The present invention seeks to address one or more of the problems associated with the valve assembly shown in US 8,210,266 and described above.

Herein disclosed is ~~According to a first aspect of the invention we provide~~ a valve assembly for use controlling flow of fluid into a drill pipe, the valve assembly having a valve body, a valve member and a valve seat, wherein

a) the valve body has a main passage

b) the valve member is movable between a closed position in which the valve member engages with a seat face of the valve seat to substantially prevent flow of fluid along the main passage, and an open position in which the valve member is spaced from the seat face,

c) the valve seat is a separate part to (not integral with) the valve body.

By virtue of making the valve seat separate to the valve body, the valve seat may be replaced, if damaged through erosion or corrosion for example, without the need to replace the valve body too.

At least the portions of the seat face and valve member which engage when the valve member is in the closed position may be metallic. In other words, the engagement of the seat face and the valve member forms a metal-to-metal seal. The valve member may be provided with an additional non-metallic sealing element (for example a polyurethane seal) which also engages with the seat face when the valve member is in the closed position.

The valve assembly may include a cap and the valve body may be provided with cap locking formations suitable for engagement with corresponding locking formations provided on the cap when the cap is located at least partially in the main passage, the engagement of these locking formations substantially preventing movement of the cap out of the main passage. The valve seat may have a further seat face which engages with a sealing part of

cap to provide a substantially fluid tight seal when the cap is retained in the main passage of the valve body by engagement of its locking formations with the cap locking formations of the valve body.

The valve body may be provided with means for securing the valve body in an aperture provided in a drill pipe. This may comprise a screw thread on the exterior surface of the valve body.

The valve member may be predominantly surrounded by the valve body and valve seat.

The valve member may be movable between the closed position and the open position by translational movement.

The valve seat may be located at a first end of the valve body.

The valve seat may have a first portion which extends into the main passage of the valve body, and a second portion which engages with the first end of the valve body. In this case, the first portion of the valve seat may engage with an interior surface of the valve body.

The valve seat may be provided with a support part for locating the valve member at least partially within the main passage.

The valve seat may be generally annular, and the support part may comprise at least one spoke which extends radially into the generally circular space enclosed by the valve seat.

The seat face may face away from the valve body.

The seat face may be generally annular and be oriented at an angle of between 30 and 60° to the longitudinal axis of the main passage.

~~According to a second aspect of the invention we provide a drilling system including a tubular element and a valve assembly having any feature or~~

~~combination of features of the valve assembly of the first aspect of the invention.~~

As mentioned in the above first aspect, ~~The~~ the tubular element ~~may have~~ has a wall enclosing a main passage and a side port which extends through the wall from the exterior of the tubular element to the main passage, in which case the valve assembly may be mounted on or at least partially within the side port so that movement of the valve member to the closed position substantially prevents flow of fluid through the side port.

The valve body may include anchor formations which are engaged with corresponding formations on the tubular element to restrict movement of the valve body relative to the tubular element. These formations may comprise a screw thread.

The valve seat may have a sealing face which is in sealing engagement with the drill pipe to substantially prevent flow of fluid from the main passage in the tubular element between the valve assembly and the tubular element.

As mentioned in the above first aspect, ~~The~~ the side port ~~may~~ includes a larger cross-sectional area portion and a smaller cross-sectional area portion, there being a shoulder in the portion of the wall of the tubular element surrounding the side port which extends between the larger cross-sectional area portion and the smaller cross-sectional area portion. In this case, maximum outer diameter of valve assembly may be less than the diameter of the larger cross-sectional area portion and greater than the diameter of the smaller cross-sectional area portion. The valve seat may engage with the shoulder so that the shoulder supports the valve assembly in the side port, a substantially fluid tight seal being provided between the shoulder and the valve seat. The valve seat may be clamped between the valve body and the shoulder. The shoulder may extend generally perpendicular to the longitudinal axis of the side port.

The valve body may be located between the valve seat and the exterior of the tubular element.

The tubular element may be a drill pipe or sub.

~~According to a third aspect of the invention we provide~~Herein disclosed is an assembly comprising a rod having a longitudinal axis, a support part, a resilient biasing element, and a nut, the nut being mounted on a screw thread around the rod, the assembly further comprising a locking collar which is mounted around the rod such that the biasing element extends between the support part and the locking collar, the locking collar having a first locking formation which engages with a corresponding locking formation of the rod to substantially prevent rotation of the locking collar around the rod, the biasing element pushing the locking ring into engagement with the nut so that at least one locking formation on the nut engages with a second locking formation on the locking collar, and, as a result, the locking collar substantially prevents further rotation of the nut about the rod.

The locking formation of the nut may comprise two or more teeth or castellations extending from the nut generally parallel to the longitudinal axis of the rod.

