July 20, 1965 G. M. McKOWN 3,195,660

DRILLING BIT

Filed April 5, 1962

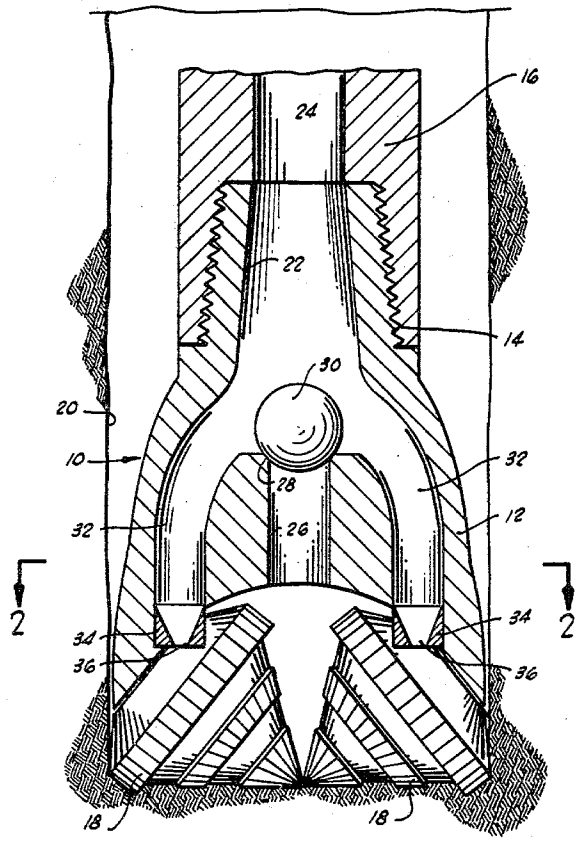


Fig. 1

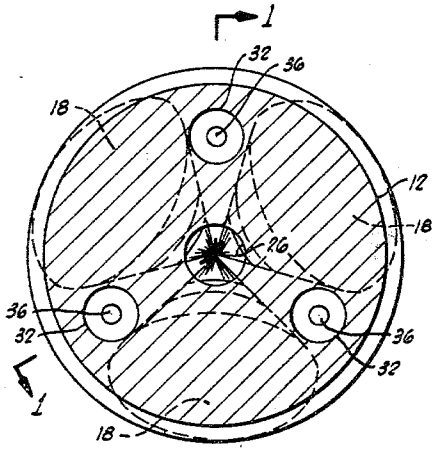


Fig. 2

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DRILLING BIT

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The present invention relates to earth boring and more particularly, but not by way of limitation, relates to an improved drilling bit of the type having drilling mud jets for cleaning the bottom of the well bore as it is cut.

In the rotary method of earth boring customarily used for drilling oil wells, a fluid called drilling mud is pumped downwardly through a tubular drill string to a drill bit which is connected to the lower end of the drill string. The drilling mud passes through the bit and circulates back to the surface through the annular space between the well bore and the drill string. As the drilling mud circulates back to the surface, the cuttings loosened from the formation by the drill bit are cleaned from the well bore. A conventional drill bit is provided with relatively large openings through which the mud passes at substantially the same, relatively slow velocity that it passes downwardly through the tubular drill string. A fluid jet type bit, on the other hand, is provided with a plurality of small nozzles, usually three, which direct a high velocity jet or stream of drilling mud against the bottom of the bore. The high velocity drilling mud jet substantially increases the efficiency with which the cuttings are removed from the bottom of the well bore so that the drill bit is always cutting on virgin rock formation. The present invention is concerned with an improved fluid jet type drill bit.

