April 5, 1949. C. E. COSTELLO 2,466,305

WELL DEVICE

Filed May 2, 1941

Fig. 1.

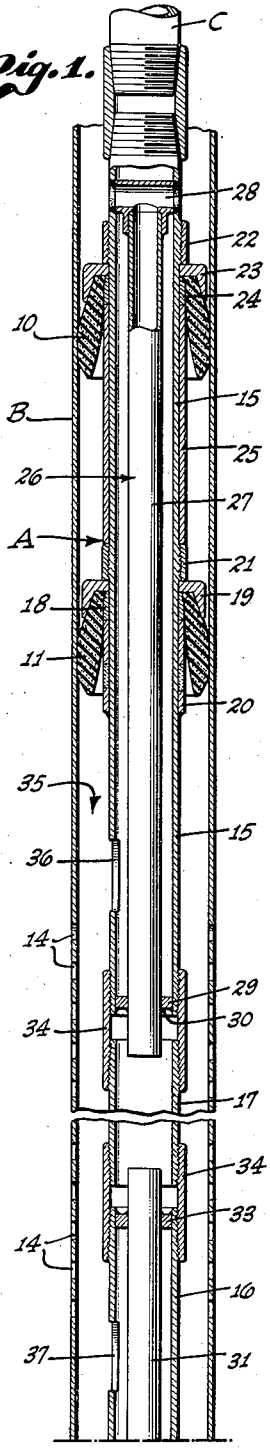


Fig. 1a.

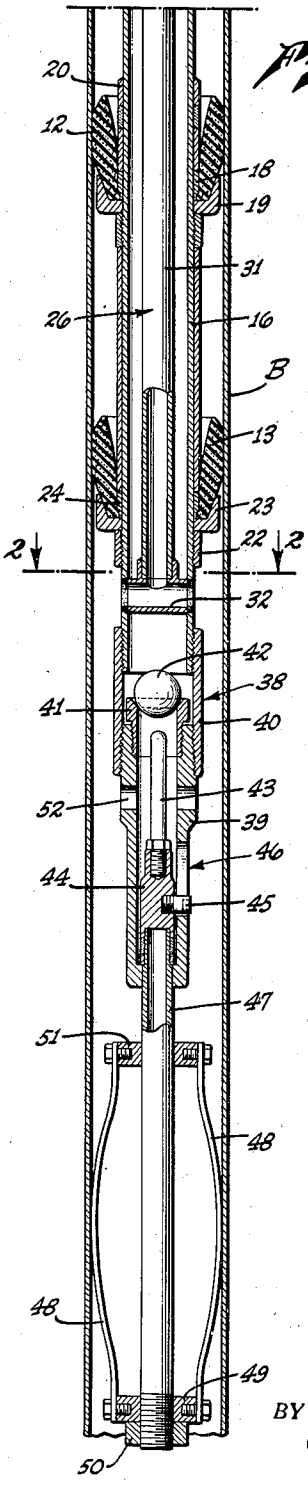


Fig. 2.

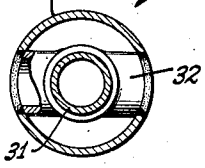
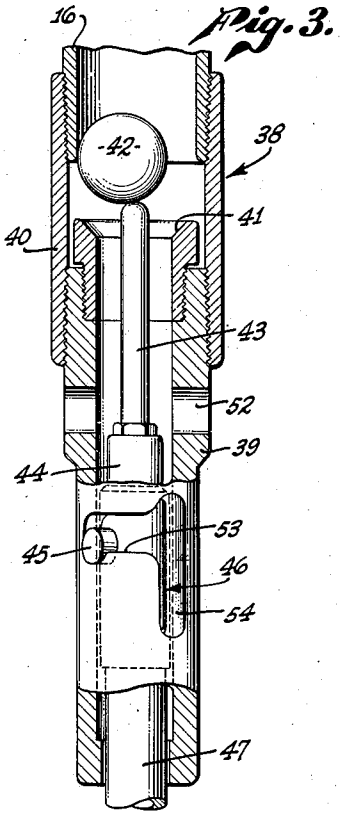


Fig. 3.



