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BACK PRESSURE PLUG VALVE

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Fig. 1.

Fig. 2.

Fig. 3.

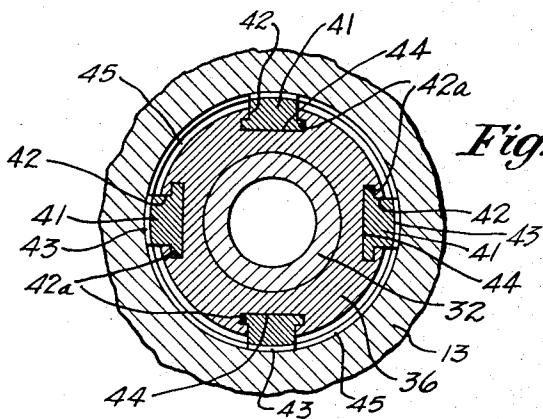
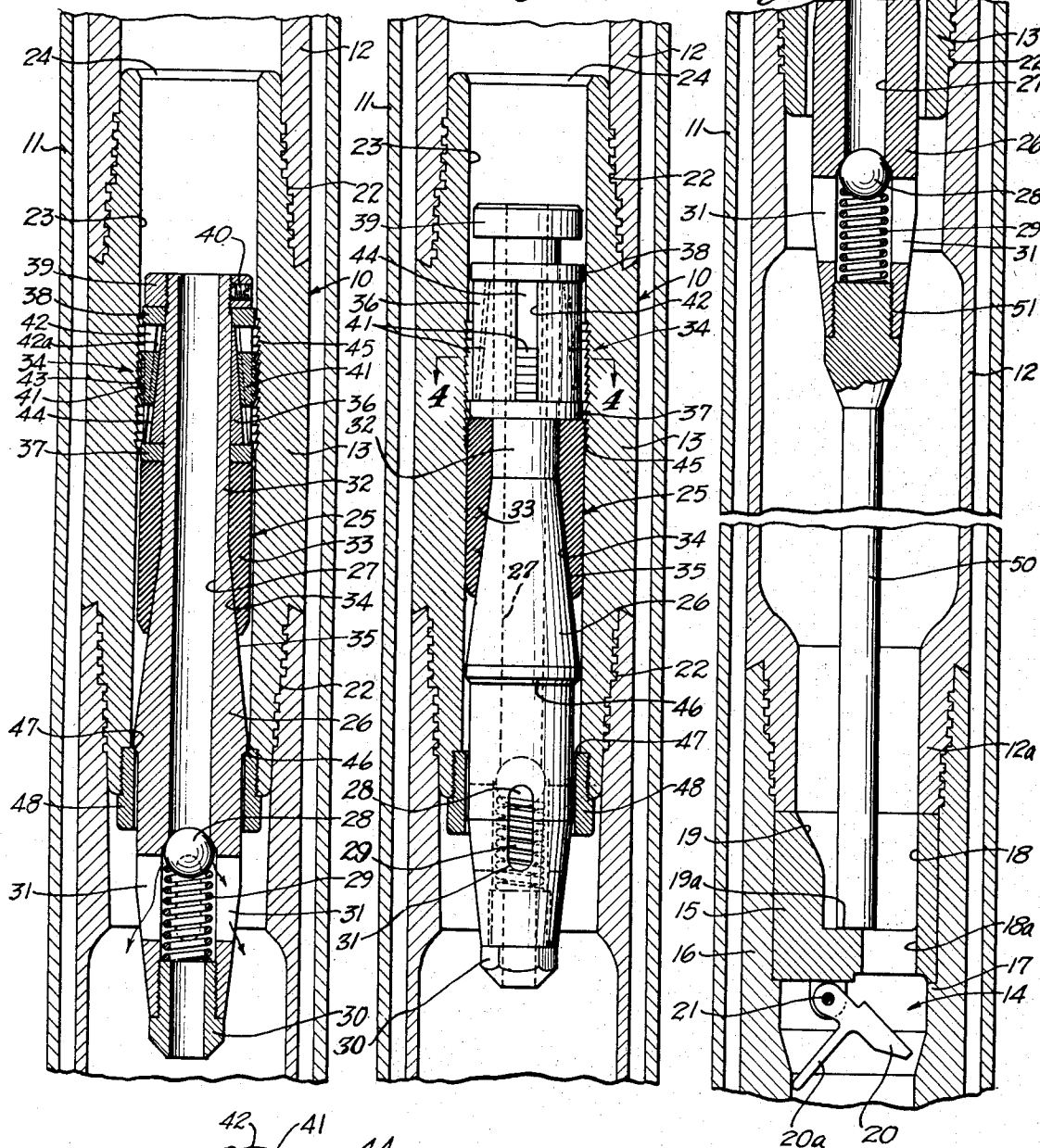


