Dec. 26, 1967 E. A. ANDERSON 3,360,057

FLUID CONTROLLED DIRECTIONAL BIT AND ITS METHOD OF USE

Filed Dec. 6, 1965 2 Sheets-Sheet 1

Fig. 1

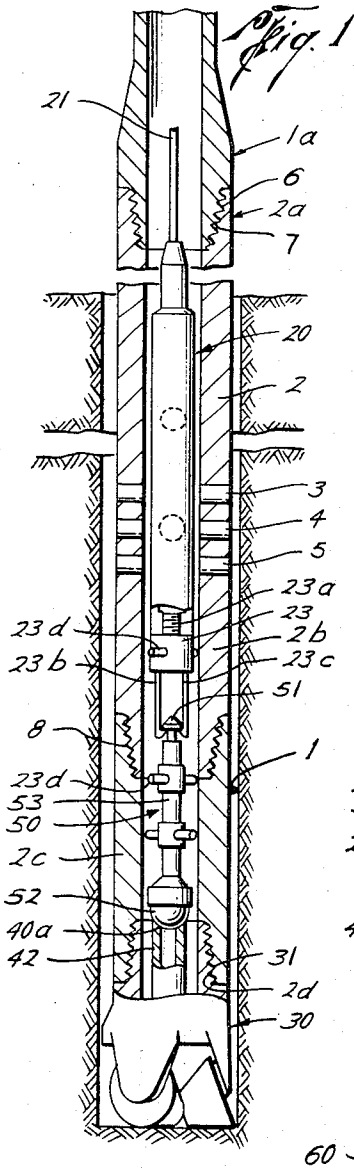


Fig. 2

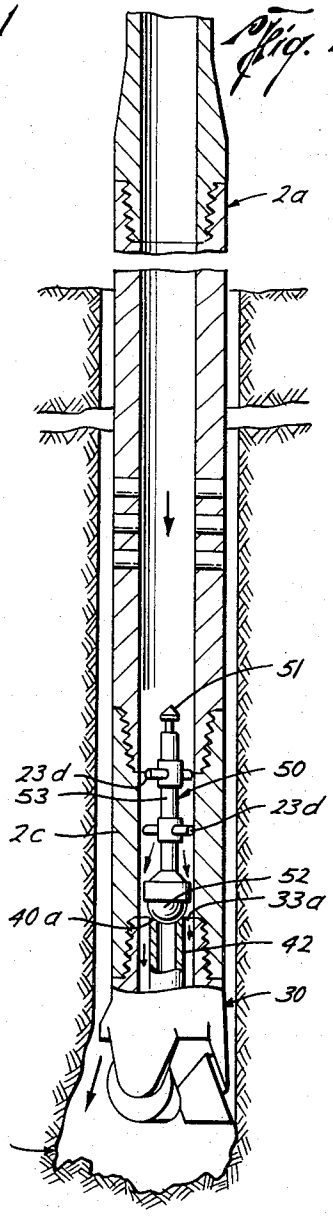
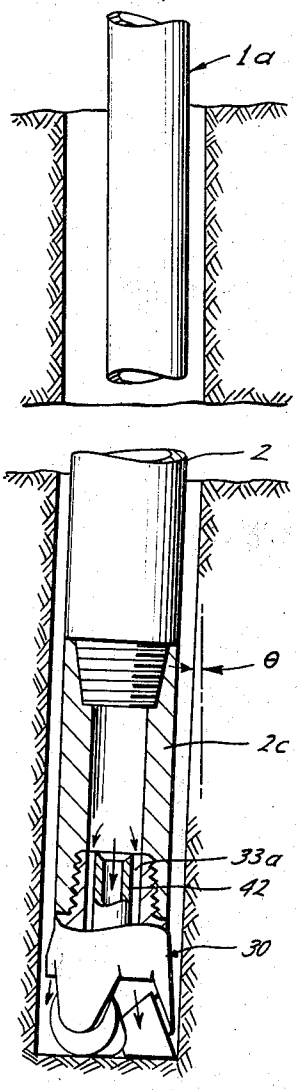