Conventional fluid jet type drill bits have very small passageways communicating with the interior of the drill string and these small passageways are further restricted by jet nozzles so that flow of drilling mud or other fluid in either direction through the drill bit is greatly restricted and requires a high pressure. Therefore, these restricted passageways through the bit, which are necessary to produce the fluid jets, create a considerable number of very real problems during normal drilling operations. For example, as the drill bit and drill string are lowered into the well bore or hole, the nozzles substantially limit the volume of fluid which will invariably be standing in the hole which may enter the drill string. Therefore, the drill bit and string act as a piston as they are lowered into the hole. The great weight of the string acting as a piston creates high pressure surges in the fluid standing in the hole. These pressure surges may break down the surrounding formations to the extent that they will take drilling mud and upon resumption of drilling, circulation of the drilling mud may be lost. Although lost circulation may be encountered without piston effects, piston effects will increase the likelihood of lost circulation. Also, if the drill string does not fill completely with fluid as it is run into the hole, when circulation of the drilling mud is started a slug or bubble of air standing in the drill string will be pumped downwardly through the drill bit and into the hole. This slug or bubble of air may directly damage the hole, may change the desirable properties of the mud, may lighten the fluid column standing in the hole and thereby substantially increase the risk of a blow-out, or may interfere with the recovery of good samples of formation from the bottom of the hole.

As a drill string having a fluid jet bit with small fluid jet passageways is removed from the hole, the small orifices seldom permit the drilling mud standing in the drill string to drain out, so that a substantial volume of the drilling mud is frequently trapped in the string. In the oil well drilling industry, this is known as a wet stand of drill pipe. When the upper stand of joints of a string of drill pipe are

unscrewed to be temporarily stored in vertical position in the derrick, mud which has not drained from the stand of pipe will be sprayed over the derrick floor. Wet stands of drill pipe are unpleasant to the crew, make the derrick floor slick and dangerous, and waste drilling mud, which may be an expensive chemical solution. In cold weather the drilling mud may freeze and coat the derrick floor and equipment with ice, which greatly slows the drilling operation and makes the drill pipe hard to handle. Further, if a string of drill pipe having a fluid jet bit connected to the lower end thereof is removed from the hole and the fluid standing in the string is not permitted to freely drain from the pipe to fill the hole, the drill string will tend to swab the hole, that is tend to create a vacuum or greatly reduced pressure within the hole. This may "suck" the hole in by causing soft rock formations to cave in, or it may start a blow-out by relieving the hydro-static pressure normally exerted by the column of drilling mud against the formations.

As previously mentioned, the fluid jets are very small and are, therefore, very easily plugged by foreign material. When circulation of the drilling mud has been lost, sometimes it is desirable to add large quantities of solid "lost circulation" material to the mud pumped down the drill string in hopes that the material will plug the formation and permit proper circulation to be re-established. These lost circulation materials are usually fibrous, granular, or laminated materials which are relatively large and actually plug up the fluid passageways in the particular rock or earth formation which is taking the mud. These lost circulation materials will also very frequently plug the small nozzles of fluid jet bits. In the event the small fluid jets become stopped up, the entire string of drill pipe must be removed from the hole so that the jet bit can be disconnected and the nozzles cleared, or the jet bit exchanged for a conventional bit, as will usually be the case if it is desired to continue to use lost circulation material in the drilling mud. Fluid jet type drill bits require a relatively high mud pump pressure to operate effectively. These high operating pressures sometimes result in a failure of the equipment which requires that the pressures be reduced if drilling is to continue until repairs can be made. In such an event, the jet drill bit must be removed from the hole and replaced by a conventional bit which is a time consuming and expensive procedure.

Therefore, it is a very important object of the present invention to provide an improved fluid jet type drill bit.

Another very important object of the present invention is to provide a novel valve mechanism for a downhole tool.

Still another object of the present invention is to provide a fluid jet type drill bit which will considerably reduce piston effects as it is lowered into a well bore.

Another object of the present invention is to provide an improved drill bit of the type described which will permit the drill string to fill with fluid and thereby eliminate the formation of a bubble of air within the drill string.

Still another object of the present invention is to provide a drill bit of the type described which will readily permit draining of drilling mud from within the drill string as the drill string is removed from the well bore to greatly reduce wet stands of drill pipe.