Fig. 4.

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BACK PRESSURE PLUG VALVE

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This invention relates generally to improvements in well pipe plugs or closures adapted to be dropped or forced downwardly through the pipe to a desired or predetermined depth to close the pipe against upward fluid flow. More specifically, the invention has to do with a drop-in or pump-down type back pressure valve for use in drilling operations to seal the drill pipe against the escape of well fluid in situations where the standard back pressure valve fails or is not used, or to provide an additional precaution against fluid escape at a time when the back pressure valve may still be in good condition.

The usual back pressure valve is carried by the drill string at or near its lower end, and the function of the valve is to pass the downward circulation, but to close the pipe against escape of well fluid during drilling operations and while the pipe string is being lowered into or pulled from the well. My general object is to provide a back pressure valve device that may be dropped or forced by fluid pressure down through the pipe to a predetermined position above the stationary back pressure valve, thus affording a safety check in the event the latter fails to function properly. In its preferred form, the present device comprises a body carrying a radially expansible packer, a valve controlled passage through the body, and means expansible into engagement with the pipe by upwardly directed fluid pressure, to hold the device against upward movement.

The device may be inserted in the drill pipe and dropped or forced down to seating position at a time when the standard back pressure valve is in good working condition, as for example during the time the circulating mud is being replaced with water before pulling the drill string. The drop-in valve device will reach its seat and remain in condition for the pipe engaging means and packer to be forced into engagement with the pipe to close the same, in the event the standard back pressure valve later fails. The device may be inserted in the usual lubricator pipe above the Kelly cock and pumped down or merely allowed to drop until it reaches seating position.

The various structural and functional aspects of the invention will be more fully understood from the following detailed description, in which reference is had to the accompanying drawing that is illustrative of the invention in certain typical and preferred forms.

Fig. 1 is a sectional view showing the drop-in back pressure valve device seated on the stop shoulder within a pipe coupling;

Fig. 2 is a view similar to Fig. 1 showing the

positions of the parts when an upward pressure is applied to the device;

Fig. 3 is a fragmentary sectional view illustrating a variant form of the invention; and

Fig. 4 is an enlarged section on line 4—4 of Fig. 2.

In the drawing, I have shown a lower portion of the drill pipe string 10 within the well casing 11, the pipe string comprising pipe lengths 12 connected by a special coupling 13 located at or near the usual drill collar and above a suitable back pressure valve, for example of the type illustrated at 14 in Fig. 3. As explained above, the function of this back pressure valve 14 is to permit downward fluid circulation through the drill string, but prevent upward escape of well fluid through the drill string, as where the well develops sudden pressure. Any desired type of standard back pressure valve may be used. The typical form shown in Fig. 3 comprises a cylindrical body 15 inserted within the bore of coupling 16 and clamped between shoulder 17 and the lower pin end 12a of the pipe 12 below coupling 13. Body 15 contains an axially offset bore 18 presenting an inclined shoulder 19 and a lower reduced diameter portion 18a. A float valve 20 is pivoted at 21 on the lower end of body 15, the valve normally being swung open to the point of engagement of the valve carried arm 20a with the coupling wall, but seating to close the lower end of bore 18 in response to sudden upward fluid pressure or rise of liquid in the drill string.

Coupling 13 has threaded external flush type joints at 22 with the drill pipe 12; the coupling bore 23 being of uniform diameter and the upper pin end of the coupling being beveled at 24 to facilitate entry of the drop-in back pressure valve into bore 23. The drop-in back pressure valve, generally indicated at 25, comprises an elongated tubular body 26 having a bore 27, the lower end of which is closed by a check valve 28 pressed upwardly against its seat by coil spring 29 supported on a tapered nose bushing 30. During drilling operations, circulating fluid is discharged downwardly through the bore 27 past valve 28 and outwardly through slots 3, as indicated by the arrows, into the drill string below, but when circulation is discontinued, the valve seats to prevent upward flow of well fluid through the body bore.

The body 26 has an upper reduced diameter mandrel portion 32 about which is placed a radially expansible packer 33, and above the packer suitable pipe engaging means, generally indicated at 34, operates to hold the device against upward

movement of the drill string, as will presently appear. Packer 33 comprises a rubber sleeve movable longitudinally relative to the mandrel 32, the lower portion 34 of the packer bore having an upward taper and receiving a correspondingly tapered surface 35 of the mandrel.

The pipe engaging means 34 comprises a carrier sleeve 36 confined between rings 37 and 38, the mandrel being movable upwardly relative to the sleeve and ring assembly from the position of Fig. 1, in which ring 38 engages a nut 39 threaded and held in fixed position by set screw 40 on the upper end of the mandrel. Sleeve 36 carries a plurality of circularly arranged wedge slips 41, typically three or four in number, contained in vertically extending ways 42, with side flanges on the slips received within inclined grooves 42a, see Fig. 4. The outer serrated faces 43 of the slips are substantially vertical and the back surfaces of the slips engage the inclined wedge surfaces 44 so that as the carrier sleeve moves upwardly relative to the slips, the latter expand into engagement with the coupling bore wall. It may be desirable, in order to insure a secure grip by the slips on the coupling, to form annular serrations 45 in the coupling wall opposite the slips.

As best illustrated in Fig. 2, the body 26 has at its point of maximum diameter a downwardly facing annular shoulder 46 adapted to seat upon shoulder 47 on the upper end of a bushing 48 that may be threaded into or otherwise positioned within the lower end of coupling 13, to arrest downward movement of the drop-in valve assembly below the position of Fig. 1.

In operation, the device is inserted within the drill string, as previously indicated, and dropped or forced down by fluid pressure through the string and into coupling 13 to the seating position of Fig. 1, in which shoulder 46 engages shoulder 47 on the upper end of the bushing. With the device in seated position, downward circulation of fluid may be maintained through the bore 27, past check valve 28 and through the back pressure valve below. So long as the back pressure valve is in good condition, holding the well pressure and closing the drill string against upward fluid flow, the parts of the drop-in device will remain in the positions of Fig. 1. If, however, at any time the back pressure valve fails or develops substantial leakage, the resultant application of well pressure to the lower end of body 26 of the drop-in device, causes the pipe gripping means 34 to be expanded to hold the device against upward displacement in the coupling, and packer 33 to be expanded into fluid tight engagement with the coupling bore wall.

Application of well pressure to the lower end of the device results in upward movement of the mandrel 32, together with packer 33 and carrier sleeve 36, causing the slips 41 to be expanded into gripping engagement with the coupling serrations 45. At that point, sleeve 36 and ring 37 become held against upward movement, with the result that as the mandrel is forced further upwardly by the fluid pressure, the packer is expanded into tight engagement with the bore wall by wedging coaction between tapered surface 34 of the packer bore and the mandrel wedge surface 35. When the device is thus set within the coupling, with the parts in the position shown in Fig. 2, the circulation passage of the drill string is effectively plugged against upward fluid leakage, and the check valve 28 then serves in the capacity of a back pressure valve.

The device may readily be removed from the coupling after the drill string is pulled from the well, simply by disconnecting the coupling 13 from the pipe, removing bushing 48, and then driving the mandrel downwardly to release the slips, by means of a piece of wood or other implement inserted within the upper end of the coupling bore. As the mandrel is driven down, the packer is released and the entire assembly may be withdrawn through the lower end of the coupling.