Fig. 3



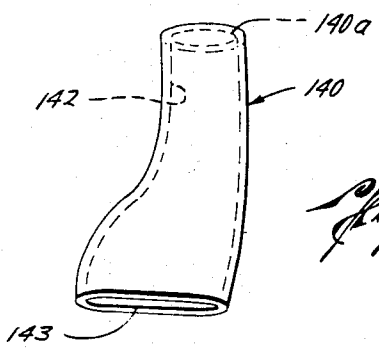


Fig. 7

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FLUID CONTROLLED DIRECTIONAL BIT AND ITS METHOD OF USE

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Fig. 4

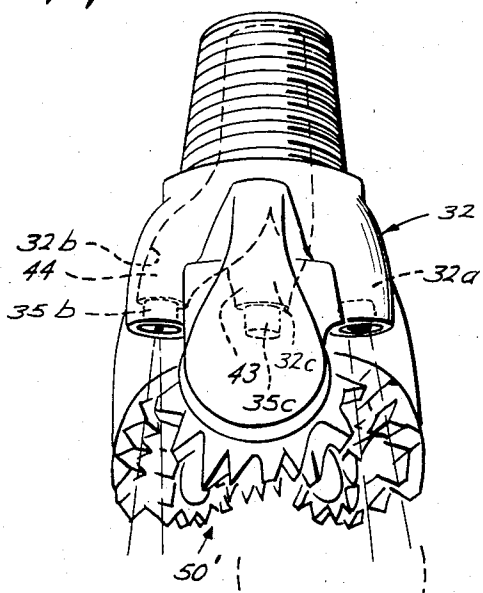


Fig. 5

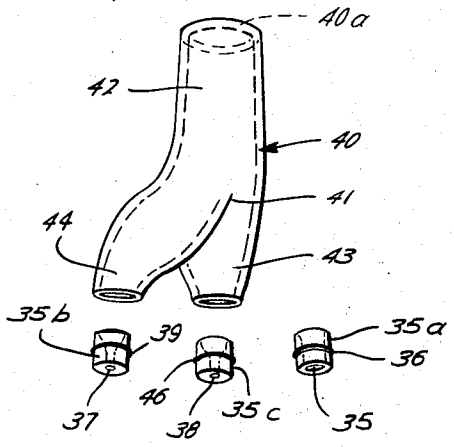
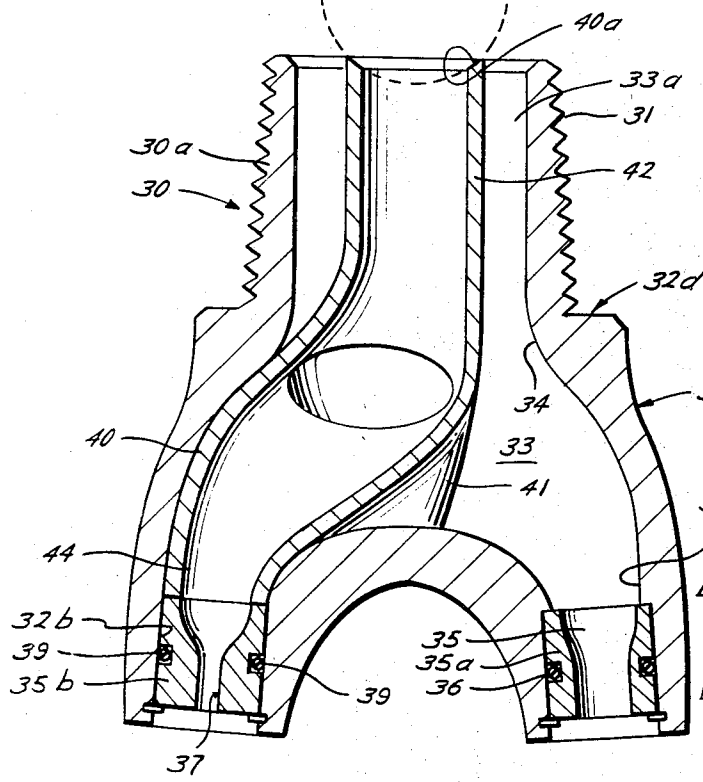


Fig. 6



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3,360,057

FLUID CONTROLLED DIRECTIONAL BIT AND ITS METHOD OF USE

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Filed Dec. 6, 1965, Ser. No. 511,773
8 Claims. (Cl. 175—67)

This invention relates to a new and improved apparatus and combination for jet deflection drilling, and more particularly, to a new and improved drill bit for jet deflection drilling and a new and improved combination used in conjunction with the drill bit to provide better jet deflection drilling.