Yet another object of the present invention is to provide a drill bit of the type described which will permit fluid within the drill string to readily pass into and fill the well bore as the drill string is raised to thereby eliminate swabbing of the hole.

Yet another very important object of the present invention is to provide a fluid jet type drill bit as described which may continue to be utilized in the event the small jets become plugged by foreign material without removing the drill bit from the hole to clean the jets.

A further object of the present invention is to provide a drill bit of the type described through which lost circulation materials can readily be pumped without replacing the jet type bit with a conventional bit.

Still another object of the present invention is to provide a drill bit of the type described which may conveniently be operated as either a fluid jet type bit for cleaning the bottom of the hole or as a conventional bit, as desired, without removing the bit from the hole.

These objects are accomplished in accordance with the present invention by an improved drill bit comprised generally of a drill bit having at least one fluid jet passageway means for directing a relatively high velocity jet of drilling mud from the bit for cleaning purposes and a considerably larger bypass passageway for passing a greater volume of drilling mud with substantially less resistance than is offered by the fluid jet passageway means. An annular valve seat is formed in the fluid bypass passageway and a buoyant valve member is provided for mating with the valve seat to block the downward passage of drilling mud through the bypass passageway. Then when drilling fluid is pumped downwardly through the drill string, the valve member will be seated and passage of drilling mud through the bypass passageway will be blocked and the drilling mud will be forced through the fluid jet passageway means at a relatively high velocity in accordance with the size of the jet passageway and the pressure of the fluid. When pumping of the drilling mud is stopped, the valve member will be buoyed up by the drilling mud to open the bypass and permit either the upward or downward passage of a substantial volume of drilling mud through the bit with relatively little pressure drop.

Many additional objects and advantages of the present invention will be apparent from the following detailed description and drawings, wherein:

FIG. 1 is a simplified longitudinal sectional view of a drill bit constructed in accordance with the present invention, the section being taken substantially on lines 1—1 of FIG. 2; and

FIG. 2 is a simplified cross-sectional view taken substantially on lines 2—2 of FIG. 1.

Referring now to the drawings, an improved drill bit constructed in accordance with the present invention is indicated generally by the reference numeral **10**. The drill bit **10** is comprised of a body portion **12** having a threaded shank portion **14** at the upper end thereof for connection to a standard drill collar **16** which is the lowermost joint of a drill string extending to a drilling rig at the surface. Three conventional conically shaped cutting members **18** are rotatably connected to the drill bit body **12** in the conventional manner. In this regard, it will be noted that the longitudinal sectional view of FIG. 1 is taken on two radials from the longitudinal axis of the bit **10** spaced 120 degrees apart, as shown by the line 1—1 on FIG. 2, so that the conical members **18** in FIG. 1 appear to be diametrically opposed. However, as shown in dotted outline in FIG. 2, the conical cutting members **18** are disposed such that the axes of rotation of the conical cutting members **18** are spaced at approximately 120 degrees. The drill bit **10** is shown disposed in a hole or well bore **20** which may be presumed as having been cut through the earth by conventional rotary drilling methods.

The shank portion **14** of the body **12** is provided with an axial fluid passageway **22** which registers with the fluid passageway **24** through the tubular drill collar **16**, and therefore through the drill string to a source of drilling mud at the rig. A relatively large axial passageway **26** is formed in the lower part of the drill bit body **12**, and in effect forms a continuation of the axial fluid passageway **22**, although being of smaller diameter, to provide a longitudinally extending passageway through the drill bit body **12**. An annular valve seat **28** is conveniently formed in the continuous passageway at the intersection of the passageways **22** and **26**. The annular seat **28** is

sufficiently small to seat a buoyant valve member **30**, hereafter described in greater detail, which will freely pass through the interior passageway **24** of the drill string and through passageway **22**.