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WELL DEVICE

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Application May 2, 1941, Serial No. 391,548

30 Claims. (Cl. 166—11)

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This invention relates to well devices, and has for its general object the provision of improved tools for displacing fluids through lateral openings in casings or liners.

It is another object of the present invention to provide a cementing, washing, acidizing or testing tool designed to pack off in a casing or liner on opposite sides of its lateral openings, and in which the pressures on opposite sides of the packed off zone are constantly equalized; the means for obtaining such equalization being selectively communicable with the passage through the tubular body of the tool to allow bypassing of fluids around the packed off zone without subjecting such zone to material pressure. More specifically, a control valve is positioned below a tool body port exiting into the annular space between the opposed packing members. When this valve is closed, pressure can be built up in the tool for forcing the fluid in the confined annular space through the lateral openings in the casing or liner, whereas opening of this valve permits free passage or circulation of fluid in either direction between the interior of the tool body and a by-pass, which establishes communication between the casing or liner regions both above and below the opposed packing members. The by-pass arrangement not only functions in conjunction with the valve for controlling the flow of fluids through the tool and the packed off zone, but it also maintains substantial equalization of the pressures on opposite sides of this zone, so that no unbalanced hydraulic forces are present tending to move the tool in either direction within the casing, which, under some circumstances, might produce a kinking or twisting of the tubular string to which the tool is attached, rendering it unfit for further use or preventing its removal from the well bore.

It is a further object of the invention to provide a by-pass around the opposed packing members of a perforation cementing, washing, acidizing or testing tool, and to so position the lateral ports of the tool body with respect to the space between the opposed packing members that washing or circulating fluid may be forced through substantially the entire length of this confined space by pumping in either direction through the tubular string, the tool connected thereto, and the latter's by-pass.

This invention has other objects that will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification.

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This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Figures 1 and 1*a* together constitute a longitudinal sectional view through the cementing tool, shown in one operative position within a well casing or liner;

Figure 2 is a cross section taken along the line 2—2 in Figure 1*a*; and

Figure 3 is a longitudinal section of part of the valve control mechanism, illustrated in another operative position.

In the embodiment of invention disclosed in the drawings, the tool A is lowered within a casing B on the end of a tubular string C until its opposed packing members 10, 11, 12, 13 are positioned on opposite sides of the casing or liner openings 14 through which fluid is to be forced. The upper packing members 10, 11 are carried on an upper tubular body member or section 15 secured to the tubing string C, while the lower packing members 12, 13 are secured to a lower tubular body member or section 16. These two body parts 15, 16 are suitably connected together in spaced relation by any desired length of blank pipe 17 to determine the distance between the opposed packing members.

The upper packing members 10, 11 consist of downwardly facing swab cups carried by the upper body section 15. In the present instance, the inner swab cup 11 is mounted on a ring 18 and seated within a thimble 19, being clamped between a stop sleeve 20 welded or otherwise secured to the body and a lock nut 21 threaded on the body. The sleeve 20 engages the packing ring 18 while the nut 21 contacts the thimble 19. The outer swab cup 10 is similarly secured to the body between a lock nut 22 engaging its thimble 23 to force the ring 24 against a spacer sleeve 25 abutting the lower lock nut 21. The lower two, upwardly facing swab cups 12, 13 are mounted on the lower body section 16 in a similar manner. It is, of course, apparent that only the inner two opposed packing members 11, 12 need be employed for effecting a seal with the casing on opposite sides of its lateral openings or perforations 14, but for purposes of greater assurance against leakage, it is preferred to add the outer two packing members 10, 13.