Heretofore, when it was desired to directional drill, it has been necessary to use a whipstock, which device is well known in the art, set in a borehole. The whipstock functions to guide the drill bit against the side wall of the borehole and deflects the bit to drill the borehole from its original path in any desired direction.

The use of a whipstock is very burdensome and time consuming because of the many round trips that must sometimes be made from the drilling rig at the surface of the earth into the borehole. For example, to use the whipstock, it must initially be set in the borehole; and after the whipstock is seated in place in the well bore, survey instruments are lowered into the well bore to determine the direction in which the whipstock is facing. If necessary, the drill string is moved and additional surveys taken until the whipstock is facing in the desired direction. This operation is well known in the art.

Thereafter, the drill string is drilled off the face of the whipstock, the whipstock removed, and the deflected portion is then reamed and survey instruments again lowered to determine if the deflection is satisfactory. If not, then the drill string is removed and a whipstock connected thereto and again lowered and the whole operation repeated.

This procedure is well known in the art and can be very expensive and time consuming where more than one deflection is required before obtaining the desired deflection of the well bore.

There are also other known methods of deviating a borehole by deflection drilling, such as jet deflection methods, wherein, for example, two of three jet nozzles in a drill bit may be restricted, plugged, or blanked off by inserts while leaving the third jet nozzle unrestricted for flowing more well fluid therethrough to deviate the borehole.

However, there are certain problems with structures presently used in this type of jet deflection drilling because there are no means provided to remove the restrictions, plugs, or blanks in the drill bit after deflection of the well bore and while the bit is still in the well bore to enable ordinary drilling to proceed, and thereafter reinsert the plugs, restrictions, or blanks while the bit is still in the well bore to accomplish subsequent deflection, if desired.

Another problem often encountered in using present structures for jet drilling is that after the jet deflection operation is completed, there is sometimes a tendency for the two restricted jet nozzles in the drill bit to stop up with mud and debris, thus hindering the normal drilling operations.

An important object of the present invention is to provide a new and novel drill bit which is partitioned so that it may be employed to accomplish normal drilling operations and which may also be employed, when desired, to jet deflect a well bore.

It is also an object of the present invention to provide a new and improved jet deflection arrangement wherein

the drill string or any portion thereof need not be removed from the well bore to control the drilling operations after deflection and during continued normal drilling operations.

A further object of the present invention is to provide in a drill bit having multiple jet cutters and multiple jet nozzles a partition means within the bit to enable all of the drilling fluid to flow through all of the nozzles during normal drilling operation, or to selectively flow all of the drilling fluid through only one nozzle in the drill bit to accomplish jet directional drilling with the bit.

It is another object of the present invention to provide a new and improved jet deflection apparatus for use with a two or three cutter drill bit having jetting nozzles wherein when it is desired to directionally drill, one of the jet nozzles may be used for directional drilling by closing off the remaining nozzles with a retrievable assembly.

It is another object of the present invention to provide a new and improved jet deflection apparatus wherein there is provided a new and improved drill bit with nozzles that do not have to be permanently plugged or restricted to accomplish directional control of the bit.

It is an important object of the present invention to provide a new and improved drill bit which may have either two or three cutters and adjacent jetting nozzles in which there is provided a partition means for directing fluid flow through all of the nozzles except the one used to directional drill.

