

Aug. 18, 1936.

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2,051,713

SET SHOE SEAL AND SETTING TOOL

Filed Oct. 5, 1934

3 Sheets-Sheet 1

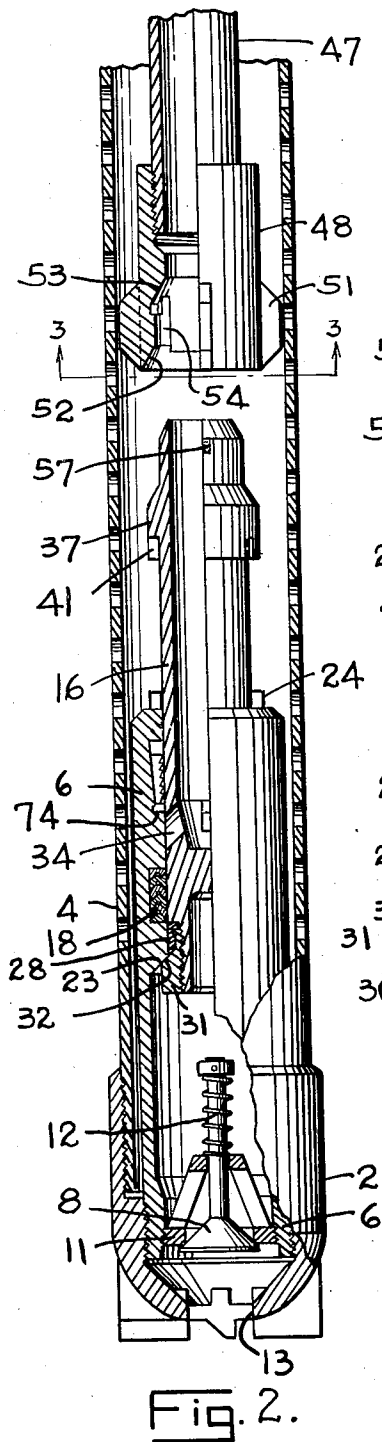


Fig. 2.

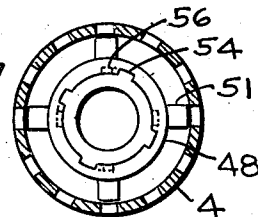
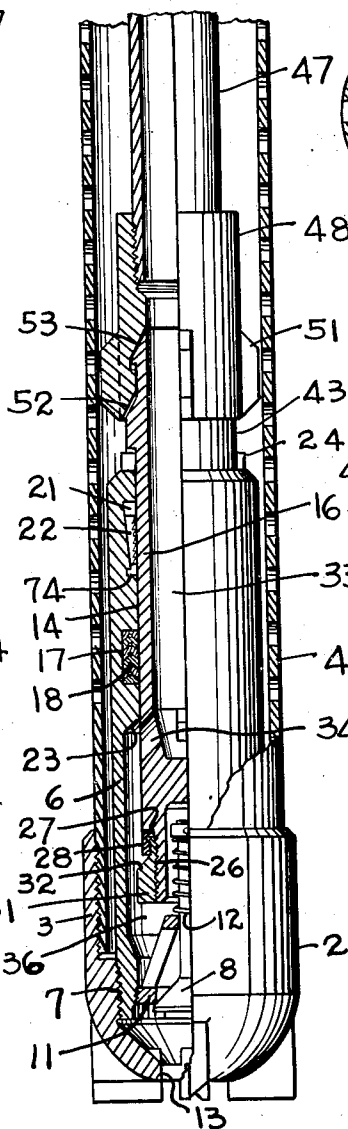


Fig. 3.

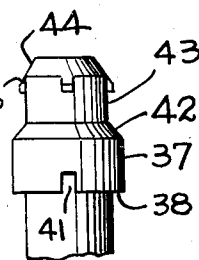


Fig. 4.

Fig. 1.