In Fig. 3 I show a variant form of means for arresting downward movement of the device, to be used in situations where a special coupling 13 may not be employed, or where there is no provision of a fixed stop such as the bushing 48. The device may be positioned and set within a coupling by providing on the lower end of the body an extension adapted to engage a stationary member in the pipe string, for example a part of the usual back pressure valve, to arrest downward travel of the drop-in assembly, the length of the extension being predetermined in accordance with the distance between the back pressure valve and the coupling so that the drop-in plug will be positioned for setting within the coupling. Referring to Fig. 3, the body 26 carries on its lower end a rod 50 threaded at 51 into the body bore 52. As the drop-in device reaches setting position, the lower end of the rod engages shoulder 19a below inclined wall 19 of the back pressure valve, to arrest downward movement of the device, the length of the rod being such that at the point of arrest, the packer 33 and pipe engaging means 34 will be positioned for expansion within the coupling, all as previously described.

The drawing is to be regarded merely as illustrative of the invention in certain of its typical and preferred forms, since various changes and modifications may be made without departure from the invention in its intended spirit and scope.

I claim:

1. A back pressure valve device adapted to be dropped within a well pipe, comprising a body containing a fluid passage, means adapted to engage said pipe to hold the device against upward movement therein, a pipe engaging packer, a valve closing said passage against upward fluid flow through said device, and a pilot rod depending from said body and adapted to engage a portion of said pipe to arrest downward movement of the device therein.

2. A back pressure valve device adapted to be dropped within a well pipe, comprising an elongated body containing a fluid passage, radially expandible pipe engaging elements, a carrier for said elements surrounding said body and movable longitudinally relative thereto, a packer surrounding said body and expandible into fluid tight engagement by upward relative movement of the body and valve means preventing upward fluid flow through said passage.

3. A back pressure valve device adapted to be dropped within a well pipe, comprising an elongated body containing a fluid passage, radially expandible pipe engaging elements, a carrier for said elements surrounding said body and movable longitudinally relative thereto, a packer surrounding said body and expandible into fluid tight engagement by upward relative movement of the body, said body having an upwardly tapered surface within and bearing against said packer, and valve means preventing upward fluid flow through said passage.

4. In combination with a well pipe string containing a coupling near its lower end, a pipe closure device adapted to be dropped within said pipe string, said device comprising a body containing a passage adapted to conduct fluid downwardly through said device, a valve closing said passage against upward fluid flow, a packer carried by said body, and expansible pipe engaging means for holding the device against upward movement in said string, and means independent of said engaging means for arresting downward movement of said device at a point at which said packer and pipe engaging means are positioned within the bore of said coupling.

5. In combination with a well pipe string containing a coupling near its lower end, a pipe closure device adapted to be dropped within said pipe string, said device comprising a body containing a passage adapted to conduct fluid downwardly through said device, a valve closing said passage against upward fluid flow, a packer carried by said body, and expansible pipe engaging means for holding the device against upward movement in said string, and means for arresting downward movement of said device at a point at which said packer is positioned within the bore of said coupling, said means comprising an annular shoulder carried by the coupling, said shoulder having smaller internal diameter than the coupling bore and being engageable by a shoulder on said closure device.

6. In combination with a well pipe string containing a coupling near its lower end, serrations formed in the coupling bore wall, a pipe closure device adapted to be dropped within the pipe string, said device comprising expansible wedge slips adapted to engage said serrations to hold said device against upward movement in the pipe string, and a packer expansible into fluid tight engagement with the coupling bore wall when said serrations are engaged by the slips.

7. In combination with a well pipe string containing a coupling near its lower end, serrations formed in the coupling bore wall, a pipe closure device adapted to be dropped within the pipe string, said device comprising expansible wedge slips adapted to engage said serrations to hold said device against upward movement in the pipe string, and a packer expansible into fluid tight engagement with the coupling bore wall when said serrations are engaged by the slips, and an annular stop at the lower end of said coupling and engageable by said device to arrest its downward travel.