It is another object of the present invention to provide a new and improved jet deflection apparatus wherein there is provided a novel drill bit construction including an arrangement which permits selectively closing two of the nozzles of a three nozzle drill bit and thereby permits jet deflection drilling on one side of the borehole and which thereafter permits opening the two nozzles for ordinary drilling operations and, if desired, to again close off the two nozzles for further directional drilling.

It is another object of the present invention to provide a new and improved arrangement for jet deflection drilling wherein there is provided a nonmagnetic drill collar adapted to be secured to a new and novel drill bit, the drill collar having magnets therein for orienting a survey instrument relative to the magnets and the unrestricted nozzle in the drill bit, a retrievable drop ball assembly for seating on the drill bit to thereby close all but one nozzle of the drill bit to thereby flow all of the drilling fluid through the remaining open nozzle to jet deflect the well bore when the rotation of the drilling string is stopped.

Yet another object of the present invention is to provide a drilling bit which may be used for jet deflection drilling and which also uses larger jetting nozzles during ordinary drilling operations than generally used heretofore and thereby increases the rate of drilling during ordinary drilling operations by increasing the rate of circulation of drilling fluid to move the cuttings off bottom.

Still a further object of the present invention is to provide a drilling bit for jet deflection drilling which is constructed and arranged so that the rate of circulation of drilling fluid is increased during normal drilling operations above that generally possible with present jet deflection bits to thereby aid in keeping the bit teeth cleaner and aid in increasing the rate of penetration by more quickly moving the cuttings away from the bottom of the borehole to inhibit regrinding thereof.

In accordance with the present invention, there is provided a means and arrangement for corrective drilling of a well bore that does not require whipstocks. In the apparatus, deflection of the drill string is obtained by directing all of the drilling fluid through one nozzle of a jet drill bit. Of course, it is to be understood in the normal

usage of a drill bit in jet deflection drilling that the jetting nozzle will be adjacent the side of the well bore where it is desired to deviate; and the deviated well bore may be in any desired direction. The novel drill bit of the present invention is adapted to be secured to a nonmagnetic drill collar so that a survey instrument may be lowered to position inside the nonmagnetic drill collar to permit a shot or picture of the well bore to thereby align the jetting nozzle for proper deviation of the well bore. There is also provided a retrievable drop ball assembly for seating on the drill bit to selectively close all but one nozzle of the drill bit and which may thereafter be removed when normal drilling operations are desired to thereby open all nozzles in the drill bit which results in substantial savings because the drill string need not be removed from the well bore to thereafter open or close the nozzles and because the rate of circulation of drilling fluid during normal drilling operations is increased over that generally possible with jet deflection bits presently employed.

Other objects and advantages of the present invention will become apparent from the following detailed description of the invention taken in conjunction with the accompanying drawings which form an integral part of this specification and wherein:

FIG. 1 is a broken sectional view representing a well bore and drill string therein with a drill bit in partial sectional view connected to the lower end of the drill string and showing in elevation the retrievable drop ball assembly seated on the bit and a survey instrument seated on the drop ball assembly to determine the direction in which the largest jet nozzle of the bit is facing;

FIG. 2 is a broken sectional view representing a well bore and drill string therein with a drill bit in partial sectional view connected to the lower end of the drill string and showing in elevation the retrievable drop ball assembly seated on the bit and whereby all of the drilling liquid is conducted through the largest jet nozzle to accomplish deflection of the well bore;

FIG. 3 is a broken cross-sectional view of a well bore with the drill string and drill bit in partial section and illustrating the well bore after it has been deflected and the retrievable drop ball assembly removed so that ordinary drilling operations may continue;

FIG. 4 is a persepective view illustrating the preferred form of the drilling bit of the present invention;

FIG. 5 is a view illustrating the partition means in the drill bit of the present invention as being in the form of an inverted Y-shaped tube;

FIG. 6 is an enlarged view in cross-section illustrating in greater detail a preferred form of the drilling bit of the present invention; and

FIG. 7 is a perspective view showing another form of the partition means of the present invention.

It is, of course, to be understood that while FIGS. 1 to 4 and 6 illustrate a drilling bit with three cutters and three nozzles, the present invention is not limited in any way to a drill bit with three cutters and three nozzles; but, of course, may include, for example, a two cutter and two nozzle drill bit or any number of multiple cutters and multiple nozzles.