Three fluid jet passageways **32** are in fluid communication with the fluid passageway **22** at a point above the annular seat **28**. The fluid jet passageways **32** are equally spaced around the periphery of the body **12** and have restrictive jet nozzles **34** which are arranged to direct a fluid jet between each adjacent pair of conical cutting members **18** onto the bottom of the well bore **20** efficiently cleaning the cuttings from the bottom of the bore and entraining the cuttings in the mud stream. The nozzle members **34** have relatively small, highly restrictive orifices **36** for converting a high fluid pressure into a high fluid velocity.

The valve member **30** is preferably spherical in shape and has a density or specific gravity less than that of the particular drilling mud being utilized in the drilling operation, so as to make the valve member **30** buoyant. As is well known in the drilling industry, the specific gravity and viscosity of the drilling mud used will vary with each particular application. Accordingly, the specific gravity of the valve member **30** should be selected so that the buoyant force acting on the valve member **30** will be sufficient to force the valve member upwardly through the drill string at approximately 300 feet per minute. Of course, the exact rate of buoyant ascension of the valve member **30** through the drill string is, in general, not critical and may vary substantially in accordance with the desired effect to be produced. However, the rate of ascension should not exceed the rate at which drilling mud is pumped down the drill string as will hereafter be evident. On the other hand, the rate of ascension should not be so slow as to cause undue delay.

The valve member **30** may conveniently be fabricated in the form of a hollow steel ball, a hard plastic, ceramic, wood or any other similar material which will withstand a considerable pressure differential without crushing and having the desired properties of hardness, resistance to abrasion and wear, and the required specific gravity to produce the desired buoyancy in the particular drilling mud being used. As mentioned, the viscosity of the drilling mud will have a direct effect upon the rate at which the buoyant valve member **30** will rise through the drill string, as will the shape of the valve member **30**. In this regard, it will be appreciated that an elongated valve member **30**, having somewhat sharpened ends will increase the rate of travel upwardly through the drilling mud if necessary. It will also be noted that the relative size between the spherical valve member **30** and the fluid jet passageways **32** in such that the valve member cannot possibly block the fluid jet passageways, but instead will positively be forced against only the valve seat **28** to close the bypass passageway **26**, as will be presently described.

The buoyant valve member **30** may be seated on the valve seat **28** merely by dropping the valve member in the top of the drill string and then pumping it downwardly through the drill string with the drilling mud. Since the drilling mud will flow downwardly at a considerably greater rate than the rate at which the valve member **30** will ascend due to its buoyancy, the valve member **30** may be firmly seated and held against the valve seat **28** to close the bypass passageway **26**. Continued pumping of the drilling mud will create a relatively high pressure drop through the fluid jets and therefore across the valve member **30** so that the valve member will remain seated, and the drilling mud will continue to be forced through the restricting orifices **36** of the nozzle members **34** and directed at the bottom of the well bore **20** at a high velocity. When it is desired to open the bypass passageway **26**, the downward flow of drilling mud is stopped and the valve member **30** is permitted to float off the seat **28**. At any time after the valve mem-

ber has floated off the seat, it may be re-seated by resuming pumping of the drilling mud, or the valve member 30 may be permitted to float all the way to the top of the drill string where it may be manually retrieved. Or if the level of fluid in the drill string is too low, the valve member 30 may be retrieved by a conventional basket lowered into the drill string by a wire line.

During normal drilling operations, the valve member 30 is retained at the surface and the drill bit 10 is lowered into the well bore by making up the drill string. As the bit is lowered into the bore, the bypass passageway 26 will be open and fluids such as drilling mud standing in the bore will easily pass through the bit 10 into the drill string to relieve the pressure surges which would otherwise be caused by piston effects. When the drill bit is resting on the bottom of the well bore, the valve member 30 may be dropped into the drill string and will fall a short distance to the fluid level standing within the drill string. Drilling mud is then pumped downwardly through the drill string in the conventional manner and is circulated back through the annulus formed by the well bore around the drill string. During the time that the valve body 30 is being pumped downwardly by the drilling mud the bit 10 will operate as a conventional bit and the pressure required will be relatively low because the drilling fluid will pass through the bypass passageway 26, as well as through the fluid jet passageways 32. When the valve member 30 seats on the valve seat 28, the pressure required to circulate the drilling mud will sharply increase and the drilling mud will pass through the restrictive jet nozzles 34 at a high velocity. The jet of drilling mud will be directed between the conical cutting members 18 and will impinge against the bottom of the well bore to very effectively remove all cuttings and present virgin formation to the conical cutting members 18. The cuttings will then be entrained in the drilling mud and washed and floated from the well bore as the drilling mud is circulating back to the surface.