8. A back pressure valve device adapted to be dropped within a well pipe, comprising a continuous elongated body mandrel, radially expansible means movable longitudinally of said mandrel and adapted to engage said pipe to hold the device against upward movement therein, and a radially expansible pipe engaging packer surrounding said mandrel and having an upwardly tapering bore receiving a correspondingly shaped portion of the mandrel, said mandrel being upwardly movable by fluid pressure to radially expand both the pipe engaging means and the packer.

9. In combination with a well pipe string containing a coupling near its lower end, a pipe closure device adapted to be dropped within said pipe string, said device comprising a body, an expansible packer, pipe engaging means for holding the device against upward movement in said string, and means on the coupling and acting independent of said pipe engaging means for

arresting downward movement of said body at a point at which said packer is positioned within the bore of said coupling.

10. In combination with a well pipe string containing a coupling near its lower end, a pipe closure device adapted to be dropped within said pipe string, said device comprising a body, an expansible packer, expansible pipe engaging means for holding the device against upward movement in said string, and means on the coupling and acting independent of said pipe engaging means for arresting downward movement of said device at a point at which said packer and pipe engaging means are positioned within the bore of said coupling, said pipe engaging means being expansible into engagement within said coupling bore by virtue of upward movement of the body from said point.

11. In combination with a well pipe string containing a coupling near its lower end, a pipe closure device adapted to be dropped within said pipe string, said device comprising a packer and expansible pipe engaging means for holding the device against upward movement in said string, and means independent of said engaging means for arresting downward movement of said device at a point at which said packer is positioned within the bore of said coupling, said means comprising an annular stop shoulder projecting inwardly from the wall of the coupling bore at its lower end and engageable by a shoulder on said closure device.

12. In combination with a well pipe string containing a series of upper couplings and a lower tubular coupling above the bottom end of the pipe string, the bore of said lower coupling having a recess formed in its wall, a pipe closure device adapted to be dropped within said pipe string and through the upper couplings into said lower coupling bore, said device comprising a body having a fluid passage extending longitudinally therethrough, a valve closing the passage against upward fluid flow, a packer carried by the body, and means for holding said body in predetermined position within said bore with the packer positioned therein, said means including radially movable means mounted on the body outside and opposite said fluid passage and engageable within said recess by movement of said device into the coupling bore, and means for radially expanding said packer by virtue of upward movement of the body while said radially movable means is engaged within said recess.

13. In combination with a well pipe string containing a series of upper couplings and a lower tubular coupling above the bottom end of the pipe string, the bore of said lower coupling having a recess formed in its wall, a pipe closure device adapted to be dropped within said pipe string and through the upper couplings into said lower coupling bore, said device comprising a body having a fluid passage extending longitudinally therethrough, a valve closing the passage against upward fluid flow, a packer carried by the body, and means for holding said body in predetermined position within said bore with the packer positioned therein, said means including radially movable means mounted on the body and engageable within said recess by movement of said device into the coupling bore, and wedge means carried by the body and operable by fluid pressure below said device to wedge against and radially expand said packer into fluid tight engagement with the coupling bore wall.

14. A pipe closure device adapted to be dropped within a well pipe, comprising a body, a sleeve surrounding and mounted on said body for vertical movement relative thereto, a member movable radially within a way formed in said sleeve into engagement with said pipe, and a packer adapted to form a fluid tight seal between said body and pipe.
15. A pipe closure device adapted to be dropped within a well pipe, comprising a body, a sleeve surrounding and mounted on said body for vertical movement relative thereto, a member movable radially within a way formed in said sleeve into engagement with said pipe, and a packer adapted to form a fluid tight seal between said body and pipe, and wedge means operable by fluid pressure below said device to wedge against and expand said packer into fluid tight engagement with the pipe.

16. In combination with a well pipe string containing a series of upper couplings and a lower tubular coupling above the bottom end of the pipe string, a pipe closure device adapted to be dropped within said pipe string and through the upper couplings into said lower coupling bore, said device comprising a body having a fluid passage extending longitudinally there-through, a valve closing the passage against upward fluid flow, a packer carried by the body, and means for arresting downward movement of the device at a predetermined position within said bore with the packer positioned therein, said means including an upwardly facing shoulder within the coupling, and means on said device positioned outside and opposite said fluid passage and engageable with said shoulder.

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