Referring now to the drawings, there is illustrated in FIG. 1 a well bore represented generally at **1** drilled with a drilling rig (not shown) wherein the means used to drill the well bore is a conventional drill string represented generally at **1***a* including drill collars therein and a drill bit **30** on the lower end thereof. The drill collar immediately adjacent the bit **30** as illustrated in FIG. 1 is a nonmagnetic drill collar **2** which is provided with a plurality of magnets **3**, **4**, and **5** that are used for orienting a survey instrument **20** in a manner well known in the art. Of course, there may be a number of drill collars connected above the nonmagnetic drill collar **2** in the drill string **1***a*; and the uppermost drill collar is secured at its upper end **2***a* to the last joint of drill pipe in drill string **1***a* by means of threads **6** and **7** on the uppermost drill collar and lowest or last drill pipe joint, respectively. The lower end **2***b* of the nonmagnetic collar **2** is secured by means of threads **8** to a sub **2***c* which, in turn, is connected to the drill bit **30** by threads **2***d* and **31** on the sub and bit, respectively.

A drill bit **30** is shown in FIGS. 4 and 6 with three cutters designated generally at **50'** and each cutter having teeth thereon of any conventional form.

The drill bit body is represented generally by the numeral **32** and is constructed to receive thereon the cutter means, which may be of any suitable form such as a rolling cutter as represented at **50'** and is hollowed to provide openings for receiving jet nozzles in the bit body as will be described. The drill bit **30** as illustrated in the drawings at FIGS. 4 and 6 is represented as having three cutters **50'** and is provided with a fluid passage means **33** with in its body **32** which extends through the portion **30***a* and is open at the upper end of the drill bit **30** for receiving drilling fluid from the drill string **1***a*. The bit body **32** is formed internally so that the passage means **33** is split into three fluid passageways **32***a*, **32***b*, and **32***c* for directing or discharging drilling fluid out the lower end of the bit body **32** as will be described.

The portion **30***a* on the drill bit body **32** is provided with threads **31**, previously mentioned, for receiving with the threads **2***d* on the sub **2***c*, the threads terminating at the surface designated generally at **32***d*.

The drill bit **30** of the present invention is provided with a partition means, one form of which is illustrated generally at **40** in FIGS. 4, 5, and 6 for directing drilling fluid through the drill bit in a selective manner to accomplish the desired results as will be described in greater detail.

The partition means **40** represented in FIGS. 4 to 6 is shown as being in the form of an inverted Y-shaped tube which is forked at **41** to thereby form a single hollow tube or channel **42** facing upwardly within the drill bit **30** and two hollow tubes or channels **43** and **44** facing downwardly in the drill bit **30** and communicating respectively with the fluid passageways **32***c* and **32***b*, respectively. In the arrangement of the drill bit **30**, as shown in FIGS. 4 to 6, the inverted Y-shaped tube or partition **40** is positioned within the drill bit body **32** as it is assembled so that the tubes **44** and **43** may be secured by any suitable means such as by welding to the inner surface **34** of the drill bit body **32**; and when so positioned, it assumes the relationship illustrated in dotted lines in FIG. 4 and more easily viewed in FIG. 6. It will be noted that the channels **43** and **44** communicate, respectively, as previously noted, with fluid passageways **32***c* and **32***b*, respectively, and the single hollow tube **42** extends upwardly within the portion of the passageway **33** that faces upwardly in the drill bit body **32** as shown in FIG. 6.

The tube **42** is smaller in diameter than the portion of the passageway **33** in which it is received, thereby forming an annular passage **33***a* within the drill bit body **32** that communicates with fluid passageway **32***a* as more clearly seen in FIG. 6.