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3 Sheets-Sheet 2

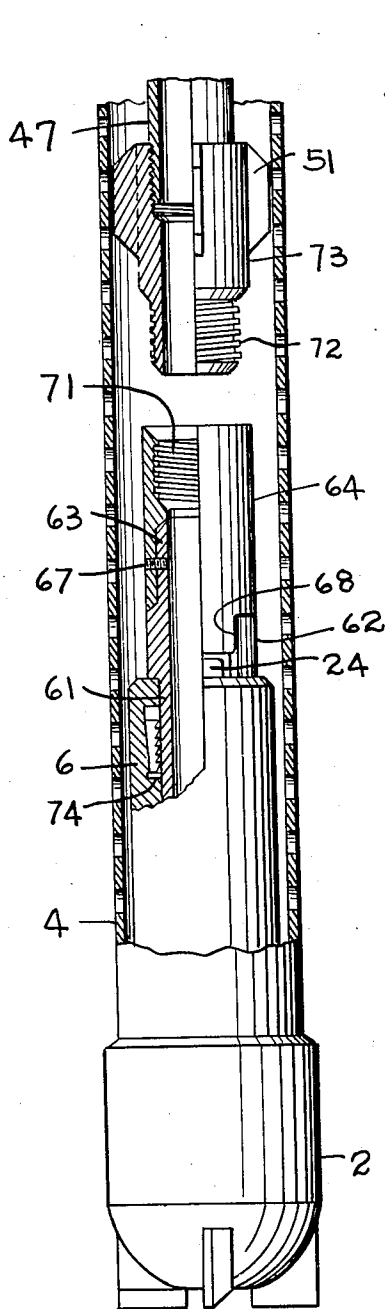


Fig. 5.

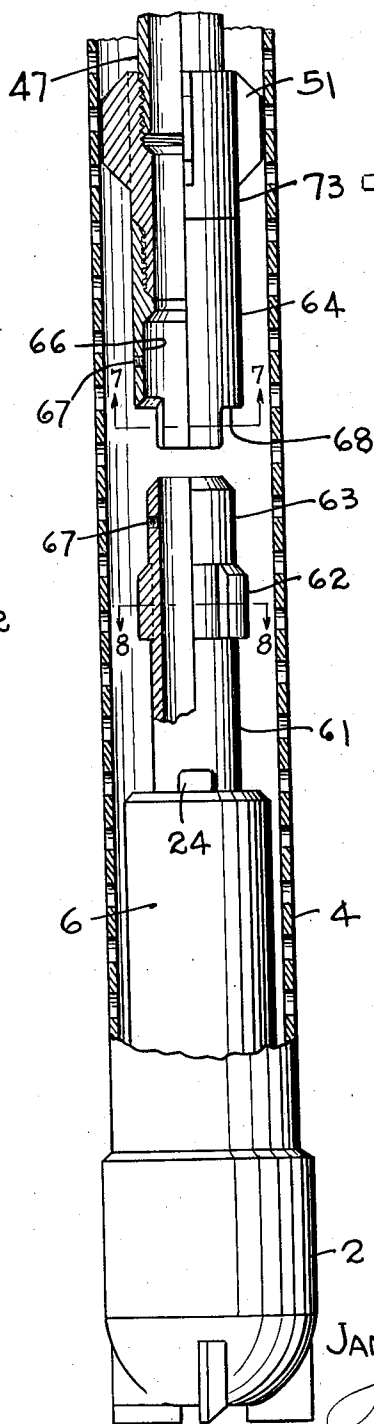


Fig. 6.

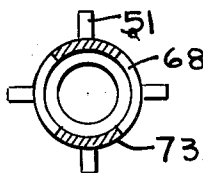


Fig. 7.

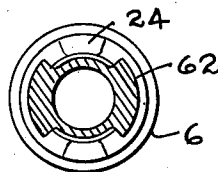


Fig. 8.

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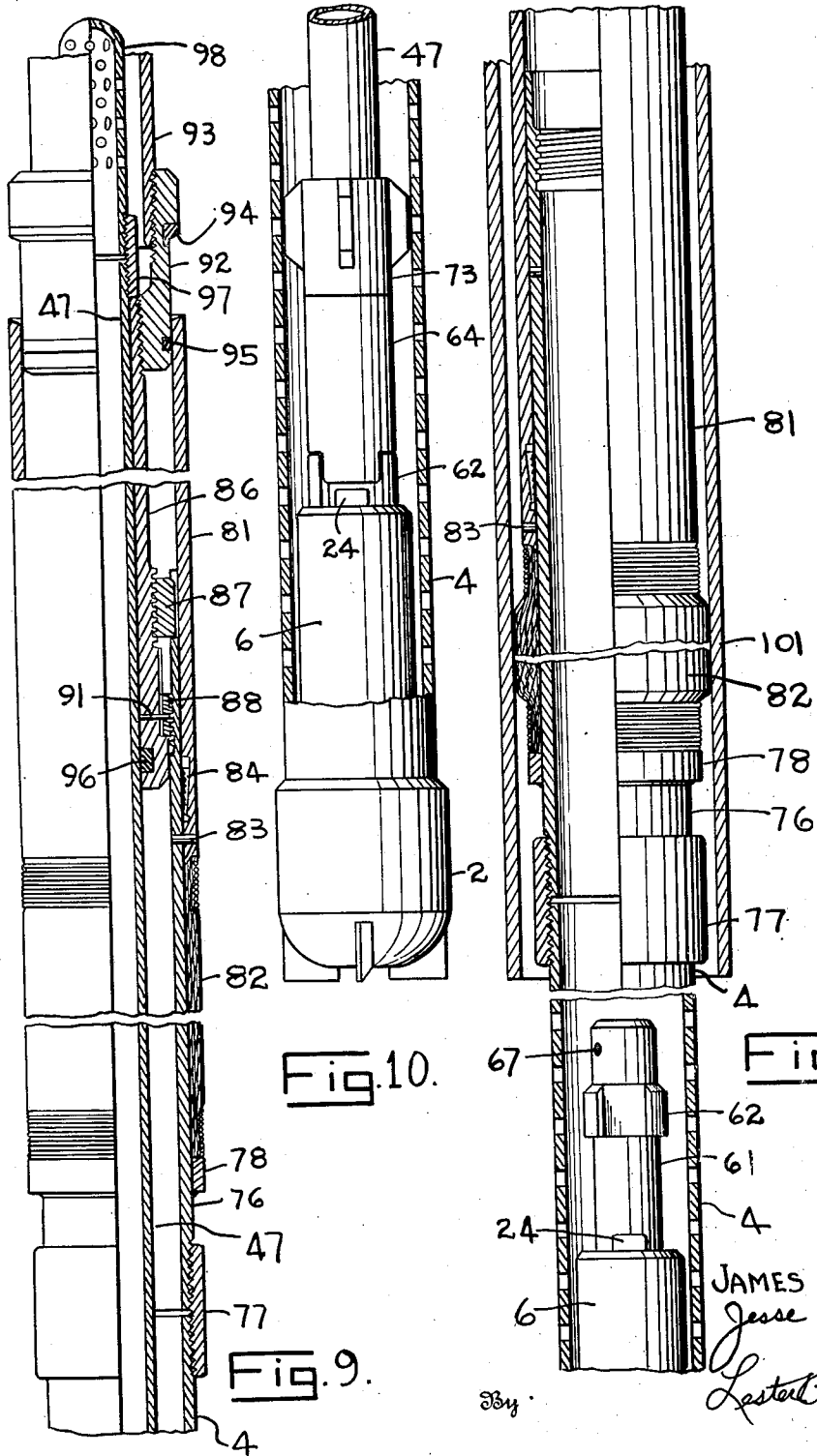
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SET SHOE SEAL AND SETTING TOOL

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,051,713

SET SHOE SEAL AND SETTING TOOL

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Application October 5, 1934, Serial No. 746,995

9 Claims. (Cl. 166—20)

The invention relates to set shoes for use on the lower end of pipe to be introduced into a well, and more particularly to set shoes having valves therein adapted to close the pipe against the entrance of fluids from the lower end thereof.