The pressures both above and below the opposed packing members are equalized at all times by a constantly open by-pass 26. This by-pass

includes a tube 27 extending through the upper body member 15 for connection at its upper end with a T 28 welded or otherwise secured to the body and opening outwardly through the upper member above the outer swab cup 10. The lower end of this by-pass tube 27 extends through an annular baffle plate 29 suitably secured in the lower end of the upper body member 15 in leak-proof relation with respect to the body and the tube, as by use of welding material 30. The lower portion of the by-pass device 26 similarly consists of a tube 31 extending through the lower body member 16 and secured to a T 32 opening outwardly through the lower member below its outer packing 13, with its upper end extending through an annular baffle plate 33 suitably secured in the upper end of body member 16. The spacer pipe 17, including its end couplings 34 threadedly connected to the inner ends of the two body members 15, 16, communicates with the open inner ends of both tubes 27, 31 to complete the constantly open by-pass passage, which extends from a point below the lowermost packing member 13 to a point above the uppermost packing member 10.

Fluid can pass between the interior of the tubing string C and the annular casing space 35 defined between the opposed swab cups through one or more lateral openings or ports 36 in the upper body member 15. The pumps at the surface of the bore may force fluid downwardly through the tubular string and upper body member for passage through this port into such annular space, from where it may flow into the lower body member 16 through its lateral ports or opening 37, and through a control valve 38 into the casing below the lowermost packing member 13.

The control valve consists of a tubular locking member 39 threaded into a coupling 40 attached to the bottom end of the lower body section 16.

This locking member carries a valve seat 41 on which a valve ball 42 is adapted to rest for the purpose of closing the passage through the lower body member 16 against downward fluid flow. This ball 42 is free to be lifted from its seat under the action of upwardly flowing fluid, such movement being limited by its engagement with a suitable stop, which can be a suitable cage or the T 32 secured to the lower by-pass tube 31. Downward seating of the ball to close the passage is determined by a valve operating stem 43 in the tubular locking member 39, its upper end being adapted to engage the ball 42 for lifting it and holding it from its seat 41, while its other end is threaded into a guide head 44 slidable in the locking member. This head has a laterally extending lock pin 45 projecting outwardly into an inverted J or L slot 46 formed in the tubular locking member 39.

A suitable friction device for operating the stem 43 is secured to the guide head 44, consisting of a guide tube 47 attached to the head, and slidable through the lower end of the tubular locking member 39. Outwardly bowed friction springs 48 are fastened at one end to a spring holder 49 threaded on the guide tube 47 and locked to it by a nut 50, with their other ends secured to a second spring holder 51 slidable on this tube. Since engagement of the friction springs 48 with the casing B serves to hold or resist movement of the guide tube 47, its attached head 44 and valve stem 43, it is apparent that longitudinal movement of the entire body 15, 16, 17 and tubular locking member 39 in a downward direction can cause the valve stem 43 to engage the ball 42 and hold it from its seat 41, while movement in an upward direction removes it from such engagement to permit the seating action to occur.

In the operation of the device, the tool is run to the desired casing point on the end of the tubular string until the opposed packing members 10, 11, 12, 13 are disposed on opposite sides of the casing outlets or perforations 14 through which fluid is to be displaced. During this running-in operation, fluid may pass into the bleeder holes 52 in the tubular locking member 39 for upward passage therethrough, unseating the ball 42 and passing into the lower body member 16, from where the fluid may flow around the T 32 and by-pass tube 31 for exit through the lower body port 37 into the confined annular space 35 between the packings. From this region, the fluid enters the upper section 15 through the other body port 36 for passage around the upper by-pass tube 27 and its connected T 28 into the tubular string C, to fill the same with fluid. While this action is occurring, the well fluid is also free to flow through the constantly open by-pass 26 from the region below the swab cups to the annular casing space thereabove, so that there is no fluid resistance to movement of the tool through the casing.