Nozzle inserts **35***a*, **35***b*, and **35***c* are received within each of the passageways **32***a*, **32***b*, and **32***c*, respectively; and each insert is formed with an opening **35**, **37**, and **38** for discharging drilling fluid therethrough with a jetting action. Each insert **35***a*, **35***b*, and **35***c* is provided with an O-ring seal **36**, **39**, and **46**, respectively, so that when the insert is seated in its respective fluid passage leakage therearound is inhibited. The nozzle inserts are formed of suitable material well known in the art and may be held in position in each passageway by means well known, such as snap rings.

With the partition means **40** arranged as illustrated in FIG. 6, nozzle opening **35** in nozzle insert **35***a* is substantially larger than nozzle openings **37** and **38** in nozzle inserts **35***b* and **35***c*, respectively.

A seat 40*a* is formed on the end of the tube 42 for receiving means 50 thereon as shown in FIG. 2 which closes off flow through passageways 32*b* and 32*c* so as to direct all drilling fluid through fluid passageway 32*a*. Also, such seat 40*a* serves as means whereby the survey instrument 20 may be positioned in the drill string since the means 50 serves also as a means for spacing the instrument 20 when it is lowered into the drill string.

Thus, to directionally drill or to use the present invention for directional drilling, it is only necessary to cap or close the upper end of tube 42. This prevents flow of drilling fluid through the passageways 32*b* and 32*c* and also prevents fluid discharge from openings 37 and 38 of jet nozzle inserts 35*b* and 35*c* while directing all the flow of drilling fluid through annular passage 33*a* for discharge through the larger opening 35 of nozzle insert 35*a* to jet away the side of the well bore in which the jet nozzle insert 35*a* is oriented, and, therefore, the drill string 1*a* begins deviating in the direction in which jetting nozzle 35*a* is digging. It should be noted that while directionally drilling, the drilling string 1*a* is not rotated.

To further amplify and describe the use of the present invention, attention is first directed to FIG. 1 of the drawings wherein the drill string 1*a* is shown as having a nonmagnetic drill collar 2 connected by means of sub 2*c* to bit 30 constructed in accordance with the present invention. At the time that the drill bit 30 is connected by sub 2*c* to nonmagnetic collar 2, the angular relationship between the magnets 3, 4, and 5 and the larger jet nozzle opening 35 is determined at the earth's surface before lowering the bit into the well bore.

After the bit 30 is on bottom in the well bore, a retrievable drop ball assembly 50 is pumped down the drill string 1*a* to rest on seat 40*a* formed on the end of tube 42 in drill bit 30.

The drop ball assembly 50 is provided with a fishing head 51 and serves as a spacer so that when survey instrument 20 is lowered on wireline 21 in drill string 1*a*, the spring arms 23*b* and 23*c* engage head 51 and position the survey instrument properly within nonmagnetic drill collar relative to magnets 3, 4, and 5 so that a determination may be made in a well-known manner in the art as to the direction in which the larger nozzle opening 35 is facing, such nozzle opening being termed a "big eye" jet in the art to which the invention pertains.

It can be appreciated that the spring arms 23*b* and 23*c* could be tied together so that when the survey instrument 20 is lowered into the well bore, they would rest on the top of head 51 and thereby not engage means 50 and cause it to be removed from the drill string each time survey instrument 20 is run.

The survey instrument is retrieved to the earth's surface; and if the survey indicated that the "big eye" jet is not facing in the desired direction, the drill string 1*a* is moved and the foregoing operation repeated until the survey indicates that the larger nozzle opening 35 or "big eye" jet is properly positioned in the well bore.

It should be noted that the survey instrument is of well-known construction and secured thereto is the retrieving tool 23 which is connected to the survey instrument 20 by the threaded shaft 23*a*. Radially extending arms 23*d* on tool 23 and on means 50 position each within the drill string 1*a*. The means 50 in the form shown includes fishing head 51 to which is connected shaft 53 with a seat member 52 on the lower end thereof for seating on seat 40*a* formed in the drill bit 30.