The locking formation of the rod may comprise a slot extending along an end of the rod generally parallel to its longitudinal axis, whilst the first locking formation of the collar comprises a protruberance or tab which extends radially inwardly of the locking collar into the slot.

The first and second locking formations of the locking collar may be integrally formed in a single part of the locking collar. They may, for example, both be a part of the tab.

The biasing element may comprise a helical spring.

~~According to a fourth aspect of the invention we provide~~Herein disclosed is a valve assembly comprising a valve seat and a valve member which is movable into and out of engagement with the valve seat to open or close the valve assembly, and an assembly according to the fourth aspect of the invention and having any feature or combination of features of the assembly according to the fourth aspect of the invention, wherein the valve member comprises the rod, the support part is fixed relative to the valve seat, and the biasing element biases the valve member into or out of engagement with the valve seat.

Preferably the valve member is biased into engagement with the valve seat by means of the resilient biasing element.

The valve member may further comprise a disc which is mounted on one end of the rod so that the rod extends centrally from and generally normal to the disc. In this case, the valve assembly may be configured such that it is the disc that engages with the valve seat when the valve member is engaged with the valve seat.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying figures of which

FIGURE 1 shows an exploded perspective illustration of a valve assembly according to the invention,

FIGURE 2 shows a perspective view of a longitudinal cross-section through the valve assembly illustrated in Figure 1 when assembled,

FIGURE 3 shows a longitudinal cross-section through a portion of drill pipe including the valve assembly shown in Figures 1 and 2,

FIGURE 4a shows a perspective illustration of one embodiment of valve member suitable for use in the valve assembly illustrated in Figures 1, 2 and 3,

FIGURE 4b shows a perspective illustration of one embodiment of collar suitable for use with the valve member illustrated in Figure 4a,

Claims

1. A drilling system including a tubular element and a valve assembly for use controlling flow of fluid into a drill pipe, the valve assembly having a valve body, a valve member and a valve seat, wherein

a) the valve body has a main passage

b) the valve member is movable between a closed position in which the valve member engages with a seat face of the valve seat to substantially prevent flow of fluid along the main passage, and an open position in which the valve member is spaced from the seat face,

c) the valve seat is a separate part to the valve body,

wherein the tubular element has a wall enclosing a main passage and a side port which extends through the wall from the exterior of the tubular element to the main passage,

wherein the side port includes a larger cross-sectional area portion and a smaller cross-sectional area portion, there being a shoulder in the portion of the wall of the tubular element surrounding the side port which extends between the larger cross-sectional area portion and the smaller cross-sectional area portion,

wherein the valve seat is clamped between the valve body and the shoulder.

2. A drilling system ~~valve assembly~~ according to claim 1 wherein at least ~~the~~ portions of the seat face and valve member which engage when the valve member is in the closed position are metallic.

3. A drilling system ~~valve assembly~~ according to claim 2 wherein the valve member is provided with an additional non-metallic sealing element which also engages with the seat face when the valve member is in the closed position.

4. A drilling system ~~valve assembly~~ according to any preceding claim further including a cap, the valve body being provided with cap locking formations suitable for engagement with corresponding locking formations provided on the cap when the cap is located at least partially in the main passage, the engagement of these locking formations substantially preventing movement of the cap out of the main passage.

5. A drilling system ~~valve member~~ according to claim 4 wherein the valve seat has a further seat face which engages with a sealing part of cap to provide a substantially fluid tight seal between the cap and the valve seat when the cap is retained in the main passage of the valve body by engagement of its locking formations with the cap locking formations of the valve body.

6. A drilling system ~~valve assembly~~ according to any preceding claim wherein the valve body is provided with means for securing the valve body in an aperture provided in a tubular element.

7. A drilling system ~~valve assembly~~ according to any preceding claim wherein the valve member is predominantly surrounded by the valve body and valve seat.

8. A drilling system ~~valve assembly~~ according to any preceding claim wherein the valve member is movable between the closed position and the open position by translational movement.

9. A drilling system ~~valve assembly~~ according to any preceding claim wherein the valve seat is located at a first end of the valve body.

10. A drilling system ~~valve assembly~~ according to ~~any preceding~~ claim 9 wherein the valve seat has a first portion which extends into the main passage of the valve body, and a second portion which engages with the first end of the valve body.

11. A drilling system ~~valve assembly~~ according to claim 10 wherein the first portion of the valve seat engages with an interior surface of the valve body.

12. A drilling system ~~valve assembly~~ according to any preceding claim wherein the valve seat is provided with a support part for locating the valve member at least partially within the main passage.

13. A drilling system ~~valve assembly~~ according to ~~any preceding~~ claim 12 wherein the valve seat is generally annular, and the support part comprises at least one spoke which extends radially into the generally circular space enclosed by the valve seat.

14. A drilling system ~~valve assembly~~ according to any preceding claim wherein the seat face faces away from the valve body.

15. A drilling system ~~valve assembly~~ according to any preceding claim wherein the seat face is generally annular and is oriented at an angle of between 30 and 60º to the longitudinal axis of the main passage.

~~16. A drilling system including a tubular element and a valve assembly having any feature or combination of features of the valve assembly of any preceding claim.~~

~~17. A drilling system according to claim 16 wherein the tubular element has a wall enclosing a main passage and a side port which extends through the wall from the exterior of the tubular element to the main passage.~~

~~18~~16. A drilling system according to any preceding claim ~~17~~ wherein the valve assembly is mounted on or at least partially within the side port so that movement of the valve member to the closed position substantially prevents flow of fluid through the side port.

~~19~~17. A drilling system according to any preceding claim ~~one of claims 16 to 18~~ wherein the valve body includes anchor formations which are engaged with

corresponding formations on the tubular element to restrict movement of the valve body relative to the tubular element.

~~20~~18. A drilling system according to any preceding claim ~~one of claims 16 to 19~~ wherein the valve seat has a sealing face which is in sealing engagement with the tubular element to substantially prevent flow of fluid from the main passage in the tubular element between the valve assembly and the tubular element.

~~21. A drilling system according to any one of claims 16 to 20 wherein the side port includes a larger cross-sectional area portion and a smaller cross-sectional area portion, there being a shoulder in the portion of the wall of the tubular element surrounding the side port which extends between the larger cross-sectional area portion and the smaller cross-sectional area portion.~~

~~22~~19. A drilling system according to any preceding claim ~~21~~ wherein the maximum outer diameter of valve assembly is less than the diameter of the larger cross-sectional area portion and greater than the diameter of the smaller cross-sectional area portion.

~~23~~20. A drilling system according to any preceding claim ~~21 or 22~~ wherein the valve seat engages with the shoulder so that the shoulder supports the valve assembly in the side port, a substantially fluid tight seal being provided between the shoulder and the valve seat.

~~24. A drilling system according to any one of claims 21 to 23 wherein the valve seat is clamped between the valve body and the shoulder.~~

~~25~~21. A drilling system according to any ~~one of claims 21 to 24~~preceding claim wherein the shoulder extends generally perpendicular to the longitudinal axis of the side port.

~~26~~22. A drilling system according to any ~~one of claims 16 to 25~~preceding claim wherein the valve body is located between the valve seat and the exterior of the tubular element.

~~27~~23. A drilling system according to any ~~one of claims 16 to 26~~preceding claim wherein the tubular element is a drill pipe or sub.

~~28. An assembly comprising a rod having a longitudinal axis, a support part, a resilient biasing element, and a nut, the nut being mounted on a screw thread around the rod, the assembly further comprising a locking collar which is mounted around the rod such that the biasing element extends between the support part and the locking collar, the locking collar having a first locking formation which engages with a corresponding locking formation of the rod to substantially prevent rotation of the locking collar around the rod, the biasing element pushing the locking ring into engagement with the nut so that at least one locking formation on the nut engages with a second locking formation on the locking collar, and, as a result, the locking collar substantially prevents further rotation of the nut about the rod.~~

~~29. An assembly according to claim 28 wherein the locking formation of the nut comprise two or more teeth or castellations extending from the nut generally parallel to the longitudinal axis of the rod.~~

~~30. An assembly according to claim 28 or 29 wherein the locking formation of the rod comprises a slot extending along an end of the rod generally parallel to its longitudinal axis, whilst the first locking formation of the collar comprises a protruberance or tab which extends radially inwardly of the locking collar into the slot.~~

~~31. An assembly according to claim 28, 29 or 30 wherein the first and second locking formations of the locking collar are integrally formed in a single part of the locking collar.~~

~~32. An assembly according to any one of claims 28 to 31 wherein the biasing element comprises a helical spring.~~

~~33. A valve assembly comprising a valve seat and a valve member which is movable into and out of engagement with the valve seat to open or close the valve assembly, and an assembly according to any one of claims 28 to 32 wherein the valve member comprises the rod, the support part is fixed relative to the valve seat, and the biasing element biases the valve member into or out of engagement with the valve seat.~~

~~34. A valve assembly according to claim 33 wherein the valve member is biased into engagement with the valve seat by means of the resilient biasing element.~~

~~35. A valve assembly according to claim 33 or 34 wherein the valve member further comprises a disc which is mounted on one end of the rod so that the rod extends centrally from and generally normal to the disc.~~

~~36. A valve assembly according to claim 35 wherein the valve assembly is configured such that it is the disc that engages with the valve seat when the valve member is engaged with the valve seat.~~

~~37. A valve assembly substantially as hereinbefore described with reference to and as shown in the accompanying drawings.~~

~~38. A drilling system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.~~

~~39. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.~~