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(54) **OFFSET VALVE SYSTEM FOR DOWNHOLE DRILLABLE EQUIPMENT**

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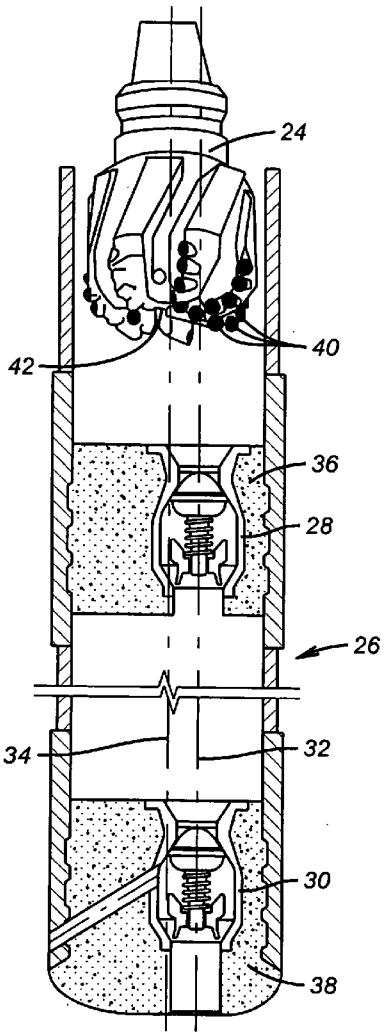
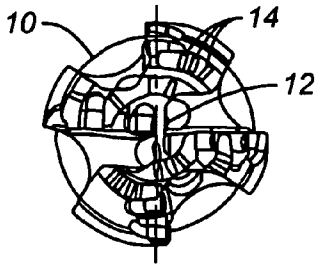
(57) **ABSTRACT**

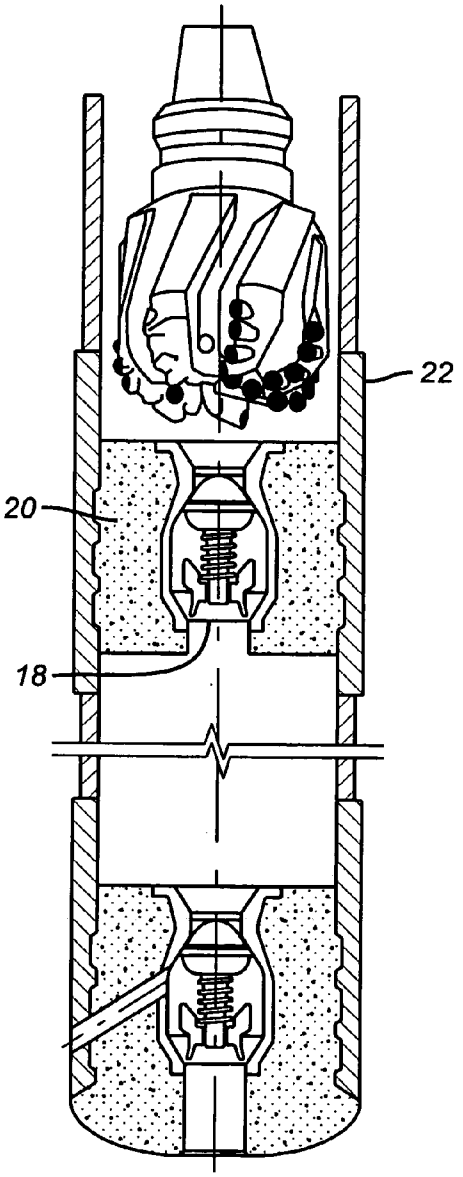
Float equipment is constructed to have the check valve in an offset and/or skewed position with respect to the centerline of the tubular housing that is part of a string. The design is applicable to poppet type check valves as well as flapper type valves that are actuated with a flow tube. The off center and/or skewed position of the valve components allows the cutting structure on a drill bit, rather than the nozzle area on the bit bottom to make intimate contact with the valve components to accelerate the milling one of the assembly and the making of additional hole beyond the recently cemented string.





(PRIOR ART)

FIG. 1



(PRIOR ART)

FIG. 2

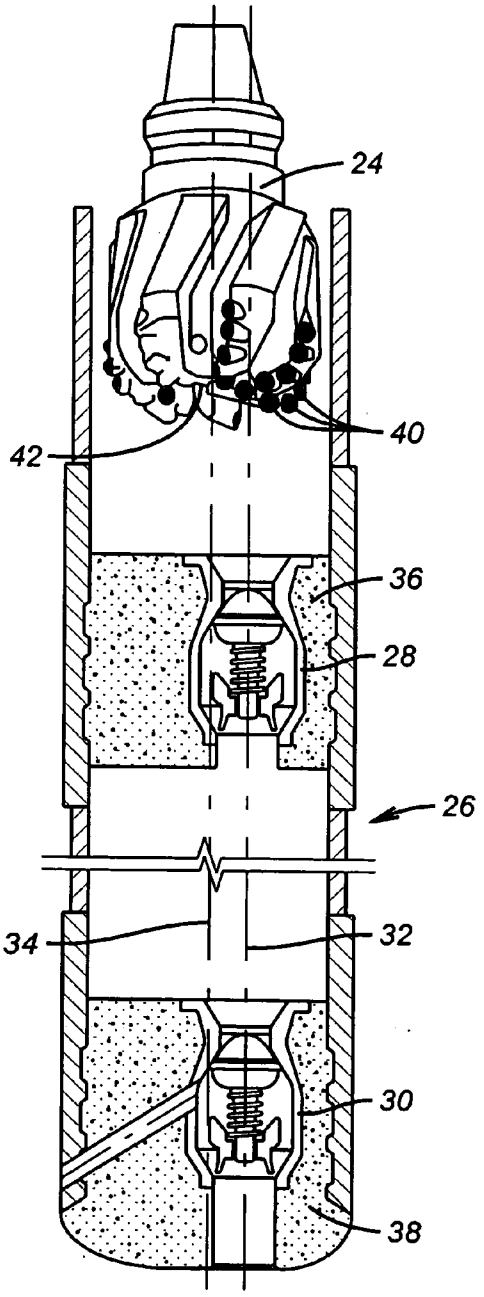
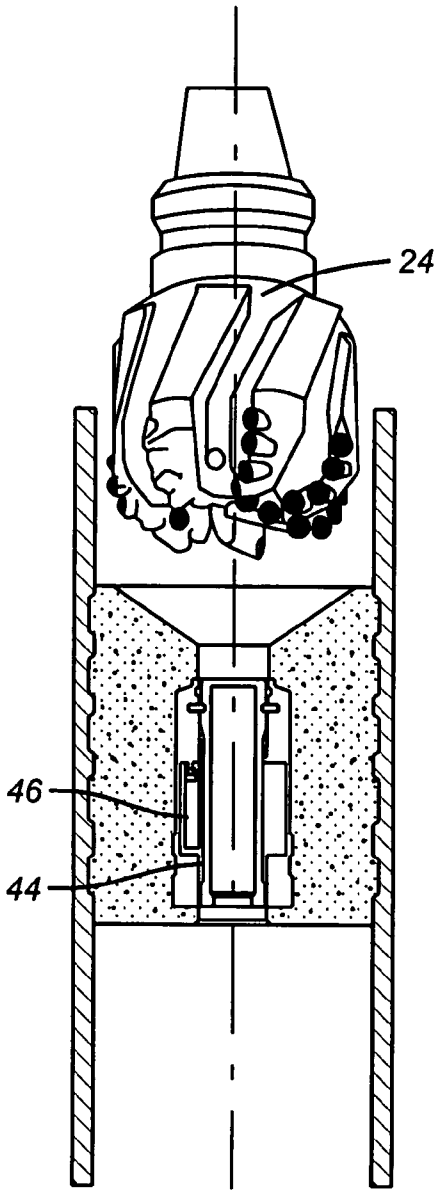