After the "big eye" jet is properly positioned in the well bore, the retrievable drop ball assembly 50 is pumped down the drill string and seated as shown in FIG. 2 and all of the drilling fluid is directed to the "big eye" jet so that without rotating the drill string 1*a*, the well bore adjacent the "big eye" jet may be cut away as illustrated generally at 60. The jetting operation may continue until it is determined by additional surveys by means of instrument 20 that the well bore 1 has been deviated the desired amount. Of course, as jet deflection is accomplished, the operator lowers drill string 1*a*. When the desired amount of deviation has been accomplished, the drop ball assembly 50 may be retrieved from the drill string when the survey instrument 20 and retrieving tool 23 are lowered into the well bore to take a picture. Thereupon, normal drill operations may continue with drilling fluid discharging through all jet nozzles and upon rotation of the well string. This is illustrated in FIG. 3 of the drawings wherein drilling fluid is discharged through all of the nozzles.

If it should thereafter become necessary or desirable to further deviate the well bore, it may be accomplished by first positioning the "big eye" jet in the proper direction, as previously described hereinabove, and then dropping ball assembly 50, as previously described, so that jet deflection may be accomplished. Of course, as the well bore is deviated by jetting action, the operator will lower the drill string 1*a*, as previously noted. Thereafter, the drop ball assembly may be retrieved, whereupon normal drilling operation may again continue.

It should be readily apparent that since the smaller nozzle inserts 35*b* and 35*c* do not have to be restricted, blanked, or plugged during directional drilling with the present invention, the nozzle openings 37 and 38 therein may be larger than nozzle openings that have to be restricted, blanked, or plugged in a directional jet bit such as generally presently employed.

This should enable normal drilling operations to proceed at an increased rate after jet deflection since a larger opening may be used in the inserts 35*b* and 35*c* than generally heretofore possible, and thus an increased rate of drill fluid may be maintained during normal drilling operations. The increase in drilling fluid circulation moves the cuttings off bottom faster and aids in preventing regrinding of the cuttings and aids in keeping the teeth on the cutters 50' cleaner. Also, since the present invention enables larger openings to be used in the inserts, restriction, or clogging thereof is greatly reduced.

Referring again to FIG. 3, the well bore has been deviated an angle θ from the vertical; and the arrows indicate that fluid is flowing through the partition means 40 and the annular space 33*a* so that all of the nozzle openings are emitting fluid therethrough. As brought out hereinabove, since the nozzle openings 37 and 38 do not have to be restricted, blanked, or plugged, the openings 37 and 38 are larger than blanked, restricted, or plugged nozzles generally in use at the present time; and this increases the rate of circulation of fluid in the bottom of the borehole which removes the cuttings from the borehole as soon as they are cut and which also keeps the teeth of the cutters, the nozzle openings, and the bottom of the borehole clean and unclogged.

Additionally, if it is desired to deviate the well bore after drop ball assembly 50 has been removed, it need only be pumped down as before described and the "big eye" jet oriented in the well bore and jet deflection drilling may then proceed.

Another embodiment of the partition means is illustrated in FIG. 7. This partition means 140 is similar in function to the partition means 40 previously described but differs structurally. For example, instead of separate channels or tubes to selected jet nozzles, there is a single hollow member or shell 142 which may be welded in place in a drilling bit so that the lower open end 143 of the member 142 surrounds one or more openings and thereby isolates the opening or openings which it surrounds. For example, in a three jet nozzle drilling bit, the member 142 is secured in the drilling bit so as to surround two of the nozzles and thereby isolate them from the third jet nozzle. On the other hand, in a two jet nozzle bit, the member 142 would surround only one nozzle to isolate it from the other. The member 142 is provided with a seat 140*a* which serves the same functions as those noted with regard to seat 40*a*.

It is apparent that various modifications could be provided without departing from the scope of my invention.

Broadly, the present invention relates to a partitioned jet deflection drilling bit and its method of use wherein drilling fluid may be passed through all of the nozzles or through only one of the nozzles, as desired.