As the well bore is deepened, it is necessary to stop the rotary drilling operation in order to add another joint of drill pipe. During this stoppage the valve member 30 will float part of the way up the drill string. However, upon resumption of circulation of the drilling mud, the buoyant valve member 30 will again be pumped downwardly and against seat on the valve seat 28 so that the drilling mud will again be jetted at high velocity from the nozzle members 34. When the conical cutting members 18 become dulled it is necessary to remove the entire string of drill pipe from the hole in order to replace the bit. During this operation pumping of the drilling mud ceases so that the buoyant valve member 30 will float upwardly from the seat 28 to the level of the drilling mud in the drill string and the bypass passageway 26 will be open. Accordingly, as the drill string is raised a sufficient distance to disconnect each successive stand of drill pipe, the drilling mud within the drill string will freely pass through the relatively large bypass passageway 26 as well as through the more restrictive fluid jet passageways 32 to both drain the drilling mud from the string and eliminate wet stands and also prevent swabbing of the hole. When the last joint 16 of the drill string and the bit 10 have been removed from the hole, the buoyant valve member 30 will be found on the annular seat 28, the valve member 30 having been deposited there as the last trace of drilling mud drained from the bit 10.

Therefore, it will be noted that during normal operation of the improved drill bit 10 the piston effects created as the more conventional jet type drill bits are lowered into the well bore have been eliminated. This is due to the fact that the bypass passageway 26 which is relatively large readily permits drilling mud standing in the well bore to enter the interior passageway 24 of the drill string as it is lowered. As previously discussed, this eliminates the pressure surges which frequently break down the formations and result in a loss of circulation of the drilling mud upon resumption of the drilling operation. Further, the ready entrance of the drilling mud into the interior of the drill string insures that the drill string will be substantially filled with drilling mud, so as to eliminate any pockets or bubbles of air which might otherwise be formed. This materially reduces the possibility of damage to the hole, changes in the properties of the mud, and the reduction of the weight of the column of drilling mud standing in the well bore annulus, which thereby reduces the risk of a blow-out.

It will also be noted that as the drill string is removed from the well bore for replacement of the bit or for any other purpose, the drill string will be raised at a rate considerably less than the rate at which the buoyant valve member 30 will float upwardly through the drill string. Accordingly, the bypass passageway 26 will be open and the drilling mud standing within the drill string will easily pass downwardly through the bypass passageway 26 to empty the drill string as it is raised. This greatly reduces the likelihood of having a wet stand of pipe. Further, the drilling mud will drain from the drill string substantially as fast as the bit is raised without an appreciable pressure drop. This substantially reduces the tendency of the drill string to swab the hole as it is raised, and therefore reduces the likelihood of caving the hole in or starting a blow-out due to a reduction of the hydrostatic pressure within the well bore.

If during the drilling operation the small openings 36 in the nozzles 34 become clogged by cuttings, lost circulation material or any other foreign body, it is sometimes possible to clean the nozzles 34 in the following manner without removing the bit 10 from the hole. First, the drilling mud pumps are stopped and the buoyant valve member 30 permitted to rise from the seat 28. Then the drill string is rapidly reciprocated up and down a few feet. Mud surging through the nozzles 34 may dislodge the plugging material, and the dislodged material will have a tendency to pass outwardly through the substantially larger bypass passageway 26. Even if the nozzles cannot be cleaned in this manner, the buoyant valve member 30 may be removed from the drill string and the drill bit 10 operated as a conventional bit rather than as a fluid jet type bit.