In lowering a screen or liner in a well preparatory to setting it, a set shoe is ordinarily used on the bottom of the screen or liner to guide the assembly into place, and such set shoes are generally provided with a check valve which permits fluid to be discharged from the liner but prevents the entrance of fluid into the liner.

Wells are washed clean by pumping a suitable fluid out through the check valve in the set shoe, and after the well has been washed it is essential that this valve effect a seal against the entrance of fluid into the liner past the valve so that the flow will be cut off except through the screen or perforated portion of the liner.

Single valves as are now employed frequently fail to seat or hold properly with the result that fluid enters therethrough, and a positive and dependable closure is not obtained.

It is an object of the invention to provide a set shoe which may be employed principally in setting screen, but which may also be employed on liners, packers, or sections of pipe when desired.

It is another object of the invention to provide a set shoe having, in addition to a check valve, a positive valve adapted to be permanently closed after the well is washed and the screen or liner is set.

Another object is to provide a set shoe having a releasable fluid connection thereabove, and a valve adapted to be permanently closed and adapted to be sealed by the action of fluid tending to leak past the check valve in the set shoe.

Another object of the invention is to provide a set shoe adapted to prevent the entrance of fluid at the lower end of a screen or liner, having a plurality of seals or closures in series, so that failure of any one will not destroy the efficacy of the tool.

A still further object is to provide a set shoe which may be permanently closed against the flow of fluid after the shoe and liner or screen have been lowered into position in a well.

It is an object of the invention to provide a set shoe which may be sealed against the ingress of fluid at separate points.

It also is an object of the invention to provide a combination of a packer, liner, setting string, wash pipe and set shoe.

It is another object to provide a tool which may be used to lower the liner, set the packer, wash

the well, permanently close the set shoe and be released from the liner and withdrawn.

These and other objects will be apparent when the following description is considered with the accompanying drawings, wherein:

Fig. 1 is a side elevation, partially in section, showing a set shoe embodying the invention as it is being lowered in a well.

Fig. 2 is a view similar to Fig. 1 showing the shoe in its set position with the wash or operating pipe 10 released.

Fig. 3 is a transverse sectional view taken on the plane 3—3 of Fig. 2 and in the direction indicated.

Fig. 4 is a view of a portion of the valve actuating stem.

Fig. 5 is the same view as shown in Fig. 1 but showing another form of release.

Fig. 6 shows the Fig. 5 form of the invention in its set position with the wash pipe and setting string released.

Figs. 7 and 8 are transverse sectional views taken on Fig. 6 on the planes 7—7 and 8—8, respectively, and in the directions indicated.

Fig. 9 is a partially sectional view of a packer and setting tool as they are lowered into a well.

Fig. 10 shows a view of the lower end of the assembly of Fig. 9 including a set shoe embodying features of this invention.

Fig. 11 is a view, partially in section, of the packer set in the casing and the upper end of the set shoe after the setting string has been withdrawn.

In Fig. 1 a set shoe is indicated generally at 2 and is threaded at 3 to receive a liner or screen 4. A hollow valve body 6 of such size to enter freely into the liner 4 is threadedly attached to the set shoe at 7 and provides an annular space inside the screen permitting the entrance of fluid through the screen at a point near the set shoe without obstruction from the valve body 6.

Within the lower end of the valve body 6 is a downwardly opening check valve 8 which seats in a cage 11 screwed into the valve body 6. The valve 8 is held yieldably closed by a spring 12. This valve is of usual construction and is adapted to permit the discharge of fluid out the opening 13 in the bottom of the set shoe, and to prevent any flow of fluid in the opposite direction.

The upper portion of the bore of the valve body 6 is reduced internally as at 14 and is adapted to receive the sleeve or slide valve 16 slidable axially therein.

Within the reduced bore 14 of the valve body 6 is an annular packing groove 17 into which suit-

able packing material 18 is fitted. A second annular groove 21 in the bore above said packing is tapered downwardly and inwardly. Slip segments 22 are positioned within the annular groove 21, and are adapted to engage the sleeve valve 16 and secure it against downward movement. An inclined shoulder 23 is formed in the valve body 6 immediately below the reduced portion 14.

