first section of tubular riser below the sealing device having a first annular space, and a second section of tubular riser above the sealing device having a second annular space, such that a substantially fluid tight seal is formed between the first and second annular spaces, wherein the first section of the tubular riser is provided with a first side outlet situated below the sealing device and connecting the outlet to a return line to return the drilling fluid to surface control equipment including at least one of a managed pressure drilling system and riser gas handling system, and a second side outlet which is connected via a flow line to a side outlet situated at the bottom end of the second section of tubular riser, there being a valve provided for opening and closing the flow line, the method further including removing the drilling fluid from the first annular space via the return line.

In this specification, the term equivalent circulating density is used to describe the increase in bottom hole pressure generated when drilling fluid is circulated in a well bore, i.e. the difference between the bottom hole pressure during circulation of a given density of drilling fluid at a particular flow rate and the bottom hole pressure when this drilling fluid is stationary in the well bore.

The reduced static density of the drilling fluid may therefore be lower than the density of fluid required to control the well (i.e. to balance the formation pressure) when there is no circulation of the drilling fluid.

The drilling fluid may be introduced into the well bore via the drill string.

As mentioned in the first aspect, the method comprises including using a tubular riser to form a substantially annular space around the drill string such that the drilling fluid passes through the annular space to the return line.

passage or line and valve which is operable to permit or prevent flow of fluid along the flow passage.

Kill fluid may be stored in the first annular space.

The method may comprise opening the valve such that the kill fluid exerts pressure on the drilling fluid sufficient to retain the drilling fluid within the second annular space in the event of a kick, influx or blowout occurring in the wellbore.

The kill fluid may have a density greater than that of the drilling fluid having said reduced static density. The density of the kill fluid may be determined based on the equivalent circulating density of the drilling fluid at the wellbore.

The kill fluid may have a density substantially equal to that of the drilling fluid having the reduced static density.In this case the kill fluid may be pressurised so as to exert a pressure on the drilling fluid equal to a pressure generated by the equivalent circulating density at the wellbore, when the valve is opened.

The kill fluid may be pressurised, at least in part, using a riser booster pump.

As mentioned in the first aspect, the first section of the tubular risers is provided with a first side outlet situated below the sealing device and connecting the outlet to the return line to return the drilling fluid to a surface control equipment including at least one of a managed pressure drilling system and riser gas handling system at a wellbore surface so as to form a first closed loop.

The method may include circulating the kill fluid in a second closed loop in the second section of the tubular risers.

The second section of the tubular risers may be provided with an outlet situated above the sealing device and the method may comprise connecting the outlet to a fluid line for returning the kill fluid to the managed pressure drilling system or riser gas handling system at a wellbore surface.

The method may comprise using a flow spool for connecting the outlets on the first and second sections of the tubular risers to the managed pressure drilling system or riser gas handling system.

The sealing device may be installed in a tubular riser near the top of the wellbore.

The method may include installing a blowout preventer near the top of the tubular risers and above the sealing device.

The method may comprise including using a second sealing device to seal the second annular space in the second section of tubular risers such that the second annular space has a top and a bottom portion that is sealed by the second sealing device and the sealing device respectively.

The method may comprise installing a blowout preventer adjacent and below the sealing device.

The sealing device may be positioned below a slip joint between tubular risers such that pressure exerted by the drilling fluid in the first annular space is not communicated to the slip joint.

Also disclosed is a method of drilling a subterranean wellbore using a drill string, including the steps of estimating or determining a preferred static density of a drilling fluid for injection into the

wellbore such that increases of the drilling fluid density caused by injection of the drilling fluid are within a control parameter associated with a formation pore pressure and/or formation fracture pressure of the wellbore, providing a drilling fluid having substantially that preferred static density, injecting the drilling fluid into the wellbore, using a tubular riser to form a substantially annular space around the drill string, using a sealing device to seal the annular space so as to form a first section of tubular riser below the sealing device having a first annular space, and a second section of tubular riser above the sealing device having a second annular space, such that a substantially fluid tight seal is formed between the first and second annular spaces, wherein the first section of the tubular riser is provided with a first side outlet situated below the sealing device and connecting the outlet to the return line to return the drilling fluid to surface control equipment including at least one of a managed pressure drilling system and riser gas handling system, and a second side outlet which is connected to a side outlet situated at the bottom end of the second section of tubular riser, there being a valve provided for opening and closing the flow line, the method further including removing the drilling fluid from the first annular space via the return line.

Features of methods set out above may be combined as needed.

Also disclosed is an apparatus for drilling a subterranean wellbore using a drill string, comprising a riser in which the drill string is at least partly contained, the riser defining a substantially annular space around the drill string, a first sealing device which seals the annular space so as to form a first section of tubular riser below the first sealing device having a first annular space, and a second section of tubular riser above the first sealing device having a second annular space, such that the sealing device forms a substantially fluid tight seal between the first and

second annular spaces, a second sealing device to seal the second annular space in the second section of tubular risers such that the second annular space has a top and a bottom portion that is sealed by the second sealing device and the first sealing device respectively and may be pressurised relative to the first annular space, the second annular space being in fluid communication with a riser booster pump such that kill mud, stored in the second annular space, may be maintained at a pressure greater than that of the drilling fluid, in the first annular space.