FIG. 3



(PRIOR ART)
FIG. 4

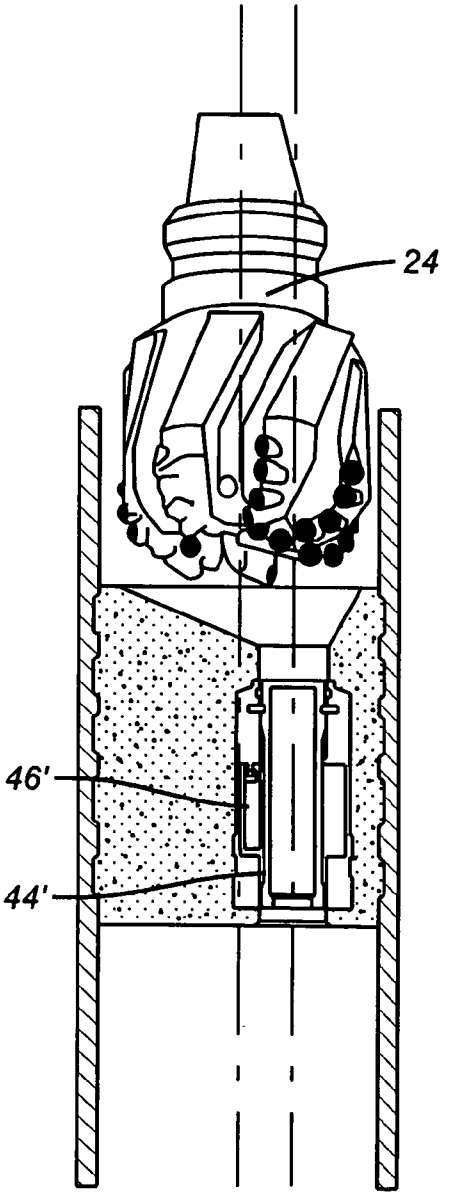


FIG. 5

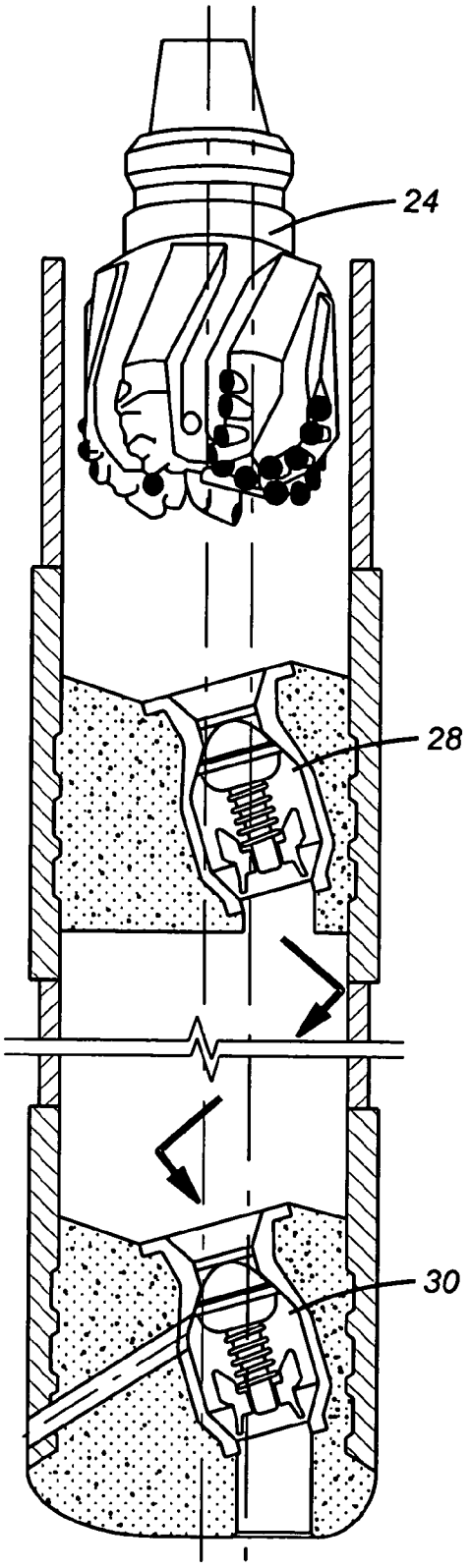


FIG. 6

OFFSET VALVE SYSTEM FOR DOWNHOLE DRILLABLE EQUIPMENT

FIELD OF THE INVENTION

[0001] The field of this invention is downhole equipment destined to be milled out after use and more particularly the positioning of the movable components within a surrounding tubular to speed up milling and even more specifically in a cementing application to obtain improved cement distribution while minimizing drilling fluid entrainment which can adversely affect the quality of the cement seal in the surrounding annulus.

BACKGROUND OF THE INVENTION

[0002] Float Equipment or an Auto-fill Collar is normally run at the bottom of a casing or tubing string to halt cement displacement. The short tubular section between the shoe and float collar is called the shoe track and is provided as a buffer within the casing to retain contamination that may build up ahead of the displacement plugs. The length of the shoe track is adjusted accommodating to well conditions.

[0003] The float shoe can prevent reverse flow, or U-tubing, of cement slurry from the annulus into the casing. The float shoe also reduces hook weight, because the check valve increases the buoyancy of the casing string by preventing backflow of fluid as the casing is lowered into the well.

[0004] Float equipment is basically delivered in two versions. The first version in based upon a check valve mechanism (Float shoe and Float Collar) and starts functioning, the moment is it run in the well bore. The second version in normally referred to as Auto-fill float equipment. This version allows the check valves to be by-passed while the tubular string is run in the wellbore. At a predetermined depth, the by-pass mechanism is de-activated (by means of flow, or a ball or plug) and converted to a check valve as described in the first version.

[0005] These valve mechanisms are normally placed in the center of the well and can create great problems when they are milled or drilled up at a later stage to deepen the wellbore.

[0006] In the present invention, placing the valve mechanism off center, on an angle (or skewed) will prevent excessive spinning of the valve mechanism when milled/drilled operations are performed. An increase decrease in drill-up time can greatly increase cost savings.

[0007] In another aspect of the present invention, a combination of the off-setting and skewing the valves will aid in the cement displacement and greatly improve the contamination possibility with conventional placed equipment.

[0008] Casing is normally run in the hole with a float shoe. This is basically a check valve that allows flow out of the casing string being run as it is delivered into position in the wellbore. Flow through the casing allows it to advance. When flow is cut off, circulation stops but well fluids are prevented from entering the casing string and it essentially floats, hence the name float shoe because the check valve assembly is at the leading end of the casing string. The excess cement is displaced with wiper plugs. After the particular string of casing is cemented additional hole will often need to be drilled beyond its lower end. To do this the float shoe assembly must be drilled out as the bit advances into the formation beyond the recently cemented casing.

[0009] Float shoes have been made in several ways. The most common is to centrally support the check valve assembly in cement that finds support in the inner wall of the casing string. Another way is to centrally mount the check valve assembly in a soft metallic material that is readily drillable.

[0010] Since time is money in drilling a well the speed with which the mill out occurs is important. Operators also want to continue the hole after mill out as quickly as possible. This has meant that bits ideally suited for making more hole have been used to do the mill out. Of late, these bits have been the polycrystalline diamond type or roller cone bits or flat bottom mills. The bottom view of a typical bit is shown in FIG. **1**. The bit **10** has centrally located nozzles **12** while the cutting inserts **16** are disposed closer to the periphery on the bottom face. What happens when such bits are employed to mill out a check valve **18** (or the valve mechanism #**46** in the Auto-fill equipment) that is suspended in cement (or composite material) **20** near the lower end of a casing string **22** is that the check valve encounters the nozzle area **12** rather than cutting inserts **14** and it starts to spin. The milling rate through the valve **18** is considerably slower than the rate that the cutters **14** go through the cement **20**. Also, since the valve mechanism is in the center of the borehole, it makes it difficult to prevent the valve mechanisms from spinning. As a result, operators either put up with the slower mill rate or actually trip out of the hole to change the bit for a mill just to mill out the float shoe and then trip out again to install the polycrystalline diamond bit to make more whole. Either option is not ideal. Despite this problem, the design of float shoes has been virtually unchanged for years.

[0011] The present invention addresses the problem by moving the position of the check valve relative to the longitudinal axis of the assembly off center or/and skewed. It places the check valve in greater alignment with the cutting structures on the bit to accelerate the milling process. Those skilled in the art will appreciate the various aspects of the present invention from the description of the preferred embodiment and the associated drawings as well as the claims that define the full scope of the invention.

[0012] The following U.S. patents relate generally to design of float equipment: U.S. Pat. Nos. 2,467,835; 4,133,378; 4,823,890; 6,296,059; 6,854,534 and 6,286,597.

SUMMARY OF THE INVENTION

[0013] Float equipment is constructed to have the check valve in an offset and/or skewed position with respect to the centerline of the tubular housing that is part of a string. The design is applicable to poppet type check valves as well as flapper type valves that are actuated with a flow tube. The off center and/or skewed position of the valve components allows the cutting structure on a drill bit, rather than the nozzle area on the bit bottom to make intimate contact with the valve components to accelerate the milling out of the assembly and the making of additional hole beyond the recently cemented string.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a bottom view of a known bit;

[0015] FIG. **2** is an elevation view of the float shoe assembly of the prior art just before a bit mills it up;

[0016] FIG. **3** shows a float shoe of the present invention with a poppet style valves off center from the longitudinal axis of the housing;

[0017] FIG. **4** is an elevation view of a prior art flapper type float shoe valve located on center in its housing;

[0018] FIG. **5** an elevation view of a flapper type float shoe valve located off center in its housing for faster mill out;

[0019] FIG. **6** shows poppet style valves off center and skewed to illustrate also the cement flow pattern between them.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] FIG. **3** shows a bit **24** just above a shoe track **26** which comprises poppet type valves **28** in a float collar and **30** in a float shoe of a typical shoe track **32** which is offset from centerline **34** of the shoe **26**. Valves **28** and **30** can also be on different centerlines from each other while both are offset radially from the centerline **34** of the shoe **26**. Cement (or any type of drillable material) **36** and **38** respectively surrounds valves **28** and **30** for support in the shoe track **26**. As an alternate to cement, other common drillable materials used in the oil industry can be used.

[0021] The bit **24** has bottom details similar to those shown in FIG. **1**. It can be a polycrystalline diamond bit, a rock bit or a tapered or flat bottom mill.

[0022] Because the valves **28** and **30** are offset from centerline **34** the inserts **40** dig directly at the valve assemblies as opposed to having the nozzles **42** that are generally in the center of the bit align with valves **28** and **30** which makes them harder to mill out. In the past with such alignment between nozzles **42** and the centerlines of the valves **28** and **30** the bit simply started the valves rotating on their own axes rather than tearing them up. This was because the nozzles on the drill bit aligned with the valve centers rather than the sharp cutters. Now with the orientation shown in FIG. **3** or another orientation where each valve is offset from centerline **34** but is on a different center than the other valve, the inserts **40** can readily mill up the valve.

[0023] FIG. **4** illustrates in Auto-fill type Float equipment where using flapper type valves for float equipment, the same difficulty milling out with a bit that had nozzles in the middle of its lower face happened.

[0024] The flow tube is pumped down hole and out of the Auto-fill float collar. The assembly normally lays on a catcher plate/sub, further down the well-bore. The parts that need to be drilled up, are the Flapper and the Flapper body. By offsetting the center of the flow tube holder **44'** and the flapper **46'** from the centerline of the surrounding tubular, the bit (not shown) can more quickly mill out the assembly as the inserts on the bit make more and initial contact with the flow tube. This keeps it from rotating on its long axis and results in faster mill out of it and the associated flapper **46'**.