The top end of the valve body 6 terminates in a plurality of upstanding lugs 24 which form a part of a dental clutch device.

The sleeve valve 16 is of generally cylindrical form and has a reduced threaded portion 26 on its lower end. A shoulder 27 is formed at the upper end of said reduced portion. A cup packing element 28 is adapted to pass over the threaded portion 26 and seat on the shoulder 27, and is clamped in place by a threaded follower 31. The packing 27 is of substantially the same outside diameter as the body of the slide valve 16.

It will be noted that the follower 31 is of greater outside diameter than the sleeve valve 16 and is provided with an inclined upper shoulder 32 which is adapted to engage the downwardly inclined shoulder 23 on the valve body to form a valve. It is contemplated that these two surfaces will be ground so as to form a seal when in contact.

The sleeve valve 16 is tubular and has fluid passage 33 axially thereof which communicates through a plurality of ports 34 with the enlarged portion 36 of the valve body 6.

As shown in Fig. 1 the ports 34 are formed in sleeve 16 adjacent the lower end of passage 33, when the valve 16 is in its lower position, and it will be seen that a limited upward movement of the sleeve valve 16 will move said ports 34 above the shoulder 23 and close the same. The lower end of the sleeve valve member is recessed to avoid contact with the stem of the valve 8.

The upper end of the valve 16 is formed into a head having an enlarged portion or collar 37, whose lower end forms a shoulder 38, as best seen in Figs 2 and 4. Notches 41 formed in the collar 37 are adapted to engage the upstanding lugs 24 as shown in Fig. 1, thus forming the mating member of the clutch, previously noted.

A tapered surface or seat 42 is formed on the top end of the collar 37. A cylindrical portion 43 of the slide valve 16 above the collar 37 terminates in the upwardly and inwardly tapered area 44. A plurality of radial lugs 46 are formed around the circumference of the cylindrical portion or extension 43, and these lugs have their upper surfaces inclined on the angle of the taper of the area 44.

With the sleeve valve 16 and the valve body 6 in the relative positions shown in Fig. 1 fluid may flow down through the passage 33 and out the ports 34 into the enlarged portion 36 of the valve body. From here it may continue out through the check valve 8 and opening 13.

A wash pipe 47 is provided which is understood as having connection with a setting string extending upwardly to the surface in the usual manner. It has a special lower connection or sub 48 threadedly attached to its lower end. The sub 48 has a plurality of centering ribs 51 around its outer surface as seen in Fig. 3. Downwardly flaring seats 52 and 53 in the sub 48 are adapted to mate with the tapered surfaces 42 and 44 respectively of the valve sleeve so that when the sub 48 is held against the slide valve 16 the mating seats will form a substantially fluid tight seal

connecting the wash pipe 47 with the interior 33 of the slide valve.

Axial grooves 54 connecting seats 52 and 53 in the sub 48 are adapted to receive the lugs 46 on the end 43 of the sleeve. Interior sockets 56 seen in Fig. 3, communicate circumferentially with the slots 54, and provide a bayonet slot connection into which the lugs 46 may be moved by relative rotation of the parts thus engaging the sleeve valve and sub against axial separation except by a rotation in the opposite direction or shearing off of the lugs 46.

It is contemplated that these lugs 46 will be sheared off in order to disengage the wash pipe from the set shoe after the washing operation has been completed and it is desired to remove the wash pipe. The lugs 46 are therefore made of such size as to be sheared off under a nominal strain without damage to other parts.

When the washing through the valve 8 has 20 been completed and it is desired to seal the set shoe permanently, the wash pipe 47 is pulled up, raising the sleeve valve to the position shown in Fig. 2 and a sufficient strain is applied to shear off the lugs 46. The sheared base of a lug is indicated at 57 in Fig. 2.

When the valve 16 is raised the ports 34 are covered, the cup packing 28 is carried into the lower end of the bore 14, and the faces 23 and 32 are brought together, thus forming a closed valve. Thus, in addition to the seal of the check valve 8, a seal is secured by the packing 18, the cup packing 28, and the ground joint between the faces 23 and 32, providing a total of four separate sealing points in series.

The sleeve valve 16 is retained in its upward position by the slip segments 22 which engage its outer surface.

In a modified form of the invention shown in Figs. 5 and 6 a slightly different form of sleeve valve is indicated at 61. Lugs 62, as seen in Fig. 8, are formed on the surface of the sleeve valve and are adapted to engage the upstanding lugs 24 on the valve body 6 to prevent relative rotation. It will be noted that the lugs 62 are of such length as to extend above the lugs 24. Above the lugs 62 is the cylindrical section 63. A coupling 64 has an interior bored portion 66 at its lower end adapted to telescope over the cylindrical section 63, and a threaded pin 67 is employed to lock the two telescoped parts together. Recesses 68 in the lower end of the coupling 64 engage the lugs 62.

The coupling 64 has a threaded box 71 therein. A sub 73, which is connected to the lower end of the wash pipe 47, has a pin 72 adapted to mate with the box 71.

When the wash pipe is to be attached to the set shoe preparatory to washing the well the parts are positioned as in Fig. 5. The sleeve valve 61 is in its downward position with its fluid ports open. The sub 72 is screwed into the coupling 64 which is held against rotation by the lugs 62 and lugs 24.

When the washing is completed the wash pipe 65 may be raised to close the slide valve 61, and further raising will shear off the pin 67 and disengage the coupling.

Should occasion subsequently arise requiring the opening of the valve 61 it is contemplated 70 that a string of pipe may be set on the upper end thereof forcing the valve and slips downward. The slip segments will encounter the shoulder 74 of the slot 21 which will limit the extent of their inward movement. While this 75

procedure of forcing the valve through the slips is not most desirable, it will permit the opening of the once closed valve:

The invention provides a set shoe which may be connected to a wash pipe for washing the well, and a check valve therein adapted to permit the discharge of the washing fluid. A secondary or auxiliary valve is provided which may be closed by raising the wash pipe; it is sealed at three different points, thus giving a total of four separate sealing points to prevent the entrance of any fluid through the set shoe, once it is closed. I am thus assured of a tight seal which will effectively close the passage through the set shoes in either direction.

Fig. 9 shows a setting tool similar to that disclosed in my Letters Patent No. 1,947,262, dated February 13, 1934.

A packer barrel 76 is attached to the upper end of the liner 4 by a collar 77, and has a ring 78 secured thereon. A compression sleeve 81 is adapted to slide over the barrel 76 and compress a suitable packing member 82 against the ring 78. A pin 83 of frangible material prevents premature expansion of the packing 82 and is adapted to be sheared off when it is desired to set the packer. Slip segments 84, housed in a recess in the inner face of the compression sleeve engage the packer barrel to lock the compression sleeve 81 in its downward position.

Packer mandrel 86 is slidable within the barrel 76 and is secured slidably thereto by the righthand threaded ring 87 and the lefthand threaded ring 88, which ring 88 is held in position by means of a pin 91 of friable material.

A special coupling 92 connects the mandrel 86 to a setting string or tubing 93. A ring of packing 95 seals between the special coupling 92 and the compression sleeve 81, and a lead faced shoulder 94 on the coupling 92 is adapted to engage the upper end of the sleeve 81.

It will be seen that a righthand rotation of the setting string, coupling and mandrel will release the mandrel from the barrel 76 by disengaging the threaded rings 87 and 88 and shearing the pin 91.

The wash pipe 47 extends upward through the mandrel 86, and a packing 96 in the mandrel seals therebetween. A coupling 97 on the top end of the wash pipe 47 receives a perforated nipple 98 which is closed at its upper end.

The coupling 97 is adapted to engage the top end of the mandrel 86 to limit the downward movement of the wash pipe therethrough.

When it is desired to set the packer within a casing 101 the setting string is rotated to disengage the mandrel within the barrel 76 and the setting string lowered so that the shoulder 94 engages the compression sleeve 81 and expands the packing 82 as seen in Fig. 11.

The well may now be washed through the setting string and wash pipe. When the washing is completed and it is desired to close the set shoe permanently the setting string and wash pipe are pulled up, closing the sleeve valve and releasing the wash pipe from the valve stem. The setting string is withdrawn from the well leaving the parts as shown in Fig. 11.

All of the apparatus is lowered on the setting string. The packer is set; the well washed and the set shoe permanently closed by means of the single setting string and the setting string is readily removable from the well.

What is claimed is:

1. A set shoe having in combination a down-

wardly opening check valve, a valve body in said shoe, a slidable valve member within said valve body, fluid ports in said valve member adapted to be opened and closed by movement of said valve member, and a plurality of sealing members adapted to seal between said valve member and valve body when said ports are closed.

2. In combination, a strainer pipe, a wash pipe, a set shoe on said strainer pipe, a check valve in said shoe adapted to permit a downward flow of fluid, a tubular valve body in said shoe, a sleeve valve slidable within said body, said sleeve having ports closable by movement of said sleeve valve, means engaging said sleeve valve to hold it in closed position, a plurality of sealing elements disposed between said sleeve valve and said body to provide a series of seals disposed below said ports when said sleeve valve is closed, and a releasable connection between said sleeve valve and said wash pipe whereby said sleeve valve may be closed.

3. A set shoe, a vertically slidable tubular valve body engaging within and projecting above said shoe, a sleeve valve in said body having ports adapted to be closed when said sleeve valve is raised, slip segments adapted to hold said sleeve valve in a closed position, a tapered valve seat in said body, a tapered surface on said sleeve valve adapted to engage said seat when the valve is raised to form a seal, and an additional pair of packing elements interposed between said valve and body whereby the valve and body are sealed together at three separate points when the valve is closed.

4. A set shoe, a tubular valve body engaging within and projecting above said shoe, a vertically movable sleeve valve in said body having ports adapted to be closed when said sleeve valve is raised, means to hold and prevent downward movement of said sleeve valve relative to said valve body, a tapered valve seal in said body, a tapered surface on said sleeve valve adapted to engage said seat when the valve is in raised position to form a seal, and an additional pair of packing elements interposed between said valve and body whereby the valve and body are sealed together at three separate points when the valve is closed.

5. A set shoe, a check valve therein, a valve body extending therefrom, a downwardly exposed seat in said body, a sleeve valve fitting slidably within said body and adapted to be moved longitudinally within fixed limits, a plurality of ports in said sleeve valve, adapted when said sleeve valve is sufficiently lowered, to be exposed below said seat and be opened, a packing member between said valve body and said valve, a plurality of sealing elements on said valve below said ports and adapted to engage said body when said valve is closed in its uppermost position, and means forming a fluid connection with said sleeve valve by means of which said valve may be closed, said means being engaged with said valve by relative rotation of the parts and disengaged therefrom by longitudinal pull on said means.

6. A set shoe, a housing attached thereto, a plurality of valves to seat in said housing, means to close one of said valves by an upward pull thereon, and means to latch said valve in said closed position.

7. In combination, a liner, a set shoe at the lower end thereof, a packer adjacent the upper end thereof, a valve body connected with said set shoe, a valve member longitudinally slidable therein, means to limit the movement of said

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valve member in said valve body, a combined setting tool and wash pipe, means thereon engaging said valve and adapted by an upward movement thereon to close said valve, and means to latch said valve in closed position.

- 5 8. In combination, a liner, a set shoe at the lower end thereof, a packer adjacent the upper end thereof, a valve body connected with said set shoe, a valve member longitudinally slidable therein, means to limit the movement of said valve member in said valve body, a combined setting tool and wash pipe, and a connection between said wash pipe and said valve whereby

said valve may be raised and closed, said connection being adapted to be released by a further upward pull thereon after said valve is closed.

9. In a device of the character described, a liner, a set shoe thereon, a tubular valve body in said liner, a valve sleeve movable longitudinally therein to open or closed position, means between said valve and said body to form a seal therewith, said sleeve having openings therein adapted to be closed by the movement of said valve to closed position, and means to hold said valve from opening thereafter.

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