Whether pressure can be built up in the tool and between the opposed packing members is dependent upon the position of the valve operating stem 43 with respect to the ball 42. This position is determinable by elevating or lowering the entire tubing string C and tool A with respect to the guide tube 47 and valve stem 43, which are held in comparatively stationary position through engagement of the friction springs 48 with the wall of the casing. If the ball 42 is to be maintained off its seat 41 to open the valve device and permit intercommunication between the tool body 15, 16, 17 and the by-pass 26, the entire tool is lowered until the lock pin 45 is positioned in the upper part of the J slot 46, which causes engagement of the valve operating stem 43 with the ball 42 to lift and hold it off its seat 41, regardless of the direction of fluid flow through the valve. When in this position, the tubular string and tool body may be turned in the proper direction to move the pin 45 into the arm 53 of the slot to effect locking of the ball valve in open position, since further relative longitudinal movement in either direction between the tubular locking member 39 and ball controlling stem 43 cannot occur. If seating of the valve ball is desired, the lock pin 45 is positioned in the longitudinal leg 54 of the J slot and the entire tool raised a sufficient distance to elevate the valve seat 41 above the end of the frictionally held stem 43, resulting in withdrawal of the ball 42 from contact with the stem to permit its engagement with the seat for the purpose of preventing downward fluid flow from the lower body member 16, enabling pressure to be built up in the tool body and confined annular space 35.

In operating the tool in the well, the pin 45 need not be positioned necessarily in the arm 53 of the J slot to hold the ball valve 42 in open position for permitting both upward or downward passage of fluid through the body. Upward flow can occur regardless of the position of the stem 43, and with the ball initially on its seat, since the upward rush of fluid will automatically raise the ball and open the valve. Downward flow can only occur with the stem holding the ball in open position; and due to the frictional drag of the springs 48 against the casing, if the valve is to

be open during elevating of the entire tool in the casing, the pin 45 should be positoned in the slot arm 53.

If pressure is to be imparted to the fluid between the opposed packing members, the pin 45 is placed in the leg 54 of the J slot and the tool elevated to lower the stem 43 from the ball 42, permitting its seating. The application of pressure to the fluid within the tubing string and tool body forces fluid under pressure through the upper body outlet 36 into the annular confined space 35 between the opposed packing rubbers, and thence through the perforations 14 to the exterior of the casing. When release of this pressure is desired, the tubular string C and body are again lowered to position the pin in the upper part of the J slot leg 54 and cause the stem to elevate the ball from its seat.

One specific use of the tool described is in connection with cementing through casing perforations or ports. After the packing members 10, 11, 12, 13 have been disposed on opposite sides of the perforations or ports 14 through which the cement slurry is to be squeezed or displaced, the tool may be lowered a slight distance to enable the stem 43 to hold the ball valve 42 off its seat 41. The fluid preceding the cement slurry pumped down the tubular string is not required to pass through the casing openings 14, but may flow outwardly through the upper body port 36 into the confined annular space 35, and back into the lower body member 16 through its lateral port 37, from where it flows downwardly around the lower by-pass tube 31 through the open valve member 38 and the bleeder holes 52 in the tubular lock member, for upward passage into and through the by-pass elements 32, 31, 17, 27, 28 to a point above the uppermost packing member 10, the fluid then proceeding upwardly around the tubular string C to the surface of the bore.

As soon as the cement slurry reaches the cementing tool A, the tubing string and tool may be elevated a slight distance to remove the valve operating stem 43 from its ball valve opening position, allowing the ball 42 to seat and close the lower end of the tool body, permitting the cement slurry to be forced under pressure from the upper body outlet 36 into the confined annular space 35 between the packing members, and through the casing outlets 14.

If excess cement slurry is to be flushed from the tubing string C, the tool A and the casing B, the tool may again be lowered a few inches to again cause the stem 43 to elevate the ball valve from its seat 41, whereupon this excess slurry can pass through the upper body port 36 back into the lower body port 37, and through the valve seat 41, the bleeder holes 52 and the tubular by-pass 26 back to the surface of the casing. As an alternative, this excess fluid or cement slurry may be flushed from the well casing and tool by pumping down around the tubing string C, the flushing fluid entering the top end 28 of the by-pass 26 and passing downwardly therethrough for exit through the lower by-pass T 32, from where it passes through the bleeder holes 52 and valve seat 41 into the lower body member 16, issuing through its port 37 into the confined annular space 35 adjacent the lower packing member 12, flowing from this point through substantially the entire annular casing space 35 between the packing members through the upper port 36 into the upper body member 15 and tubular string C to the surface of the casing. This alternative flushing method can be performed even with the ball permitted to rest on its seat 41 by the stem 43, since the reverse flow of fluid will elevate the ball upwardly automatically from its seat.