In order to float the bouyant valve member 30 completely from the drill string so that it may be retrieved by hand, it may be necessary to make the drill string stand completely full of liquid by adding water, oil or mud that has a density less than the density of the drilling mud which is standing in the well bore annulus around the drill string. Otherwise the level of the drilling mud within the drill string will equalize with the level of the mud within the well bore annulus, which may be substantially below the floor of the drilling rig and therefore below the top of the drill string. In any event, the buoyant valve member 30 may easily be retrieved the last few feet, or from any depth if necessary, by a conventional retrieving basket lowered by a wire line.

In the event circulation of the drilling mud is lost due to the drilling mud entering the formations around the well bore, it may be desirable to mix heavy concentrations of lost circulation material with the drilling mud in hopes that the lost circulation material will plug the formation and permit proper circulation to be re-established. In the more conventional fluid jet type drill bits it would usually be necessary to remove the bit from the hole and replace it with the conventional bit having sufficiently large passageways to pass lost circulation material. However, the improved drill bit 10 permits lost circulation material to be added to the drilling mud without removing it from the hole, simply by permitting the buoyant valve member 30 to float upwardly through the drill string and retrieving it from the drill string as described above. The lost circulation material may then be circulated through the relatively large bypass passageway 26 as the bit 10 is operated in the conventional manner.

In the event that circulation has been lost to the extent that the drill string cannot be made to stand full of drilling mud, it will be impossible to float the valve member **30** from the drill string. In such an event a conventional fishing basket may conveniently be lowered through the drill string by a wire measuring line to the top of the liquid standing in the string and the buoyant valve member **30** retrieved. In addition to removing the buoyant valve member **30** in order to permit use of lost circulation material, it will be appreciated that the valve member can be removed for any purpose, such as when it is necessary due to mechanical failure to reduce the pump pressure of the drilling mud. In such a case, the buoyant valve member **30** can be removed and the bit **10** operated as a conventional bit rather than as a fluid jet type bit, to thereby substantially reduce the pressure required.

In view of the above detailed description of a preferred embodiment of the improved jet type drill bit, it will also be obvious to those skilled in the art that the novel valve member **30** may be effectively utilized in connection with other types of downhole tools without departing from one important aspect of the present invention. Further, it is to be understood that various changes, substitutions and alterations can be made in the particular embodiments disclosed without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An improved jet drill bit comprising, in combination:

a drill bit having at least one fluid jet passageway means through the bit for directing a jet of drilling mud from the bit at high velocity, and having a fluid bypass passageway for passing drilling mud through the bit,

a valve seat in the fluid bypass passageway, and a valve member for seating on the valve seat and blocking the downward passage of drilling mud through the bypass passageway having a specific gravity less than that of the drilling fluid being used with the drill bit,

whereby so long as drilling mud is pumped downwardly through the drill bit the valve member will be seated on the valve seat and the drilling mud will be prevented from passing through the bypass passageway and will be directed through the jet passageway means, and upon cessation of the flow of drilling mud, the valve member will float upwardly from the valve seat to open the fluid bypass passageway to and again permit the downward flow of mud through the bypass passageway.

2. An improved drill bit for attachment to the lower end of a tubular drill string through which drilling mud is pumped downwardly to the bit for cleaning the well bore, the improved drill bit comprising, in combination:

a drill bit having a body;

at least one fluid jet passageway means through the body for directing a jet of drilling mud from the body;

a fluid bypass passageway through the body for passing drilling mud through the body;

a valve seat in the bypass passageway; and,

a valve member for seating on the valve seat and blocking the downward passage of drilling mud through the bypass passageway having a specific gravity less than that of the drilling fluid being used with the drill bit,

whereby the valve member will be seated when drilling mud is pumped downwardly through the drill string and the valve member will be floated upwardly through the drill string by the drilling mud standing therein when pumping of the drilling mud is stopped to open the bypass passageway and again permit the downward flow of fluid through the bypass passageway.

