings of the tubular ducts for sealing off an annular space in the casing between the casing and tubing above and below the lower end of the tubular member, said swabs being spaced apart a distance greater than the length of the portion of the casing occupied by holes to be cemented; the tubing having permanently open ports above and sealing swabs under the enlarged end of the tubular member and additional ports above the open ports and below the

lower swabs respectively, the additional upper port being above the flared out end of the tubular member; sleeves slidably supported on the tubing for closing the upper and lower additional ports respectively; frictional members extending from the sleeves to the inner walls of the casing for retaining the sleeves stationary when the tubing is moved; upper collars on the tubing above the additional ports for engaging the sleeves when the tubing is moved downwardly in which position of the sleeves the additional ports are closed by the sleeves; lower collars on the tubing below the additional ports and spaced therefrom for engaging the sleeves when the tubing is moved upwardly in which position of the sleeves the additional ports are opened, the distance between the upper and lower collars on that portion of the tubing above the swabs being greater than the distance between the collars below the swabs for enabling the lower additional ports to be closed ahead of the upper additional ports when the tubing is moved upwardly; and means including a downwardly closing check valve at the bottom of the tubing, for admitting a fluid from the well into the casing through permanently open ports when the tool is being lowered.

CHRISTIAN W. BREUKELMAN.

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