DOWNHOLE MATERIAL DELIVERY

FIELD OF THE INVENTION

This invention relates to a downhole material delivery. The invention has particular application in bypass tools and methods of operating such tools.

BACKGROUND OF THE INVENTION

Bypass valves may be provided in drill strings to provide a flow path between the drill string bore and the annulus without the requirement for fluid to pass through elements of the bottom hole assembly (BHA). This may be useful for a number of reasons. When it is considered appropriate or necessary to deliver lost circulation material (LCM) to the annulus, it is preferred that measurement-while-drilling (MWD) tools and the jetting nozzles in the drill bit are isolated from the LCM, which might otherwise cause damage or blockage. Thus, a bypass valve may be provided above the MWD tool. Furthermore, for hole cleaning it may be desirable to achieve a higher circulation rate of fluid in the annulus above the valve, and this is more readily obtained if the circulating fluid can bypass the drill string and MWD below the bypass valve which would otherwise consume pressure and thus hydraulic power.

SUMMARY OF THE INVENTION

~~According to an aspect of the invention there is provided a~~There is described herein an activating device for location in downhole tubing, the device having an activation profile configurable to be maintained at a larger diameter than a tubing seat to hold the device on the seat, and the profile further being re-configurable to radially retract.

~~According to a further aspect of the invention there is provided a~~There is described herein a downhole method comprising: locating an activating device defining an activation profile in downhole tubing; configuring the activation profile to maintain a larger diameter than a seat provided in the tubing; retaining the device on the seat; and re-configuring the profile such that the profile radially retracts and the device passes through the seat.

Alternative features ~~of these aspects~~ are described in the appended dependent claims.

~~According to another aspect of the present invention there is provided a~~There is described herein a downhole bypass valve comprising:

a tubular body including a side port;

a sleeve axially movably mounted in the body and defining an internal activation seat of a first diameter, the sleeve normally biased upwards to a closed position to close the side port;

an activating device having an external activation profile defining an activation diameter larger than said first diameter, the device configured to be translatable into the body to engage the activation profile with the activation seat and permit application of a fluid pressure opening force to the device and the sleeve to move the sleeve downwards to an open position and open the side port; and

a latch having a part in the body and a part in the activating device, the parts of the latch configured to engage when the activation seat and profile are engaged and retain the sleeve in the open position,

the activating device further being operable to disengage the activation profile from the activation seat so that the activation device is translatable down through the sleeve and the parts of the latch further being operable to disengage and permit the sleeve to return to the closed position.

~~According to another aspect of the present invention there is provided a~~There is described herein a method of operating a downhole bypass valve having a tubular body including a side port and a sleeve mounted in the body and normally biased upwards to close the port, the method comprising:

landing an activating device in the valve such that an external activation profile provided on the sleeve engages an internal activation seat on the sleeve;

applying a fluid pressure opening force to the activating device and the sleeve to move the sleeve downwards and open the side port;

engaging a latch part in the body with a latch part in the activating device to retain the sleeve in the open position;

passing fluid through the side port;

disengaging the activation profile from the activation seat;

translating the activating device down through the sleeve; and

disengaging the parts of the latch, permitting the sleeve to return to the closed position.

In a variation ~~of the second aspect of the invention~~ the activation profile and seat may remain engaged, as may the parts of the latch, such that the sleeve remains in the open position. This may be useful to facilitate dry tripping of a drill string including the valve, as will be described below.

proportion of the fluid passing into the string is directed through the open side port while a proportion of fluid passes into the string beyond the valve. This may be useful in bore cleaning operations, allowing a portion of fluid to continue to flow to the distal end of the string to provide cooling of stabilisers and the like and to maintain movement of cuttings in the bore below the valve. The activating device may include a nozzle or other flow restriction to facilitate application of a fluid pressure force to move the sleeve to the open position and engage the latch. The nozzle may be erodable, to permit a higher rate of flow through the activating device once the sleeve is in the open position. Alternatively, the activating device may include a burst disc or a dissolvable plug. Activating devices ~~in accordance with aspects of the invention~~ intended to provide split flow in a bypass valve may include an erosion resistant flow surface. This may be provided by a suitable coating or hard facing, or the devices may incorporate sleeves or liners of erosion resistant material, such a ceramics.

The activation seat may have a relatively small radial extent, for example 2mm or less. This minimises the flow and access restriction created by the seat. Thus, the bore diameter of the sleeve above the seat may be only very slightly larger than the seat. This permits provision of a release device which, by provision of a flexible or deformable external seal, forms a sliding sealing contact with the sleeve bore. The release device may thus act as a piston and translate a fluid pressure force applied by the fluid above the release device to a mechanical force to be applied to the activating device. The flexible seals of the release device then permit the release device to pass through the seat. Similarly, seals provided on the activating device may provide a sealing sliding contact with the sleeve bore above the seat and be deformed or compressed to permit the device to pass through the seat.