The first and second chambers may be upper and lower chambers, respectively.

The apparatus may comprise one or more of the features of the methods set out above.

Also disclosed is a drilling system comprising a drill string, a riser in which the drill string is at least partly contained, the riser defining a substantially annular space around the drill string, a first sealing device disposed within the riser and forming a first riser chamber around the drill string below the first sealing device and a second riser chamber around the drill string above the first sealing device, the first sealing device providing a substantially fluid tight seal between the first riser chamber and the second riser chamber, a second sealing device which is mounted in the riser above the first sealing device to seal the second riser chamber such that the second riser chamber has a top and a bottom portion that is sealed by the second sealing device and the first sealing device respectively and that pressurised fluid can be retained in the second riser chamber, a source of drilling fluid operable to inject drilling fluid into the first riser chamber, a source of kill fluid operable to inject kill fluid into the second

A blowout preventer may be installed near the top of the tubular risers and above the sealing device.

As mentioned, the drilling system includes a second sealing device which is mounted in the riser above the first sealing device to seal the second riser chamber such that the second riser chamber has a top and a bottom portion that is sealed by the second sealing device and the first sealing device respectively.

The drilling system may further comprise a blowout preventer installed adjacent and below the sealing device.

The sealing device may be positioned below a slip joint between tubular risers such that pressure exerted by the drilling fluid in the second annular space is not communicated to the slip joint.

Also disclosed is a method of drilling a well bore using a drilling system as set out above, the method comprising pumping drilling fluid into the first riser chamber via the drill string, while the valve in the flow line is in its closed position.

The method may further include pumping kill fluid into the second riser chamber whilst removing kill fluid from the second riser chamber from an outlet in the second riser chamber.

The method may further include the steps of operating a pump to maintain the kill fluid in the second riser chamber at a greater pressure than the drilling fluid in the first riser chamber.

The method may further include monitoring the fluid pressure at the bottom of the well bore, and if an influx, kick or blowout is detected, opening the valve in the flow line.

CLAIMS

1. A method of drilling a subterranean wellbore using a drill string including the steps of:

estimating or determining a reduced static density of a drilling fluid based on the equivalent circulating density of the drilling fluid in a section of the wellbore,

providing a drilling fluid having substantially that reduced static density,

introducing the drilling fluid having said reduced static density into the wellbore,

using a tubular riser to form a substantially annular space around the drill string,

using a sealing device to seal the annular space so as to form a first section of tubular riser below the sealing device having a first annular space, and a second section of tubular riser above the sealing device having a second annular space, such that a substantially fluid tight seal is formed between the first and second annular spaces, wherein the first section of the tubular riser is provided with a first side outlet situated below the sealing device and connecting the outlet to a return line to return the drilling fluid to surface control equipment including at least one of a managed pressure drilling system and riser gas handling system, and a second side outlet which is connected via a flow line to a side outlet situated at the bottom end of the second section of tubular riser, there being a valve provided for opening and closing the flow line,

the method further including removing the drilling fluid from the first annular space via the return line.

2. A method according to claim 1 wherein the drilling fluid is introduced into the well bore via the drill string.

3. A method according to claim 1 including storing kill fluid in the second annular space.

4. A method according to claim 3 including opening the valve in the event of a kick, influx or blowout occurring in the wellbore.

5. A method according to claim 3 or 4 wherein the kill fluid has a density greater than that of the drilling fluid having said reduced static density.

6. A method according to claim 5 wherein the density of the kill fluid is determined based on the equivalent circulating density used in determining the reduced static density of the drilling fluid.

7. A method according to claim 3 or 4 wherein the kill fluid has a density substantially equal to that of drilling fluid having the reduced static density and wherein the kill fluid is pressurised so as to exert a pressure on the drilling fluid equal to a pressure generated by the equivalent circulating density at the wellbore, when the valve is opened.

8. A method according to claim 7 wherein the kill fluid is pressurised, at least in part, using a riser booster pump.

9. A method according to any one of claims 3 to 8 including circulating the kill fluid in a second closed loop in the second section of the tubular riser.

10. A method according to claim 9 wherein the second section of the tubular riser is provided with an outlet situated above the sealing device and connecting the outlet to a fluid line for returning the kill fluid to the managed pressure drilling system or riser gas handling system at a wellbore surface.

11. A method according to any preceding claim including using a flow spool for connecting the outlets on the first and second sections of the tubular riser to the managed pressure drilling system or riser gas handling system.

12. A method according to any preceding claim wherein the sealing device is installed in a tubular riser near the top of the wellbore.

13. A method according to any preceding claim including installing a blowout preventer near the top of the tubular riser and above the sealing device.

14. A method according to any preceding claim including using a second sealing device to seal the second annular space in the second section of tubular riser such that the second annular space has a top and a bottom portion that is sealed by the second sealing device and the sealing device respectively.

15. A method according to claim 14 including installing a blowout preventer adjacent and below the sealing device.

16. A method according to any preceding claim wherein the sealing device is positioned below a slip joint between tubular risers such that pressure exerted by the drilling fluid in the first annular space is not communicated to the slip joint.