[0025] While radial offset has been described, it is also within the scope of the invention to skew the longitudinal axis of the valve member in the float shoe such that the skewed axis still intersects the longitudinal axis of the housing. Alternatively, the longitudinal axis of the valve assembly in the shoe can be both radially offset from the housing longitudinal axis and skewed as shown in FIG. **6**. The skew of the mechanism places the cement more uniform in the shoe track, preventing possible leakage after curing of the cement. Additionally, the larger casing sizes will more likely accommodate a skew than smaller casing sizes. The skew also allows the inserts from the bit to get a better bite on the valve components to speed up the milling process. Again while the selected valve materials may be soft, the prior designs aligned them with the nozzles of bits making it easier for the mechanism to spin, thus retarding the milling rate overall. The bits were desired to be able to make more hole after the cementing of the casing string and milling out the shoe track used to deliver the string.

[0026] Those skilled in the art will appreciate that the offset technique works well with valves of all types used in float equipment as well as other tools. For example, when using bridge plugs, anchors or packers, collectively referred to herein as "packers" that later had to be drilled out prior designs tended to use plastics, soft metals or composite materials that presented reduced resistance to drilling out. However, past designs positioned a mandrel of such packer or bridge plug on center in the surrounding tubular as a result of the setting process. The present invention contemplates a set packer or bridge plug or other tool whose center is offset from the surrounding tubular center to also take advantage of the faster milling afforded by such a relationship. The seal and slips, in another embodiment, could be asymmetrical with respect to the mandrel centerline plug so that when set it could obtain the offset central axis position with respect to the surrounding tubular centerline. The slip mechanism needs to be secured into the surrounding tubular to prevent the complete system from rotating during milling or drilling.

[0027] 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.

I claim:

1. A completion assembly, comprising:

a tubular housing having a longitudinal axis;

a valve member having a valve longitudinal axis in a flow path therethrough, wherein said axes are not aligned.

2. The assembly of claim 1, wherein:

said axes are parallel.

3. The assembly of claim 1, wherein:

said valve longitudinal axis is skewed with respect to the housing longitudinal axis.

4. The assembly of claim 3, wherein:

said axes intersect.

5. The assembly of claim 1, wherein:

said axes do not intersect.

6. The assembly of claim 1, wherein:

said valve member comprises at least one spring loaded poppet.

7. The assembly of claim 1, wherein:

said valve member comprises a flapper actuated by a flow tube.

8. The assembly of claim 1, further comprising:

a bit having cutters surrounding circulation nozzles on a bottom face thereof, said cutters being in alignment with more of said valve member as a result of said non alignment of said axes as compared to said axes being aligned.

9. The assembly of claim 8, wherein:

said valve member comprises at least one poppet or flapper.

10. The assembly of claim 8, wherein:

said valve member comprises a flapper actuated by a flow tube.

11. A method of inserting and removing a downhole tool, comprising:

running a tool to a desired position downhole;

supporting the tool so that its longitudinal axis is not aligned with the longitudinal axis of the surrounding tubular or the wellbore;

running a bit to the tool;

drilling up the tool.

12. The method of claim 11, comprising:

making said axes parallel.

13. The method of claim 11, comprising:

making said axes skewed.

14. The method of claim 13, comprising:

making said axes intersect.

15. The method of claim 11, comprising:

making the longitudinal axis in said tool coincide with a selectively closeable passage in said tool.

16. The method of claim 15, comprising:

using a valve in a float shoe or collar as said tool.

17. The method of claim 15, comprising:

using a flapper valve actuated by a flow tube in a float shoe or collar as said tool.

18. The method of claim 11, comprising:

drilling more hole after drilling up the tool.

19. The method of claim 11, comprising:

supporting said tool in cement.

20. The method of claim 11, comprising:

using a packer as said tool.

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