

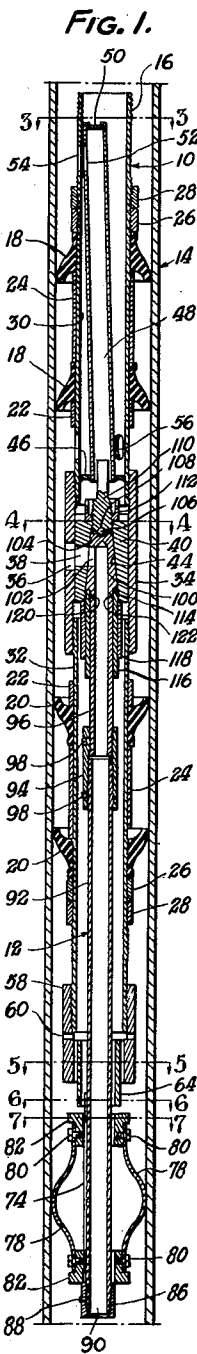
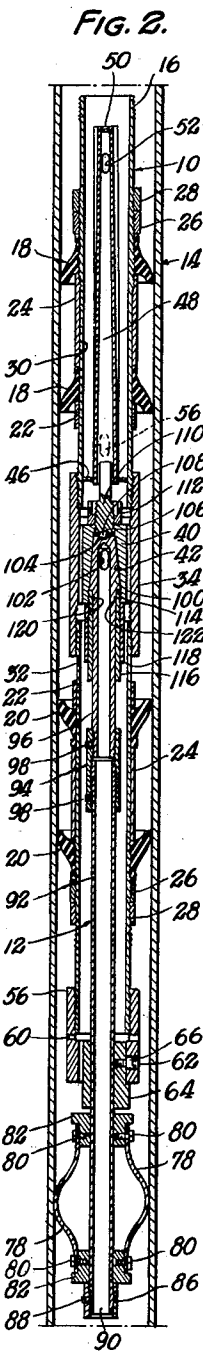
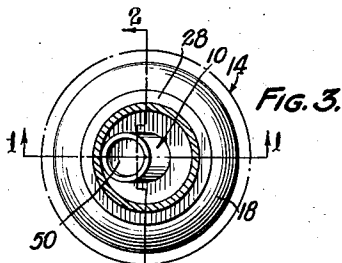
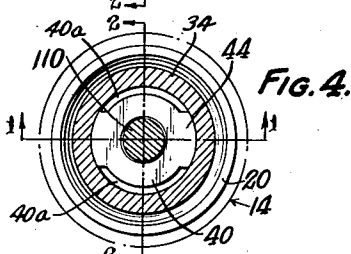
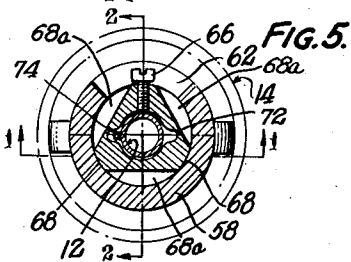
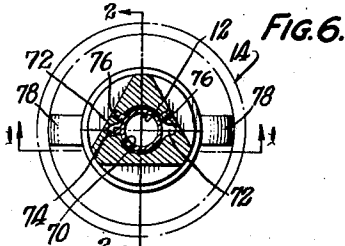
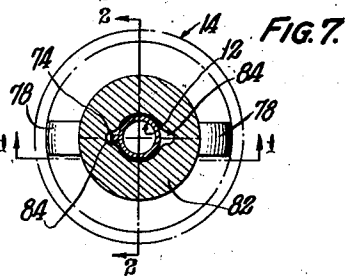
Sept. 25, 1951

A. P. SPRINGER
WELL APPARATUS

2,569,026

Filed Dec. 9, 1946

3 Sheets-Sheet 1



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WELL APPARATUS

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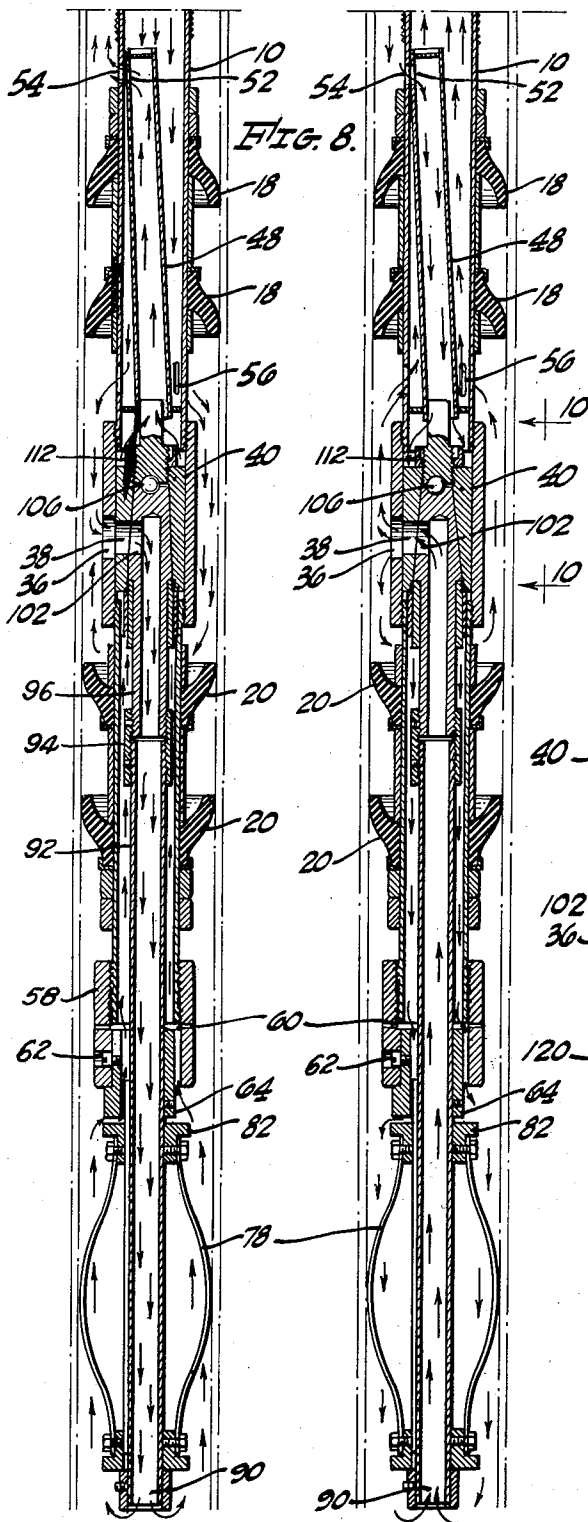
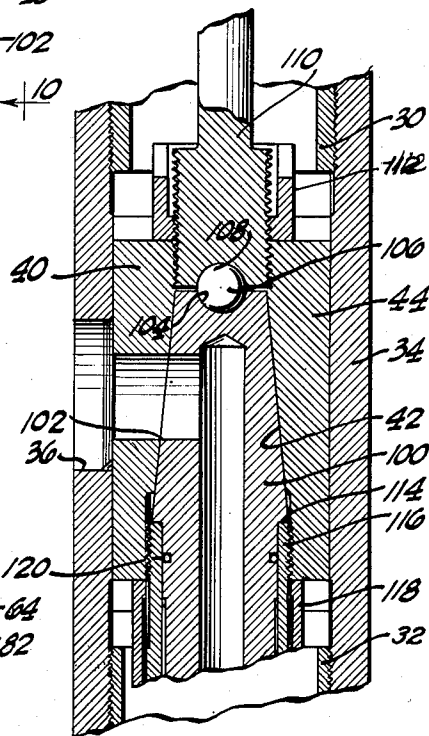


FIG. 9.

FIG. 10.



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3 Sheets-Sheet 3

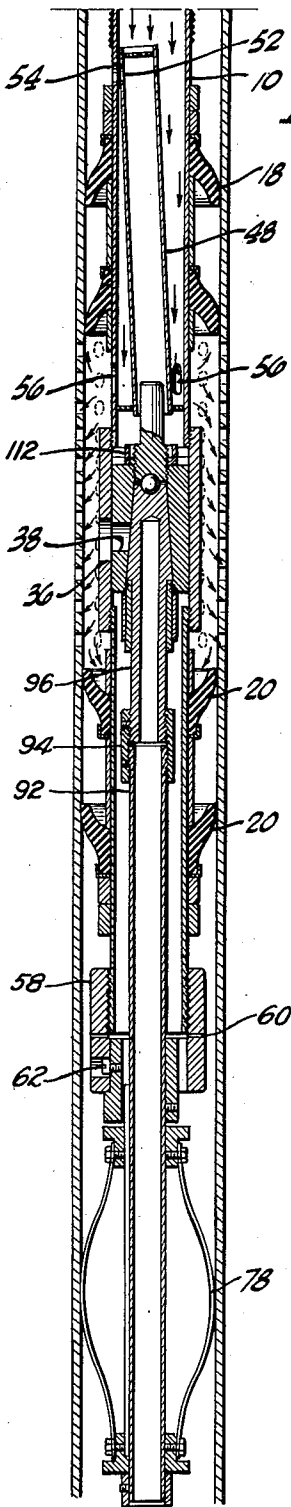


FIG. 11.

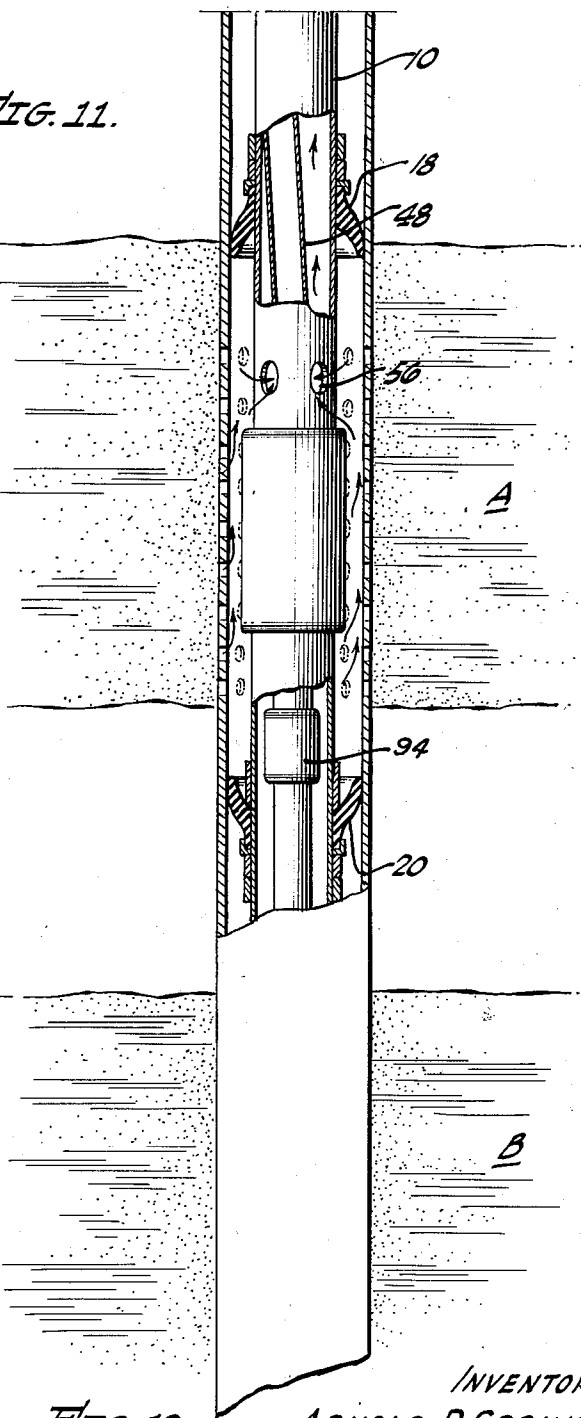


FIG. 12.

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UNITED STATES PATENT OFFICE

2,569,026

WELL APPARATUS

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Application December 9, 1946, Serial No. 714,973

10 Claims. (Cl. 166—11)

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In well drilling operations, the time consumed during the introduction and removal of various tools represents a major item of the total operating costs. In accordance with usual existing practices, after a cementing operation, the string is removed from the casing in order that a drill may be introduced to remove the plug. If this is to be followed by a testing or acidizing operation, it is then necessary to remove the drill and introduce other apparatus especially intended to serve these purposes.

When it is realized that many of these operations are performed at great depths below the earth's surface, the time and expense occasioned by such manipulation will be recognized and the elimination of many of these tool interchanging procedures will be appreciated, particularly by those skilled in the art.

The apparatus of the present invention is eminently suited for cementing, washing, testing, acidizing, and removal of bridges or other deposits by washing straight ahead or by back scuttling. The apparatus is adapted for introduction into a well casing and comprises a tubular body carrying spaced packers which cooperate with the internal wall of the casing, to define a chamber which will be closed with respect to the spaces above and below the packers. A plurality of independent passages extend longitudinally within the tubular body, one of the passages extending beyond the packers and another of the passages having a port opening radially with respect to the body intermediate of the packers. As a matter of fact, under certain conditions there will be a plurality of passages having ports opening radially of the body intermediate of the packers. Means may be provided to control one or more of the ports opening intermediate of the packers, which means may comprise a valve operable from above ground. The passages extending through the tubular member preferably communicate with the casing below the packers and at least one of the passages preferably communicates with the casing above the packers. The means for controlling the port or ports will preferably be located in the tubular body intermediate the packers. The tubular body preferably comprises a tubular member forming a part thereof and relatively rotatable with respect thereto, the relatively movable valve members being secured respectively to the tubular body and tubular member. The tubular member preferably carries means for frictionally engaging the inner wall of the casing so that when the tubular body is rotated through a predetermined angle from above

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ground, the tubular member will remain stationary, thus opening or closing the valve, depending upon the direction of rotation and the condition of the valve before such rotation. The independent rotation of the tubular body with respect to the tubular member is preferably limited by suitable means such as a pin and slot connection. The valve seat may be formed in an element of spider-like configuration to provide for the passage of fluid around and independently of the valve itself. The valve seat is preferably secured to the tubular body, the tubular member depending therefrom having the valve plug secured thereto. The clearance between the valve seat and its plug is preferably adjustable to compensate for wear and to assure proper operation of the valve. Towards this same end, a thrust bearing is preferably arranged between the valve plug and its seat, which bearing may assume the form of a ball interposed between these elements.

With the valve closed, the apparatus is well suited for cementing and testing and with the valve open, the apparatus is particularly well adapted for washing bridges, back scuttling, acidizing and other uses which will readily suggest themselves to oil field operators.

A more complete understanding of the invention will follow from a detailed description of the accompanying drawings wherein:

Fig. 1 is a sectional elevation of the apparatus depicting the relationship of parts with the valve open;

Fig. 2 is a sectional elevation taken at right angles to Fig. 1;

Fig. 3 is a section taken along line 3—3 of Fig. 1;

Fig. 4 is a section taken along line 4—4 of Fig. 1;

Fig. 5 is a section taken along line 5—5 of Fig. 1;

Fig. 6 is a section taken along line 6—6 of Fig. 1;

Fig. 7 is a section taken along line 7—7 of Fig. 1;

Fig. 8 is a vertical cross-sectional view of the device illustrating the manner in which circulation is established to remove a sand bridge which may be encountered as the device is lowered into a hole;

Fig. 9 is a vertical cross-sectional view of the device showing the manner in which circulation can be reversed to remove cement and sand from the extreme bottom of the well;

Fig. 10 is an enlarged vertical cross-sectional view of the valve portion of the device;

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Fig. 11 is a vertical cross-sectional view of the device illustrating the manner in which a cementing operation is carried out; and,

Fig. 12 is a combined vertical cross-sectional and elevational view of the device being used for testing a particular portion of a formation.

The apparatus comprises a tubular body 10 which has depending therefrom a tubular member 12 of smaller diameter, adapted to be suspended from tubing or a string not shown and lowered into a casing 14 depicted in broken lines. The tubular body has an upper threaded end 16 for attachment to a drill string and is provided with an upper pair of packers 18 and a lower pair of packers 20. The proximate packers of the pairs are located axially of the tubular body by collars 22 which may be welded in position with respect to the tubular body, the two packers constituting a pair being spaced from one another by spacing sleeves 24. The remote packers of the two pairs are adjusted with respect to their spacing sleeves by means of retainer nuts 26 threaded on the tubular body and are held against accidental movement by means of locking nuts 28 likewise threaded upon the tubular body.

Interposed between the proximate packers and threaded to upper and lower sections 30 and 32 respectively of the tubular body, is a valve body 34 having a radial port 36, in registry with a radial port 38 formed in a spider 40 which defines a frusto conical valve seat 42, the arms 44 of the spider being secured to the valve body by means of welding and the exterior faces of said spider forming vertically extending passages 40a with the interior of body 34. An annular partition 46 is secured within the upper section of the tubular body near its lower end, as by welding, the central portion of the annular partition receiving the end of a tubular conduit 48 whose axis is inclined with respect to that of the tubular body so that its upper end will be located adjacent the inner wall of the tubular body and secured thereto by welding. The extreme upper end of the tubular conduit is closed by means of a cap 50, below which but above the upper packers there is provided a radial port 52 in registry with a radial port 54 formed through the wall of the tubular body. Below the upper pair of packers, but above the annular partition 46, the tubular body is provided with a plurality of radial ports 56.

The lower end of the tubular body lower section 32 is threaded to receive a sleeve 58 containing a plurality of radial ports 60 and a radial arcuate slot 62 which serves to limit relative rotation of a shouldered plug 64 articulated thereto by a fillister headed screw 66. The reduced portion of the plug 64 received within the sleeve 58 has a polygonal periphery, the prominences 68 thereof serving to center it within the sleeve and form vertically extending passages 68a therewith. An enlarged portion of the plug 64 extends beyond the sleeve 58 and has a periphery similar to that of its reduced portion, the shoulder formed between the enlarged and reduced portions limiting the position of the plug axially with respect to the sleeve. The plug is provided with an internal bore 70 to receive the lower end of the tubular member 12, the plug having diametrically disposed keyways 72, one of which loosely receives a key 74 secured to the lower end of the tubular member as by welding. The shouldered plug is further secured to the tubular member to prevent relative axial movement by means of one or more set screws 76. To the end of the tubular member 12 extending be-

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low the shouldered plug 64, there is applied a plurality of bowed drag springs 78 whose ends are secured by screws 80 to shouldered drag spring collars 82, one or both of which may move axially with respect to the tubular member, but which are retained nonrotatable with respect thereto by means of one or more keyways 84 receiving the key 74. This drag spring assembly is retained on the tubular member by means of a collar 86 fixed near the extreme lower end of the tubular member by means of a suitable number of set screws 88. The lowermost end of the tubular member is open to define an axial port 90.

The lower section 92 of the tubular member has its upper end threaded to receive a coupling sleeve 94 whose upper end is threaded to receive the lower threaded end of the upper section 96 of the tubular member. The coupling sleeve 94 is provided with set screws 98 to secure it in adjusted position with respect to the sections of the tubular member.

The upper end of the tubular member terminates in a valve plug 100 having a radial port 102 for selective registry with the radial ports 36 and 38 of the spider and valve body respectively. The upper radial surface of the plug contains an arcuate depression 104 serving as a lower seat for a ball thrust bearing 106. An upper seat 108 of similar configuration is formed in the lower radial end of an adjusting screw 110 threadedly received in the upper end of the spider 40, to which it is secured in locked position by means of a castellated locking nut 112 threadedly mounted on the adjusting screw.

The lower end of the plug 100 is defined by a shoulder 114, in bearing relationship with which is the end of an adjusting sleeve 116 whose upper end is threaded into the lower end of the spider. Externally threaded on the adjusting sleeve there is provided a locking sleeve 118 the upper end of which bears upon the lower radial surface of the spider when the parts have been properly adjusted to assure correct operation of the valve with regard to fluid tightness and proper clearance. The tubular member contains an annular groove 120 below the valve plug to receive a packing 122 which may be of the O-ring type.

As shown in Figs. 1 and 8 of the drawings, the valve is open. Inasmuch as the drag springs 78 frictionally engage the inner wall of the casing, when it is desired to close the valve it is only necessary to rotate the tube or string from above ground through a suitable angle of predetermined magnitude.

When bridges are encountered as may best be seen in Fig. 8, and it is desired to effect straight through washing, fluid will be introduced through the drill string entering the tubular body at its upper end, flowing radially through the ports 56 into the chamber defined between the packers and the well casing, reentering the tubular body through the radial ports 36, 38 and 102, flowing down the tubular member 12 against the bridge through the axial port 90, passing upwardly with the deposits externally of the tubular member and entering the tubular body between the shouldered drag spring collar 82 and the shouldered plug 64 as well as through the radial ports 60, around the spider 40, into the tubular conduit 48, and radially therefrom through the ports 52 and 54 for expulsion above the packers.

When it is desired to effect back scuttling as best seen in Fig. 9, fluid will be introduced through the radial port 54, producing a reversal of the flow just described, delivery then being

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through the upper axial end of the tubular body 10.

When it is desired to perform a cementing or testing or comparable operation as best seen in Fig. 11, the drill string is rotated sufficiently to close the valve whereupon fluid introduced through the upper end of the tubular body will flow radially from the ports 56 into the chamber defined by the packers and the well casing to cement off a formation occurring in that region. As is customary in such cases, the casing may be perforated at this region so that the green cement will flow to the desired point.

It will be seen that in all conditions of operation, the fluid pressure applied to the chamber between the packers and the casing wall will tend to expand the packers into fluid tight relationship with the wall.

My device with the valve closed as shown in Fig. 11 may also be used for locating possible leaks in the casing. The tool is lowered in steps, with each one of the steps constituting a vertical interval of the casing which is tested by applying fluid pressure through the tubing or drill string to the body 10, with the fluid flowing through the ports 56 to apply pressure to the chamber formed between the packers 18. In the event there is no leak in the casing the fluid flowing downwardly through the tubing to the body 10 cannot escape, and the pressure on the pump will rise until the pump stalls. However, should there be a leak in the casing the fluid will flow therethrough, and the pressure on the fluid being pumped will not rise, or rise more slowly than when no leak is encountered. By lowering the tool in steps, and conducting the above operation, the desired section of the casing can be tested. Should a leak be encountered it may be cemented by pumping cement downwardly through the tubing to the body 10, and through the ports 56 to complete this operation as may be seen in Fig. 11. Excess cement and sand is removed from the device by back scuttling as previously discussed and shown in Fig. 9 without removing it from the hole.

It will be understood that the apparatus of the present invention may be attached to the lower end of a drill pipe or string or to the well tubing itself in performing the various operations described.

Whereas this invention has been described with respect to a specific embodiment of apparatus conforming thereto, this example should not be construed as limiting beyond the scope of the appended claims.

I claim:

1. A device adapted to be connected to a tubular string for operation in a well casing that includes: 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 port formed at the extreme lower end of said body; a bypass extending from a point below said lower packing member to a point above said upper packing member; valve means in the path of fluid flow through said passage means, with said valve when in the closed position enabling pressure to be built up on the fluid within said space, and when in the open position causing all fluid circulated through said body between said bypass and string to flow under and through said port for washing purposes; and

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means to open or close said valve means by movement of said string.

2. A device adapted to be connected to a tubular string for operation in a well casing that includes: 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 port formed at the extreme lower end of said body; a bypass extending from a point below said lower packing member to a point above said upper packing member; valve means positioned in said body between said packing members, with said valve when in the open position permitting fluid communication between said space and said passage means leading to said port whereby fluid circulated through said body between said string and bypass must flow through and under said port for washing purposes, and said valve when in the closed position permitting pressure to be built up on fluid in said space; and means to open or close said valve by movement of said string.

3. A device adapted to be connected to a tubular string for operation in a well casing that includes: 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 port formed at the extreme lower end of said body; a bypass extending from a point below said lower packing member to a point above said upper packing member; rotary valve means positioned in said body between said packing members, with said valve when in the open position establishing communication, without vertical movement of said body, between said string and said bypass whereby all fluid circulated through said body must flow through and under said port for washing purposes, and said valve when in the closed position permitting pressure to be built up on fluid in said space; and means to open and close said valve by rotation of said string.

4. A device adapted to be connected to a tubular string for operation in a well casing that includes: an upper tubular section that may be affixed to said string and having a port formed therein; a lower tubular section; a rotary valve body rigidly connecting said sections, and said body having a radially positioned port formed therein; a packing member mounted on said upper section above said port and an oppositely disposed packing member mounted on said lower section, with said members sealing with said casing and forming a confined space therewith; a tubular member longitudinally positioned in said lower section and extending downwardly therebelow; means to rotatably support said member in said lower section; a valve plug rigidly mounted on the upper end of said tubular member and rotatably seated in said body, with said plug having an upwardly extending bore that is in communication with said tubular member and a radially positioned port formed in said plug; a bypass extending from below said lower packer to above said upper packer; and spring means non-rotatably affixed to said tubular member that frictionally engage said casing to permit said string to rotate said valve body relative to said plug without vertical movement of said body whereby when said ports in said valve body and plug are in alignment all fluid circulated between

said string and bypass must flow through and under the extreme lower end of said tubular member for washing purposes, and said ports when not in alignment preventing circulation of fluid between said string and bypass whereby pressure may be built up on fluid in said space.

5. A device adapted to be connected to a tubular string for operation in a well casing that includes: an upper tubular section that may be affixed to said string and having a port formed therein; a lower tubular section; a tubular valve body rigidly connecting the inner ends of said sections, and said body having a radial port formed therein; a packing member mounted on said upper section above said port and an oppositely disposed packing member mounted on said lower section, with said members sealing with said casing and forming a confined space therewith; a spider that defines a frusto-conical valve seat mounted within the confines of said valve body, with said spider having a lateral port that is in alignment with said port formed in said body; a valve plug that rotatably engages said seat, with said plug having a longitudinally extending bore that is in communication with a lateral bore formed in said plug, and said lateral bore being alignable with said bores formed in said spider and valve body when said valve body is rotated relative to said plug; a partition positioned in said valve body above said spider, with said partition having a bore formed therein; a tubular member extending upwardly from said partition and in communication with the bore therein and a lateral bore formed in said upper section above said packer member mounted thereon; a tubular member rigidly affixed to the lower end of said valve plug and in communication with said longitudinally extending bore formed therein and extending longitudinally downward below the lower end of said lower section; a sleeve mounted on the lower end of said lower section that rotatably engages and supports said tubular member, and lateral ports formed in said sleeve that communicate through passages formed in said lower section and between said spider and valve body with said tubular member above said partition to provide a constantly open bypass; spring means non-rotatably mounted on the lower end of said tubular member that frictionally engage said casing and permit rotation of said string to rotate said valve body relative to said plug, with said valve when in the open position permitting circulation of fluid between said string and bypass, and all of said fluid so circulating being forced to flow through and under the lower end of said longitudinally positioned tubular member for washing purposes, and said valve when in the closed position forcing pressure to be built up in the fluid in said space.

6. A device adapted to be connected to a tubular string for operation in a well casing that includes: an upper and lower tubular section, with each of said sections having a packing member mounted thereon that seals with said casing to form a confined space between said packers, and said packer on said upper sections being situated above a lateral bore formed in said section; a tubular valve body that rigidly connects the inner ends of said sections and has a radial bore formed therein; a spider positioned in said valve body that defines a valve seat, with said spider having a lateral port in registry with said port formed in valve body; a valve plug rotatably seated in said spider, with said plug having a

lateral bore that may be aligned with said bores in said body and spider, and a downwardly and longitudinally extending bore that is in communication with said lateral bore; a tubular member rigidly affixed to the lower end of said valve plug and in communication with said bore formed therein, and extending downwardly through said lower section below the lower end thereof; spring means non-rotatably mounted on the lower end of said tubular member and frictionally engaging said casing to permit said sections to be rotated relative to said valve plug by said string when said upper section is mounted on the lower end thereof; a sleeve mounted on the lower end of said lower section and rotatably supporting said downwardly extending tubular member; and a constantly open bypass extending from a point below said lower packer to a point above said upper packer, with the bore in said valve plug when aligned with said bores in said body and spider permitting circulation of fluid between said tubing string and bypass, with all of said fluid so circulated being forced through and under the lower extremity of said downwardly extending tubular member for washing purposes, and said bore in said valve plug when not in alignment with said bores in said body and spider preventing circulation of fluid between said bypass and tubular string whereby pressure is built up on fluid in said confined space.

7. A device adapted to be connected to a tubular string for operation in a well casing that includes: an upper and lower tubular section, with each of said sections having a packing member mounted thereon that seals with said casing to form a confined space between said packers, and said packer on said upper section being situated above a lateral port formed in said section that provides communication between said space and said tubular string when said upper section is connected to said section; a tubular valve body rigidly connecting the inner ends of said sections and situated in said confined space, and formed with a radial port therein; rotary valve means rotatably positioned in said valve body; a tubular member rigidly connected to and extending downwardly from said valve means to below the lower end of said lower section, with said valve means when in one position establishing communication between said port in said valve body and said tubular member, and in another position blocking communication between said port and said tubular member; spring means non-rotatably mounted on the lower end of said tubular member that frictionally engage said casing to permit said valve body to be rotated relative to said valve means by rotation of said tubular string; and a constantly open bypass extending from a point below said lower packer to a point above said upper packer, with said valve means when in the open position permitting circulation of fluid between said tubular string and bypass, with all of said fluid so circulated passing through and under the lower extremity of said downwardly extending tubular member for washing purposes, and said valve means when closed preventing said circulation to build up pressure on said fluid situated in said confined space.

8. A device adapted to be connected to a tubular string for operation in a well casing that includes: an upper and lower tubular sections, with each of said sections having a packing member mounted thereon that seals with said casing to

form a confined space between said packers, and said packer on said upper section being situated above a lateral port formed in said section that provides communication between said space and said tubular string when said upper section is connected to said string; a tubular rotary valve body rigidly connecting the inner ends of said sections, with said body having a radial port formed therein; a valve plug rotatably mounted in said body, with said plug having a connecting lateral port and longitudinally extending bore formed therein; a tubular member rigidly affixed to said plug and in communication with said bore, and extending downwardly from said plug to below the lower end of said lower member; means to rotatably support said tubular member in said lower section; spring means affixed to the lower end of said tubular member and frictionally engaging said casing whereby said valve body may be rotated relative to said plug; and a bypass extending from a point below said lower packing member to a point above said upper packing member, with said valve body when rotated by said tubular string to a position where said bores are in alignment permitting circulation of fluid between said tubular string and bypass, with all of said fluid so circulated flowing through and under the lower extremity of said tubular member for washing purposes, and said valve body when rotated to a position where said ports are not in alignment preventing circulation of fluid and causing pressure to be exerted on said fluid in said confined space.

9. A device adapted to be connected to a tubular string for operation in a well casing that includes: a tubular body having two longitudinally spaced packing members mounted thereon that make sealing contact with said casing to form a confined space, with said body having a lateral port formed therein adjacent to said upper packer that permits communication between said space and tubular string when said body is affixed thereto; a partition formed in the upper portion of said body under said port; a tubular valve body forming a portion of said body between said packers and having a radial port formed therein; a valve plug rotatably mounted in said valve body, with said plug having a lateral port and longitudinally extending bore that may be placed in communication with said bore formed in said valve body by rotating said body relative to said valve plug; a tubular member extending downwardly from said plug to below the lower end of said body, with said member rigidly affixed to said plug and in communication with said bore formed therein; spring means non-rotatably mounted on

said tubular member that frictionally engage said casing to permit said body to be rotated relative to said plug to control flow of fluid therethrough; means to rotatably support said tubular member in said body; and constantly open bypass passage means extending upwardly in said body from a port in said body below said lower packer and through said partition to a port in said body above said upper packer, with said valve plug when in the open position allowing circulation of fluid between said tubular string and said bypass means, with all of said fluid so circulated flowing under and through the lower extremity of said tubular member for washing purposes, and said valve plug when in the closed position preventing said circulation and causing pressure to be exerted on said fluid in said confined space.

10. A device adapted to be connected to a tubular string for operation in a well casing that includes: 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 a port formed in said body between said packing members, and also between said space and a port formed in the extreme lower end of said body; a bypass extending from a point above said lower packing member to above said upper packing member; rotary valve means in the path of fluid flow through said passage means, with said valve when in the closed position enabling pressure to be built up on fluid within said space, and when in the open position causing all fluid circulated through said body between said bypass and string to flow under and through said port formed in the extreme lower end of said body for washing purposes; and spring means frictionally engaging said casing and non-rotatably affixed to a portion of said valve means whereby said valve may be opened or closed by said string rotating said body relative to said spring means.

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