The valve may further comprise a catcher for location below the body and to receive one or more activating devices. The catcher may also be arranged to receive one or more release devices. The catcher may be configured to permit fluid passage around any devices retained in the catcher.

A plurality of activating devices may be provided, allowing multiple activations of the valve without requiring retrieval and resetting of the valve at surface. The activating devices may be of different forms or constructions, such that the utility or function of the valve may be varied, merely be selection of an appropriate activating device. Thus a single body and valve combination may provide multiple functions. One of the activating devices may not feature a latch part as described above, use of such a device allowing the sleeve to be moved to the open position when fluid is flowing into the tool, but allowing the sleeve to move to the closed position when flow ceases. Such a form of activating device may be employed in situations where well control is an issue and it is desired that the valve will always close in the absence of flow from surface. This activating device may be configured to latch or lock within the sleeve, such that the activating sleeve will not be dislodged or displaced from the sleeve. Such an activating device ~~forms a further aspect of the present invention, and~~ may tend to be shorter than activating devices as described above which are required to latch with the body below the end of the sleeve.

Accordingly, a larger number of such activating devices may be accommodated in a given catcher located below the valve, increasing the number of cycles achievable. Alternatively, a shorter catcher may be provided.

The various features and advantages described above may equally apply to the various aspects of the invention described below.

~~According to another aspect of the present invention there is provided a~~There is described herein a downhole bypass valve comprising:

a tubular body including a side port;

a sleeve axially movably mounted in the body and normally biased to a closed position to close the side port;

an activating device configured to be translatable into the body to engage the sleeve and permit movement of the sleeve to an open position and open the side port; and

a latch having a part in the body and a part in the activating device, the parts of the latch configured to engage and retain the sleeve in the open position,

the activating device further being operable to disengage from and translate through the sleeve and the parts of the latch further being operable to disengage and permit the sleeve to return to the closed position.

~~According to another aspect of the present invention there is provided a~~There is described herein a method of operating a downhole bypass valve having a tubular body including a side port and a sleeve mounted in the body and normally biased to close the port, the method comprising:

landing an activating device in the sleeve;

moving the sleeve to open the side port;

engaging a latch part in the body and a latch part in the activating device to retain the sleeve in the open position,

passing fluid through the side port;

disengaging the activating device from the sleeve;

translating the activating device through the sleeve; and

disengaging the parts of the latch, permitting the sleeve to return to the closed position.

The sleeve may include a seat adapted to engage a cooperating part or profile of the activating device. The seat may be provided internally of the sleeve, and may take the form of a bore restriction. The cooperating part of the activating device may take any appropriate form and may be an external profile. One or both of the seat and profile may be reconfigurable to permit the seat and profile to disengage. For example, one or both of the seat or the cooperating part may be deformable or retractable.

~~According to another aspect of the present invention there is provided a~~There is described herein a downhole tool comprising:

a tubular body;

an operating member axially movably mounted in the body and initially located in a first position;

an activating device configured to be translatable into the body to engage the operating member and permit movement of the member to a second position; and

a latch having a part in the body and a part in the activating device, the parts of the latch configured to engage and retain the operating member in the second position,

the activating device further being operable to disengage from the operating member and the parts of the latch further being operable to disengage.

The operating member may provide a function including at least one of: opening or closing a valve, actuating a seal or packer, and controlling the extension or retraction of external members, which external member may be cutting blades.

~~Another aspect of the invention relates to a~~There is described herein a downhole tool comprising:

a tubular body;

an operating member axially movably mounted in the body and initially located in a first position;

an activating device configured to be translatable into the body to engage the operating member and permit movement of the member to a second position; and

a latch configured to retain the operating member in the second position,

the activating device further being operable to disengage from the operating member and the latch further being operable to disengage.

~~According to another aspect of the present invention there is provided a~~There is described herein a method of operating a downhole tool having a tubular body and an operating member mounted in the body, the method comprising:

landing an activating device in the tool;

moving the operating member from a first position to a second position;

engaging a latch part in the body with a latch part in the activating device to retain the operating member in the second position; and

disengaging the parts of the latch whereby the operating member may return to the first position.

The operating member may provide or serve any appropriate function. For example, the member may open or close a valve, actuate a seal or packer, or may control the extension or retraction of external members, such as cutting blades provided on a reamer.

~~According to another aspect of the present invention there is provided a~~There is described herein a method of operating a downhole tool having a tubular body and an operating member mounted in the body, the method comprising:

landing an activating device in the tool;

moving the operating member from a first position to a second position;

engaging a latch to retain the operating member in the second position; and

disengaging the latch whereby the operating member may return to the first position.

~~According to another aspect of the present invention there is provided a~~There is described herein a downhole tool comprising:

a tubular body;

a sleeve axially movably mounted in the body and defining an internal activation seat of a first diameter;

an activating device having an external activation profile defining an activation diameter larger than said first diameter, the device configured to be translatable into the body to engage the activation profile with the activation seat,

at least one of the activation seat and the activation profile being reconfigurable to retract and define a release diameter, whereby the activating device may pass through the seat.

The tool may further comprise a release device configured to be translatable into the body to engage the activating device and reconfigure the activation profile to define a release diameter smaller than said first diameter, whereby the activating and release devices may pass through the seat. Alternatively, the release device may

reconfigure the activation seat. In other embodiments, at least one of the activation seat and the activation profile may be reconfigurable to retract in response to a signal or condition, for example an elevated pressure, which elevated pressure may be towards the upper end of the available pressure, or may be above the normally available pressure. Such embodiments may also be reconfigurable using an appropriate release device.

~~According to another aspect of the present invention there is a~~There is described herein a method of operation a downhole tool having a tubular body and a sleeve mounted in the body, the method comprising:

providing an internal activation seat of a first diameter in the sleeve;

landing an activating device in the tool such that an external activation profile on the device defining an activation diameter larger than said first diameter engages the activation seat;

engaging the activating device with a release device thereby reconfiguring the activation profile to define a release diameter smaller than said first diameter; and

passing the activating and release devices through the seat.

In alternative embodiments there is provided a downhole tool comprising:

a tubular body defining an internal seat of a first diameter;

an activating device having an external profile defining a diameter larger than said first diameter, the device configured to be translatable into the body to engage the profile with the seat,

at least one of the profile and the seat being retractable to define a release diameter, whereby the activating device may pass through the seat.

The external profile may be defined by one or more profile members. In an extended configuration the profile member may be radially supported, and in a retractable configuration the profile member may be movable radially inward to define the release diameter.

The activating device may be reconfigured by engagement with a release device, such as described with reference to ~~the seventh or~~ other aspects of the invention. Alternatively, or in addition, the activating device or the internal seat maybe reconfigured by application of fluid pressure or by some other activation signal. Where the release device is configured to provide a close fit with the body or a sleeve mounted in the body and would otherwise trap a volume of fluid between the release device and the activating device, the tool may comprise a relief valve for relieving pressure from the volume between the devices.

The tool and activating device may include one or more of the features of the tools and activating devices of the other aspects of the invention described herein. The activation device may take the form of a plug, valve, choke, logging device or indeed any downhole device it is desired to releasably locate in a bore.

According to ~~another~~ an aspect of the present invention there is provided a downhole bypass valve comprising:

a tubular body including a side port;

a sleeve axially movably mounted in the body and defining an internal ~~activation~~ seat of a first diameter, the sleeve normally biased upwards to a closed position to close the side port;

the string bore closure member being ~~an activating~~ a sleeve closing device having an external ~~activation~~ profile defining ~~an activation~~ a diameter larger than said first diameter, the device configured to be translatable into the body to engage the ~~activation~~ profile with the ~~activation~~ seat ~~and permit application of a fluid pressure opening force to the device and the sleeve to move the sleeve downwards to an open position and open the side port~~; and

a latch having a part in the sleeve and a part in the activating device, the parts of the latch configured to engage when the ~~activation~~ seat and profile are engaged to retain the ~~activating~~ sleeve closing device in the sleeve and the ~~activation~~ profile and ~~activation~~ seat in engagement,

the ~~activating~~ sleeve closing device further being operable to disengage the ~~activation~~ profile from the ~~activation~~ seat so that the ~~activation~~ sleeve closing device is translatable down through the sleeve, optionally

wherein engagement of the profile with the seat permits application of a fluid pressure opening force to the device and the sleeve to move the sleeve downwards to an open position and open the side port, optionally

wherein the latch is configured to disengage when the activation profile disengages from the activation seat, and optionally wherein the latching is below the bypass port.

~~According to another aspect of the present invention there is provided a~~ There is described herein a method of operating a downhole bypass valve having a tubular body including a side port and a sleeve mounted in the body and normally biased upwards to close the port, the method comprising:

landing an activating device in the valve such that an external activation profile provided on the sleeve engages an internal activation seat on the sleeve and a latch part on the activating device engages a latch part on the sleeve to retain the activating device in the sleeve and maintain the activation profile and seat in engagement;

applying a fluid pressure opening force to the activating device and the sleeve to move the sleeve downwards and open the side port;

passing fluid through the side port;

disengaging the activation profile from the activation seat; and

translating the activating device down through the sleeve.

The latch ~~of these aspects of the invention~~ retains the activating device in the sleeve and maintains the activation profile and the activation seat in engagement. Thus, the activating device will not be dislodged from the sleeve, and reverse flow up through the valve is prevented. On landing on the sleeve the activating device may provide a substantially sealing contact with the sleeve and the latch may be configured to retain the sealing contact.

~~In other aspects of the invention t~~The side ports may be opened using power supplied from surface, for example electrical or hydraulic power. Alternatively, an additional device or member may be provided, for example a ball or dart dropped from surface, to allow the sleeve to be moved to the open position. ~~In such aspects a~~A plug or other sleeve closing device may be utilised to prevent reverse flow.

Activating devices ~~of these aspects~~ may be configured to provide 100% bypass or split flow.

~~According to another aspect of the present invention there is provided a~~There is described herein a downhole bypass valve comprising:

a tubular body including a side port;

a sleeve axially movably mounted in the body and defining an internal activation seat of a first diameter, the sleeve normally biased upwards to a closed position to close the side port;

an elongate activating device having an external activation profile defining an activation diameter larger than said first diameter, the device configured to be translatable into the body to engage the activation profile with the activation seat and permit application of a fluid pressure opening force to the device and the sleeve to move the sleeve downwards to an open position and open the side port; and

a latch having a part in the sleeve and a part in the activating device, the parts of the latch configured to engage when the activation seat and profile are engaged to retain the activating device in the sleeve,

the activating device further being operable to disengage the activation profile from the activation seat so that the activation device is translatable down through the sleeve.

~~According to another aspect of the present invention there is provided a~~There is described herein a method of operating a downhole bypass valve having a tubular body including a side port and a sleeve mounted in the body and normally biased upwards to close the port, the method comprising:

landing an elongate activating device in the valve such that an external activation profile provided on the device engages an internal activation seat on the sleeve and a latch part on the activating device engages a latch part on the sleeve to retain the activating device in the sleeve;

applying a fluid pressure opening force to the activating device and the sleeve to move the sleeve downwards and open the side port;

passing fluid through the side port;

disengaging the activation profile from the activation seat; and

translating the activating device down through the sleeve.

Other ~~aspects of the invention~~examples relate to the activating device, independently of the other elements of the valve.

According to a ~~still~~ further aspect of the present invention there is provided a method of delivering material into a hole via a tubular string, the method comprising:

opening a bypass port in a tubular string located in a drilled hole, the bypass port being provided above ~~jetting nozzles~~fluid outlets in the distal end of the string;

translating a plug into the string;

blocking the string with the plug below the port;

delivering material through the string from surface, the material passing through the bypass port and into the drilled hole; and

~~trapping a volume of~~locking fluid in the string between the plug and the fluid outlets whereby fluid is prevented from passing ~~from the hole into~~up the string ~~via~~ and past the ~~jetting nozzles~~plug.

According to a yet further aspect of the invention there is provided apparatus for use in delivering material into a hole via a tubular string, the apparatus comprising:

a bypass valve having a bypass port, the valve configured to be located in a tubular string above ~~jetting nozzles~~fluid outlets provided towards the distal end of the string and the port configured to be opened to permit material to be delivered through the string from surface and into the hole via the port;

a string bore closure member ~~configured~~ adapted to be ~~located~~ translated ~~in~~ into the ~~string bore, whereby~~valve and located below the bypass port to lock a volume of fluid ~~may be trapped~~ in the string below the member and prevent the fluid ~~is prevented~~ from ~~flowing from the hole into~~passing up the string ~~via the jetting nozzles~~.

These aspects of the invention may be utilised, for example, to protect elements of a BHA, such as an MWD tool, from contamination by LCM which has been delivered into a drilled hole via the bypass valve. The trapped volume of fluid, typically drilling mud or fluid, prevents any further fluid containing LCM from flowing into the string through the jetting nozzles, as may otherwise occur due to U-tubing effects, as described above.

The closure member may be located below the bypass port, and may prevent fluid from flowing down through the string bore.

The closure member may be configured to be dropped or pumped into the string, and may be configured for landing in the bypass valve. Alternatively, the closure member may be configured to be incorporated in the string or bypass valve.

The closure member may be configured to facilitate opening of the bypass port. The closure member may lock or latch the bypass port open, or the bypass port may be closed and opened with the closure member in place.

The closure member may include one or more features of the activation or activating devices of the other aspects of the invention.

In certain embodiments the bypass valve may open or close in response to signals transmitted from surface, for example: pressure pulses or acoustic signals; or by electrical, optical or hydraulic signals or power transmitted from surface via appropriate wiring, cabling or control lines: or by signalling chips or devices pumped into the string.

~~According to an aspect of the present invention there is provided a~~There is described herein a downhole bypass valve comprising:

a tubular body including a side port;

a sleeve axially movably mounted in the body and defining an internal activation seat of a first diameter, the sleeve normally biased upwards to a closed position to close the side port:

a plurality of activating devices, each activating device having an external activation profile defining an activation diameter larger than said first diameter, each