3. An improved drill bit for attachment to the lower end of a tubular drill string through which drilling mud is pumped downwardly to the bit for cleaning the well bore, the improved drill bit comprising the combination as defined in claim **2**, wherein:

the valve member is spherically shaped and is sufficiently small to pass downwardly through the tubular drill string and sufficiently large to seat on the valve seat.

4. An improved drill bit for attachment to the lower end of a tubular drill string through which drilling mud is pumped downwardly to the bit for cleaning the well bore, the improved drill bit comprising in combination:

a drill bit having a cylindrical body and a plurality of cutting members disposed at the lower end thereof for cutting a bore;

a central fluid passageway extending longitudinally through the center portion of the body;

a fluid jet passageway means in fluid communication with the central fluid passageway means at a midpoint of the body, the fluid jet passageway means having a plurality of jet nozzle means in the lower end of the body for directing a jet of drilling mud downwardly for cleaning the bore;

a valve seat in the central fluid passageway below the point at which the fluid jet passageway means communicates with the central fluid passageway means; and,

a valve member having a specific gravity less than that of the drilling fluid being used with the drill bit for seating on the valve seat and blocking the downward passage of pumped drilling mud through the central fluid passageway,

whereby the pumped drilling mud will be prevented from passing through the central fluid passageway and will be forced through the jet nozzle means at high velocity to clean the well bore, and when pumping of the drilling fluid is ceased, the buoyant valve member will be buoyed upwardly by the drilling mud to open the central fluid passageway.

5. A method for operating a downhole valve mechanism comprised of an annular seat formed in a fluid passageway which is to be opened and closed and a valve member having a specific gravity less than that of the fluid being passed through the fluid passageway and adapted to seat on the annular seat to block fluid passage therethrough, the method comprising the steps of:

pumping the valve member downwardly to the valve seat by pumping a liquid of greater specific gravity than the valve member downwardly through the fluid passageway at a velocity greater than the rate at which the valve member will rise through the liquid until the valve member is seated,

maintaining the valve member seated on the valve seat by maintaining a pressure differential across the valve member sufficient to overcome any buoyant force exerted by the liquid on the valve member; and

reducing the pressure differential across the valve member to permit the valve member to float free of the valve seat and open the valve mechanism and permit the subsequent downward passage of fluid through the passageway.

6. In combination:

a tool for insertion in a well bore,

a fluid passageway through the tool;

an upwardly facing annular valve seat in the fluid passageway; and

a valve member having a specific gravity less than that of the fluid in the well bore for seating on the valve seat and blocking the downward flow of fluid through the fluid passageway and floating from the valve seat upon equalization of pressure across the valve seat;

whereby the valve formed by the valve seat and valve member may be repeatedly opened and closed at will by alternately starting and stopping the downward flow of fluid through the fluid passageway.

7. A drill bit comprising:

a rotary bit having a plurality of fluid passageways with jet nozzles therein for directing jets of drilling fluid downwardly from the bit onto the bottom of the borehole,

a centrally located bypass passageway for passing drilling fluid downwardly through the bit, the bypass passageway having a cross-sectional area substantially greater than that of the jet nozzles for passing fluid through the bit substantially more freely,

an upwardly-facing, annular seat formed in the bypass passageway, and

a valve member having a specific gravity less than that of the drilling fluid to be used for seating on the valve seat, the valve member being free to rise from the bit into a drill string connected to the bit,

whereby the bypass passageway may be closed and the bit operated as a jet bit by pumping the valve member down against the seat, and the bypass passageway may be opened to permit the downward flow of drilling fluid by temporarily stopping the downward flow of drilling fluid and permitting the valve member to float upwardly from the seat.

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CHARLES E. O'CONNELL, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,195,660 July 20, 1965

George M. McKown

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 52, for "in" read -- is --; column 5, line 45, for "against" read -- again --; column 7, line 48, strike out "and"; column 8, lines 38 and 39, for "mechaanism" read -- mechanism --; colum 10, line 9, for "2,313,789" read -- 2,312,789 --.

Signed and sealed this 15th day of March 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents