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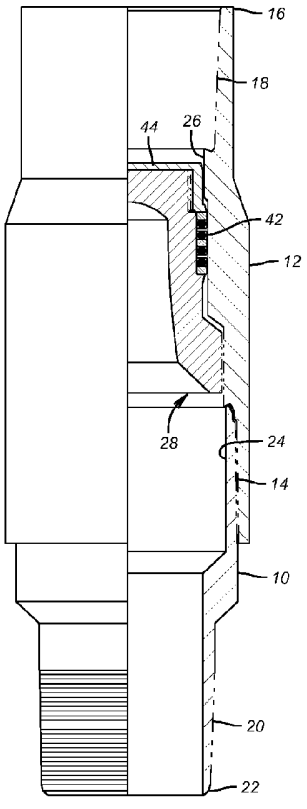
(54) Title: MILLABLE PRE-INSTALLED PLUG



(57) Abstract: A tubing plug (28) is preinstalled in a premium connection that allows support for the plug outside the drift dimension of the tubulars above and below. The plug is supported in a rotationally locked manner to avoid turning when being milled out. The plug shape internally comprises gentle sloping walls rather than surfaces in alignment with the longitudinal axis of the tubular to allow smaller cuttings to be produced that can be caught on a magnetic sub or circulated to the surface. Because the plug is supported in a zone outside the drift dimension of the adjacent tubulars, milling out the plug does not reduce the drift of the tubular assembly in which the plug was initially mounted. Seals can be provided for bubble tight sealing around the plug.

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Millable Pre-installed Plug

FIELD OF THE INVENTION

[0001] The field of this invention is tubular plugs and more particularly plugs to temporarily obstruct a tubular in a bore while a lateral is drilled and removable at a later time preferably without reduction of drift dimension of the tubular.

BACKGROUND OF THE INVENTION

[0002] Plugs have been used in tubulars downhole to temporarily close off a wellbore until another procedure such as drilling a lateral was completed. Plugs have been placed below whipstocks and even integrated into whipstocks as shown in USP 6,135,206 and 5,992,524. Other designs such as those offered by Total Catcher Offshore AS of Norway have incorporated a pup joint into which a sealed plug is installed. The pup joint is placed in the tubular string when it is made up. It features a firing system for an explosive charge that is hydraulically actuated or timer set to break the plug. An emergency release of the plug is stated to occur with a wireline emergency shoot down tool. This plug is referred to as a disappearing plug made of glass that as a result of setting off the explosive charge disintegrates into sand like particles. While such is the advertised performance of such a plug actual attempts to remove the plug when no longer required have resulted in the plug not completely disintegrating so as to partially obstruct the bore and reduce production from the previously isolated tubular. Another issue was large chunks forming that could not be removed from the wellbore or that would fall further into the well and interfere with later production.

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general knowledge in Australia or any other jurisdiction or that this prior art could reasonably be expected to be ascertained, understood and regarded as relevant by a person skilled in the art.

SUMMARY OF THE INVENTION

According to one aspect of the invention, there is provided a removable tubular plug, comprising: a pin and box components extending from ends of tubulars securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string, at a location away from said ends of said tubulars, having a drift diameter therethrough; a plug having an outermost dimension and supported at said outermost dimension by contact with a recess formed by at least one of said pin and box, said recess, where said contact with said outermost dimension occurs, is a greater dimension than said drift diameter; said outermost dimension of said plug is rotationally locked with said plug being not removable from said pin or box, when secured to each other, without destruction thereof.

According to another aspect of the invention, there is provided a removable tubular plug, comprising: a pin and box components securable to each other and defining a passage having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter, said plug blocking flow from downhole in said passage when supported in said recess; said plug is supported in said recess in a rotationally locked manner; splines lock said plug rotationally.

According to another aspect of the invention, there is provided a removable tubular plug, comprising: a pin and box components extending from ends of tubulars securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is removably supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave.

According to another aspect of the invention, there is provided a removable tubular plug, comprising: a pin and box components extending from ends of tubulars

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securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is removably supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave; said concave underside features a sloping wall with respect to a longitudinal axis of said plug.

According to another aspect of the invention, there is provided a removable tubular plug, comprising: a pin and box components securable to each other and defining a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave; said concave underside features a sloping wall with respect to a longitudinal axis of said plug.

[0004] In the present disclosure, details are provided of a tubing plug which is preinstalled in a premium connection that allows support for the plug outside the drift dimension of the tubulars above and below. The plug is supported in a rotationally locked manner to avoid turning when being milled out. The plug shape internally comprises gentle sloping walls rather than surfaces in alignment with the longitudinal axis of the tubular to allow smaller cuttings to be produced that can be caught on a magnetic sub or circulated to the surface. Because the plug is supported in a zone outside the drift dimension of the adjacent tubulars, milling out the plug does not reduce the drift of the tubular assembly in which the plug was initially mounted. Seals can be provided for bubble tight sealing around the plug.

[0003] The plug may be configured to be drilled or milled in a manner that will present small cuttings that can be captured on an adjacent magnetic sub or circulated to the surface. The plug is secured in a manner to prevent rotation during the mill out process and to leave a drift dimension in the tubular at least as large as the drill or mill that was run in to remove the plug in the first place.

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Features of the present invention will be more apparent to those skilled in the art from a review of the description of the preferred embodiment and the drawing as well as the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Figure 1 is a section view of an assembled plug in a tubular connection;

[0006] Figure 2 is a section of the female component of the connection holding the plug;

[0007] Figure 3 is a section of the male component of the connection holding the plug;

[0008] Figure 4 is a section of the plug;

[0009] Figure 5 is a section of the retaining cap for a seal assembly on the plug.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] Figure 1 illustrates a pin **10** secured to the box **12** at thread **14**. The upper end **16** of the box **12** has a premium thread **18** to secure a tubular string (not shown) above. Pin **10** has a premium thread **20** near its lower end **22**. When assembled, as shown in Figure 1, a recess **24** is formed that has a greater diameter than the drift dimension **26**

in the box **12**. The plug **28** is preferably secured in a manner that will prevent rotation when it is drilled or milled out within the recess **24**. The fixation against rotation can be varied to comprise among other techniques splines, dogs, or opposite hand threads from the direction of mill or drill rotation.

[0011] The plug **28** is preferably made from materials that are compatible with well temperatures and fluids and is relatively easy to mill through as well. The plug **28** is preferably made of at least one of a metallic, a non-metallic, plastic, ceramic and a composite material. Referring to Figure 4, the plug **28** has a hollow interior **30** that preferably has sloping walls **32** and **34** with respect to a longitudinal axis of the plug **28**. A curved surface **36** joins walls **32** and **34** near the top surface **38** of the plug **28** so that collectively a concave shape is defined. In reality walls **32** and **34** are simply a continuous circular sloping wall but other configurations are within the scope of the invention. The sloping walls **32** and **34** coupled with the curved surface **36** that joins them have been found to create very small cuttings that can be easily captured by an adjacent magnetic sub (not shown) or can be readily circulated to the surface and screened out. The upper surface **38** being preferably flat was not found to create issues with large cuttings that could fall into the tubular as the plug **28** is milled out. Of course, the hollow interior also speeds up the milling or drilling process.

[0012] On the exterior of the plug **28** is a surface **40** that accepts a seal assembly **42** that is shown in Figure 1. Cap **44** shown in Figures 1 and 5 has an internal thread **46** to secure the cap **44** to thread **48** on the plug **28**. When so secured, the seal assembly **42** is secured at surface **40**.

[0013] One way to secure the plug **28** is to provide a left hand thread **50** on it to thread into mating thread **52** on box **12**. When milling occurs, the drill or mill passes through the drift dimension **54** on the box **12** as well as the preferably same drift dimension **56** on the pin **10**. While this could leave a ring shaped remnant of plug **28** still secured to thread **52** on box **12** the opening size should be at least as large as the mill or drilled that just passed through and could be somewhat larger approaching the drift

dimensions **54** and **56**. This result happens even if the anti-rotation mechanism is something other than a left handed thread.

[0014] The sub that holds the plug **28** supports it in a recess to allow drilling or milling to present a drift dimension at least as large as **54** or **56**. The plug **28** is rotationally locked for mill out or drill out. The plug is preferably hollow and made of a material that expedites mill out or drill out. The wall on the plug underside features angled orientation to the longitudinal axis with an arcuate crown **36**. These features are designed to create smaller cuttings that can be more easily captured with a magnetic sub or circulated to the surface rather than falling down the tubular or remaining in place and hampering future production. The design eliminates the uncertainties of the prior designs that used glass and an explosive to make the plug hopefully disappear. This design is way cheaper to produce and can reliably remain in place for long periods of time. It can be effectively removed with assurance that the drift dimension will be clear after the removal.

[0015] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

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The claims defining the invention are as follows:

1. A removable tubular plug, comprising: a pin and box components extending from ends of tubulars securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string, at a location away from said ends of said tubulars, having a drift diameter therethrough; a plug having an outermost dimension and supported at said outermost dimension by contact with a recess formed by at least one of said pin and box, said recess, where said contact with said outermost dimension occurs, is a greater dimension than said drift diameter; said outermost dimension of said plug is rotationally locked with said plug being not removable from said pin or box, when secured to each other, without destruction thereof.

2. The plug of claim 1, wherein: a left hand thread locks the plug rotationally when milled or drilled by a tool turning the opposite direction.

3. The plug of claim 1, wherein: said plug leaves a drift dimension as large as said drift dimension in said pin and box after it is drilled or milled out.

4. The plug of claim 3, wherein: said drift dimension left by said plug after mill out or drill out includes some portion of it that remains in said recess.

5. The plug of claim 1, wherein: said plug is made of a material that is readily milled or drilled.

6. The plug of claim 5, wherein: said plug is made of at least one of a metallic, a non-metallic, plastic, ceramic and a composite material.

7. A removable tubular plug, comprising: a pin and box components securable to each other and defining a passage having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter, said plug blocking flow from downhole in said passage when supported in said recess; said plug is supported in said recess in a rotationally locked manner; splines lock said plug rotationally.

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8. A removable tubular plug, comprising: a pin and box components extending from ends of tubulars securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is removably supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave.

9. The plug of claim 8, wherein: said concave underside features a sloping wall with respect to a longitudinal axis of said plug.

10. The plug of claim 9, wherein: said concave underside features an arcuate surface between said sloping wall and a top end of said plug.

11. The plug of claim 10, wherein: said top end is substantially flat.

12. The plug of claim 11, wherein: said top end comprises a cap that retains a seal assembly to said plug.

13. The plug of claim 12, wherein: said cap is flat and is secured to said plug with threads.

14. A removable tubular plug, comprising: a pin and box components extending from ends of tubulars securable to each other and defining at least a portion of a tubing string for placement in a wellbore, said string having a drift diameter therethrough; a plug supported by at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is removably supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave; said concave underside features a sloping wall with respect to a longitudinal axis of said plug.

15. A removable tubular plug, comprising: a pin and box components securable to each other and defining a drift diameter therethrough; a plug supported by

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at least one of said pin and box and in a recess formed by at least one of them where said recess is a greater dimension than said drift diameter; said plug is supported in said recess in a rotationally locked manner; said plug has an elongated shape defining a top side that initially is drilled or milled away and an underside that is concave; said concave underside features a sloping wall with respect to a longitudinal axis of said plug.

16. The plug of claim 15, wherein: said concave underside features an arcuate surface between said sloping wall and a top end of said plug.

17. The plug of claim 16, wherein: said plug leaves a drift dimension as large as said drift dimension in said pin and box after it is drilled or milled out.

18. The plug of claim 17, wherein: said drift dimension left by said plug after mill out or drill out includes some portion of it that remains in said recess.

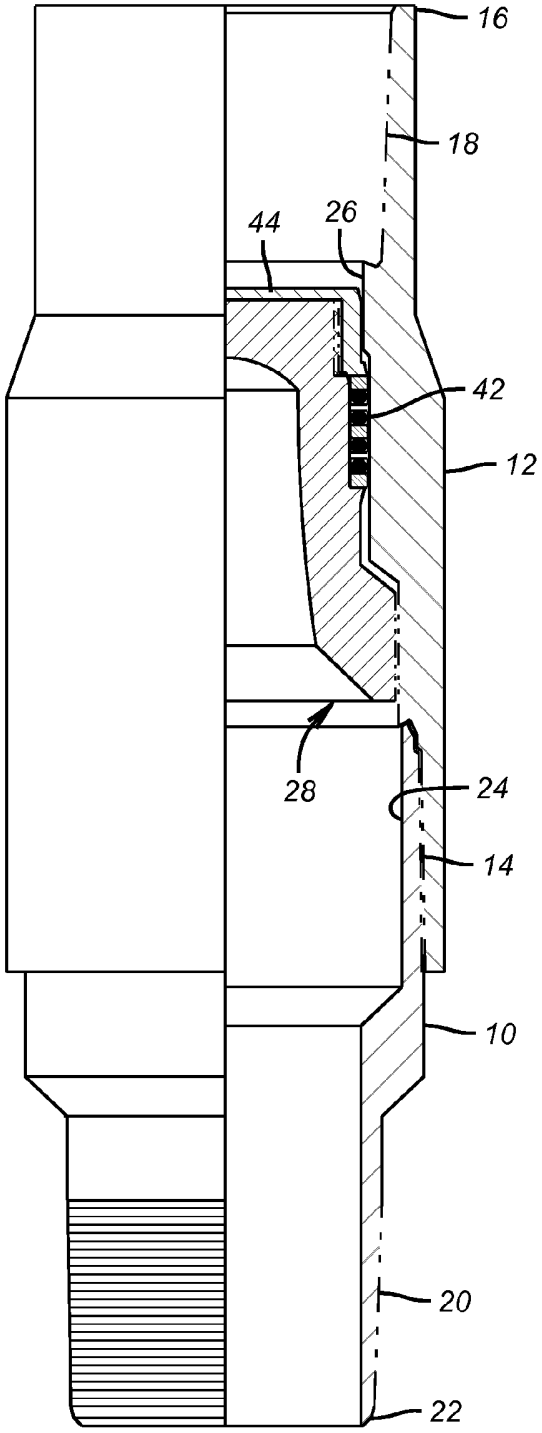

FIG. 1

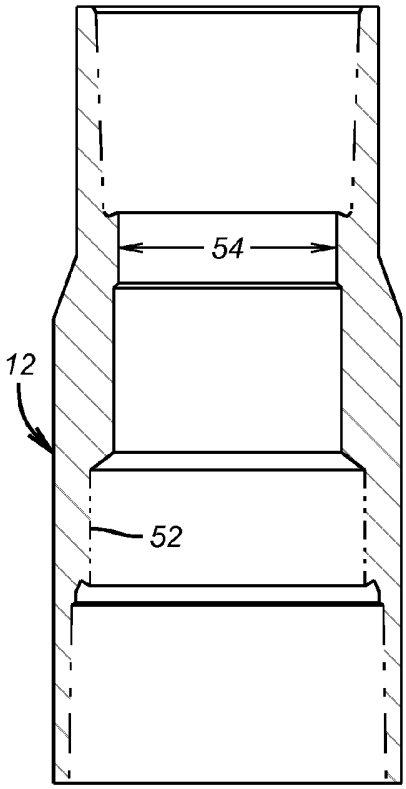

FIG. 2

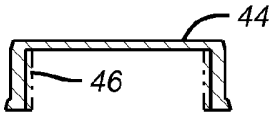

FIG. 5

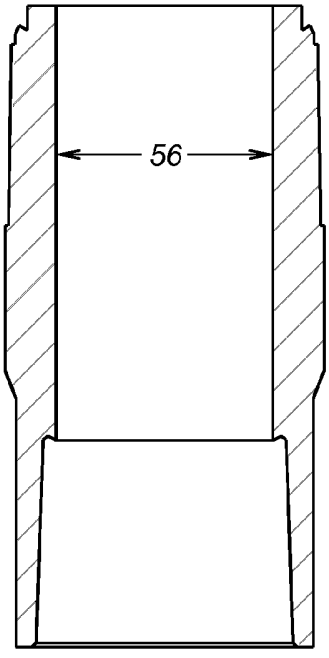

FIG. 3

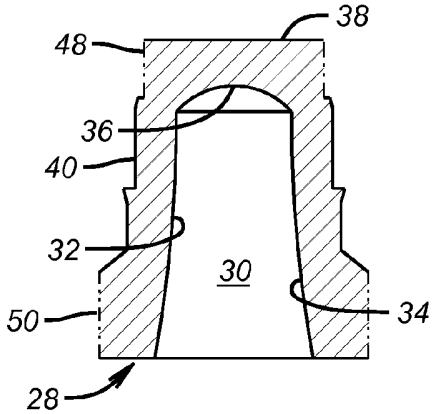

FIG. 4