It will be noted that the upper and lower body ports 36, 37 are adjacent the inner packing members 11, 12, or at the extremities of the confined casing space 35. As a result of such locations, flushing of the fluid from the tool in the manners just described cleans substantially this entire annular space, in view of the necessity for the fluids to pass through the entire distance between these ports when the valve 38 is open.

After the cementing operation has been completed and the excess slurry washed from the casing, the tool is lowered a few inches to cause the stem 43 to elevate the ball 42 from its seat, if this has not already taken place, the tool being turned to position the lock pin 45 in the arm 53 of the J slot, thus holding the ball valve in open position during elevation of the entire tool in the well casing, preventing the pulling of a "wet job" while the tool is being removed to the surface of the bore.

Although employment of the tool in performing cementing operations has been specifically described, it can also be used to advantage for many other purposes, including the washing, testing or acidizing of wells. With the tool described, the pressures imposed upon the fluid between the opposed packing members cannot tend to elevate it in the casing, since such pressures are equal and act in opposite directions on the packing members. In the event that the lower packing members 12, 13 should leak, or if the bottom hole pressure below the tool is greater than the hydrostatic head of fluid above the tool, such upwardly acting pressure differential cannot force the tool up the casing and possibly kink or damage the tubing string, since the by-pass 26 is always open, enabling the pressures immediately above and below the packing members to equalize automatically, except, of course, for the slight difference in hydrostatic head, which value is small and can be disregarded for all practical purposes.

The by-pass arrangement 26 further offers the advantage that the distance between the packing rubbers 11, 12 may be readily varied simply be employing different lengths of by-pass spacer pipe 17 secured to and between the upper and lower body sections 15, 16. The only relatively movable elements in the entire tool are the valve control members, attesting to the simplicity of design of the tool, to its ease of operation in performing a diversity of functions, and to its efficiency. The valve member 38 is positioned below the lower tool body opening 37, and determines, in conjunction with the open by-pass 26, whether pressure can be built up in the annular space 35 between the packing members, or whether circulation can take place through and around the tool in either direction.

I claim:

1. A device adapted to be connected to a tubular string for operation in a well casing; including a body carrying spaced upper and lower packing members for sealing with said casing; said body having passage means for conducting fluid between said string and the space between said packing members, and also between said space and a point below said lower packing member; valve means in the path of fluid flow through said passage means for controlling flow of fluid to said point below said packing member to enable pressure to be built up in the fluid within said space; and a by-pass extending from below

the lower packing member to above the upper packing member and communicable with said passage means when said valve means is in open position.

2. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body having fluid passage means terminating at a point below said lower packing member and which also has a fluid exit between said packing members, valve means in the path of fluid flow through said passage means and positioned below said fluid exit for controlling flow of fluid to said point below said lower packing member, and a fluid by-pass extending from below the lower packing member to above the upper packing member.

3. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body having fluid passage means terminating at a point below said lower packing member and which also has a fluid exit between said packing members, valve means in the path of fluid flow through said passage means and positioned below said fluid exit for preventing flow of fluid to said point below said lower packing member to permit the pressure of the fluid in the space between said packing members to be increased, a fluid by-pass extending from below the lower packing member to above the upper packing member and communicable with said passage means when said valve means is in open position, and means for preventing flow of fluid within said body between said passage means and by-pass when said valve is in closed position.

4. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body having fluid passage means communicable with said tubular string which terminates at a point below said lower packing member and which also has a fluid exit between said packing members, valve means in the path of fluid flow through said passage means and positioned below said fluid exit for controlling flow of fluid to said point below said lower packing member, a by-pass extending from below the lower packing member to above the upper packing member and communicable with said passage means when said valve means is in open position, and means operable by manipulation of said tubular string for controlling said valve means.

5. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body having fluid passage means terminating at a point below said lower packing member and which also has a fluid exit between said packing members, a fluid by-pass extending from below the lower packing member to above the upper packing member, and downwardly seating valve means in the path of fluid flow through said passage means and positioned below said fluid exit for determining the flow of fluid through said exit and between said fluid passage means and by-pass.

6. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing and having a first passage to receive fluid from said string and discharge it into the space between said packing members, and a second passage to receive fluid from said space and discharge it at a point below said lower packing member, valve means in the path of fluid flow through said second passage and positioned below said first passage for controlling flow of fluid through said second passage, a by-pass extending from below the lower packing member to above the upper packing member and communicable with said second passage when said valve means is in open position, and means for preventing flow of fluid within said body between said passages and by-pass.

7. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, and having a first passage for conducting fluid between said string and the space between said packing members, and a second passage for conducting fluid between said space and a point below said lower packing member, valve means in the path of fluid flow through said second passage and positioned below said first passage for controlling flow of fluid through said second passage, a constantly open by-pass extending from below the lower packing member to above the upper packing member and communicable with said second passage when said valve means is in open position, means for preventing flow of fluid within said body between said passages and by-pass, and means operable by manipulation of said tubular string for controlling said valve means.

8. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular member having upper and lower sections, opposed upper and lower packing members around said tubular member for sealing with said casing to define a confined longitudinal space therein, a first port in said upper section adjacent said upper packing member for establishing communication between the interior of said upper section and said confined space, a second port in said lower section adjacent said lower packing member for establishing communication between the interior of said lower section and said confined space, means for preventing passage of fluid between said upper and lower sections through the interiors thereof, means for providing a passage extending from a point below said lower packing member to a point above said upper packing member for by-passing fluid around said confined space, and valve means below said second ported means for determining the flow of fluid through said lower section and between its interior and said by-pass passage.

9. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular body having upper and lower sections, opposed upper and lower packing members secured to said upper and lower sections, respectively, for sealing with said casing to define a confined longitudinal space therein, a first ported means adjacent said upper packing member for establishing communication between the interior of said upper section and said confined space, a second ported means adjacent said lower packing member for establishing communication between the interior of said lower section and said confined space, baffle means for preventing passage of fluid between said upper and lower sections through their interiors, means for providing a passage for by-passing fluid around said

confined space, and valve means below said second ported means for determining the flow of fluid through said lower section and between its interior and said by-pass passage.

10. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular body having upper and lower sections, opposed upper and lower packing members secured to said upper and lower sections, respectively, for sealing with said casing to define a confined longitudinal space therein, a first ported means for establishing communication between the interior of said upper section and said confined space, a second ported means for establishing communication between the interior of said lower section and said confined space, means for providing a passage for by-passing fluid around said confined space, valve means below said second ported means for determining the flow of fluid through said lower section and between its interior and said by-pass passage, said by-pass means comprising tubular means extending through said upper section and opening outwardly thereof above said upper packing member, tubular means extending through said lower section and opening outwardly thereof below said lower packing member, means for preventing passage of fluid between said tubular means and sections within said body, and a spacer pipe connecting said upper and lower sections together and communicating with both of said tubular by-pass means.

11. A device adapted to be connected to a tubular string for operation in a well, including a tubular body having upper and lower sections, opposed upper and lower packing members secured to said upper and lower sections, respectively, for sealing with said casing to define a confined longitudinal space therein, ported means for establishing communication between said body and said confined space, and means for providing a passage for by-passing fluid around said confined space comprising tubular means extending through said upper section and opening outwardly thereof above said upper packing member, tubular means extending through said lower section and opening outwardly thereof below said lower packing member, means for preventing passage of fluid within said body between said tubular means and sections, and a tubular member communicating with both of said tubular by-pass means and connecting said upper and lower sections together in spaced relation.

12. A device adapted to be connected to a tubular string for operation in a well, including upper and lower tubular sections longitudinally separated from one another, opposed upper and lower packing members secured to said upper and lower sections, respectively, for sealing with said casing to define a confined longitudinal space therein, ports in said tubular sections for establishing communication between said sections and said confined space, a by-pass extending from below the lower packing member to above the upper packing member and comprising a tubular member connected to said sections to bridge the longitudinal distance therebetween and secure them together in spaced relation, and means for preventing direct passage of fluid between said by-pass and said sections.

13. A device adapted to be connected to a tubular string for operation in a well, including upper and lower tubular sections longitudinally separated from one another, upper and lower packing members around said upper and lower

sections, respectively, for sealing with said casing to define a confined longitudinal space therein, ports in said tubular sections for establishing communication between said section and said confined space, means for providing a passageway for by-passing fluid around said confined space comprising a tubular member connected to said sections to bridge the longitudinal distance therebetween and secure them together in spaced relation, and means for preventing passage of fluid directly between said by-pass passageway and said sections.

14. A device adapted to be connected to a tubular string for operation in a well, including upper and lower sections longitudinally separated from one another, upper and lower packing members around said upper and lower sections, respectively, for sealing with said casing to define a confined longitudinal space therein, ports in said tubular sections for establishing communication between said sections and said confined space, means for holding said sections in spaced relation with respect to each other comprising a passageway for by-passing fluid around said confined space, and means for preventing direct flow of fluid between said by-pass passageway and said sections.

15. In the placing of cement through an opening in the casing of a well with a tool suspended within the casing from a tubing and provided with vertically spaced packing means for sealing off a localized zone in the casing therebetween, said tubing being adapted to communicate with the localized zone, the steps which comprise; bringing the tool into position in the casing with the packing means located at opposite sides of the opening in the casing to seal off a localized zone in the portion of the casing containing the opening; forcing cement down the tubing into the localized zone and through the opening; and thereafter, while maintaining the tool positioned with the packing means located at opposite sides of the opening, forcing liquid down the casing around the tubing, through the localized zone, and up through the tubing, the flow of said liquid from the casing into the tubing being substantially wholly through said localized zone between the packing means, whereby cement is substantially completely removed from said zone by the flushing action of said liquid while maintaining in said zone a fluid pressure at least equal to the hydrostatic head of the liquid in the entire length of the tubing above the tool.

16. In the placing of cement through an opening in the casing of a well with a cementing tool of the type suspended within the casing from a tubing and provided with upper and lower packers sealing with the interior of the casing at vertically spaced positions to seal off a portion of the casing therebetween, and having a cementing port providing communication between the tubing and the portion of the casing between the packers, the steps which comprise: bringing the tool into a cementing position to seal off a localized zone in the portion of the casing containing the opening; forcing cement down the tubing through the cementing port and through the localized zone into and through the opening; and thereafter retaining the tool in said cementing position until the cement around the opening has taken at least an initial set, while maintaining the tubing full of liquid to maintain in said zone a fluid pressure at least equal to the hydrostatic head produced by the liquid in the tubing; and during at least part of the time said tool is so retained in said

cementing position, forcing liquid down the casing around the tubing and into the localized zone, and thence through the cementing port and up through the tubing, the flow of said liquid from the casing into the tubing being substantially wholly through said localized zone between the packing means, whereby cement is substantially completely removed from said zone by the flushing action of said liquid while maintaining such fluid pressure in said zone.

17. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, a by-pass extending from below the lower packing member to above the upper packing member, said body having passage means for conducting fluid between said string and the space between said packing members, said passage means also being communicable with said space and said by-pass, and valve means for controlling flow of fluid between said passage means and by-pass to enable pressure to be built up in the fluid within said space when said valve means is closed.

18. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, a fluid by-pass extending from below the lower packing member to above the upper packing member, said body having fluid passage means communicable with said by-pass, said passage means also having a fluid exit between said packing members, and valve means in the path of fluid flow through said passage means for controlling flow of fluid between said passage means and by-pass.

19. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing and having a first passage to receive fluid from said string and discharge it into the space between said packing members, a by-pass extending from below the lower packing member to above the upper packing member, said body having a second passage to receive fluid from said space and which is communicable with said by-pass, and valve means in the path of fluid flow through said second passage for controlling flow of fluid between said second passage and by-pass.

20. 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 movement of said body with respect to said slidably mounted means, to open said valve means.

21. 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 movement of the body relative to the casing to open said valve means.

22. 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 movement of the body relative to the casing to open said valve means.

23. 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 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 movement of the body relative to the slidably mounted means to positively open the check valve.

24. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body being provided with fluid passage means having a fluid exit between said packing members and terminating at a point below said fluid exit, valve means in the path of fluid flow through said passage means and positioned below said fluid exit

for controlling flow of fluid from said passage means, and a fluid by-pass extending from below the lower packing member to above the upper packing member.

25. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing, said body being provided with fluid passage means having a fluid exit between said packing members and terminating at a point below said fluid exit, a fluid by-pass extending from below the lower packing member to above the upper packing member, and downwardly seating valve means in the path of fluid flow through said passage means and positioned below said fluid exit for determining the flow of fluid through said exit and between said fluid passage means and by-pass.

26. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing means for sealing with said casing and having a first passage to receive fluid from said string and opening into the space defined between said packing members, and a second passage opening into said space to receive fluid from said space, means for preventing direct passage of fluid between said first and second passages through the interiors thereof, valve means in the path of fluid flow through said second passage and positioned below said first passage for controlling flow of fluid through said second passage, and a by-pass extending from below the lower packing member to above the upper packing member and communicable with said second passage when said valve means is in open position.

27. A device adapted to be connected to a tubular string for operation in a well casing, including a body carrying spaced upper and lower packing members for sealing with said casing and having a first passage to receive fluid from said string and opening into the space defined between said packing members, a by-pass extending from below the lower packing member to above the upper packing member, said body having a second passage communicable with said by-pass and opening into the said space, means for preventing direct passage of fluid between said first and second passages through the interiors thereof, and valve means in the path of fluid flow through said second passage for controlling flow of fluid between said second passage and by-pass.

28. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular member having upper and lower sections, upper and lower packing members around said tubular member for sealing with said casing to define a confined longitudinal space therein, a first port in said upper section for establishing communication between the interior of said upper section and said confined space, a second port in said lower section for establishing communication between the interior of said lower section and said confined space, means for preventing passage of fluid between said upper and lower sections through the interiors thereof, means providing a passage extending from a point below said lower packing member to a point above said upper packing member for by-passing fluid around said confined space, and valve means for determining the flow of fluid between the interior of said lower section and said by-pass passage.

29. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular member having upper and lower sections, upper and lower packing members around said tubular member for sealing with said casing to define a confined longitudinal space therein, a first port in said upper section for establishing communication between the interior of said upper section and said confined space, a second port in said lower section for establishing communication between the interior of said lower section and said confined space, means for preventing passage of fluid between said upper and lower sections through the interiors thereof, means providing a passage extending from a point below said lower packing member to a point above said upper packing member for by-passing fluid around said confined space, and valve means in the path of fluid flow through said lower section for determining the flow of fluid between the interior of said lower section and said by-pass passage.

30. A device adapted to be connected to a tubular string for operation in a well casing, including a tubular member having upper and lower sections and an intermediate section connecting said upper and lower sections in spaced relation, upper and lower packing members around said tubular member for sealing with said casing to define a confined longitudinal space therein, a first port in said upper section for establishing communication between the interior of said upper section and said confined space, a second port in said lower section for establishing communication between the interior of said lower section and said confined space, means for preventing passage of fluid between said upper and lower sections through the interiors thereof, means including said intermediate section providing a passage extending from a point below said lower packing member to a point above said upper packing member for by-passing fluid around said confined space, and valve means for determining the flow of fluid between the interior of said lower section and said by-pass passage.

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