What is claimed is:

1. A drill bit adapted to be connected to a drill string including:
   (a) a body,
   (b) cutter means mounted on the lower end of said body,
   (c) said body being hollowed to form fluid passage means therein for receiving drilling fluid from the drill string,
   (d) said passage means extending through said body to form a plurality of separate discharge passages for discharging fluid from the bit,
   (e) jet nozzle inserts in each of said discharge passage means,
   (f) partition means in said passage means for separating fluid flow from the drill string to conduct it to all but one of said discharge passages, and
   (g) seat means formed on the upper end of said partition means for receiving a closure member thereon whereby all of the drilling fluid may be directed to said one discharge passage.

2. The invention of claim 1 wherein said partition means includes:
   (a) a tubular member extending upwardly within said passage means formed in said bit,
   (b) said member having a smaller diameter than the passage means to form an annular passage therebetween, and
   (c) channel means connected to the lower end of said member and extending into all but one of said discharge passages formed in said bit.

3. The invention of claim 2 wherein said annular passage communicates with said discharge passage in which there are no channel means whereby when said seat formed on said partition is provided with a closure member, all of drilling fluid is conducted through said annular passage and discharge passage in communication therewith.

4. In a drill bit adapted to be connected to a drill string for receiving drilling fluid therefrom:
   (a) a plurality of nozzles mounted in said bit and each having an opening therein for discharging the drilling fluid out the lower end of said bit,
   (b) fluid conducting passage means formed in said bit for conducting drilling fluid to said nozzles, said fluid conducting passage means including:
      (1) partition means for conducting drilling fluid to two of said nozzles and for conducting fluid separately to one of said nozzles, and
   (c) said one nozzle to which fluid is separately conducted having a substantially larger opening whereby selective communication of all the drilling fluid therethrough enables the drill bit to function as a directional drilling device.

5. In a rotary drill bit adapted to be connected to a drill string and used for directional drilling of a well bore with fluids comprising:
   (a) a body,
   (b) means on said body for cutting the well bore when the bit is rotated,
   (c) a plurality of nozzles positioned on said body,
   (d) said nozzles having openings for ejecting fluid from the bit,

   (e) passage means formed in said bit for conducting fluid to all of said nozzles,
   (f) partition means in said bit so that fluid may be conducted separately to one of said nozzles,
   (g) a seat on said partition means for receiving a closure thereon whereby all of the drilling fluid may be conducted to said nozzle, and
   (h) said one nozzle to which fluid is conducted separately having an opening substantially larger than said other nozzle openings whereby fluid passage only through said one nozzle enables said bit to drill directionally when said bit is not rotated.

6. The invention of claim 5 wherein said partition means includes a tube extending upwardly in said bit and having an annular seat thereon for receiving a closure member whereby all the drilling fluid may be conducted to said one nozzle.

7. In a drill bit adapted to be connected to a drill string for receiving drilling fluid therefrom:
   (a) a plurality of nozzles mounted in said bit and each having an opening therein for discharging the drilling fluid out the lower end of said bit,
   (b) fluid conducting passage means formed in said bit for conducting drilling fluid to said nozzles,
   (c) partition means in said body for separating fluid flow in said passage means to conduct drilling fluid to two of said nozzles and for conducting fluid separately to one of said nozzles, and
   (d) said one nozzle to which fluid is separately conducted having a substantially larger opening whereby selective communication of all the drilling fluid therethrough enables the drill bit to function as a directional drilling device.

8. A method of drilling a well bore comprising the steps of:
   (a) securing a drill bit to a drill string wherein the drill bit is provided with a plurality of jet nozzles, one of which is substantially larger than the others,
   (b) lowering the drill string with the drill bit thereon into a well bore,
   (c) lowering a survey instrument and spacer means to seat on the drill bit and aligning the large jet nozzle in a predetermined direction in the well bore,
   (d) removing the survey instrument from the drill string,
   (e) the spacer means also functioning to close off fluid flow to all of the jet nozzles except the large one,
   (f) deviating the well bore by jet deflection,
   (g) removing the spacer means and thereafter continuing normal rotary drilling operations,
   (h) subsequently jet deflecting the same well bore by replacing the spacer means and survey instrument to first align the larger jet nozzle in a predetermined manner in the well bore,
   (i) thereafter removing the survey instrument to enable jet deflection of the well bore to proceed, and
   (j) removing the spacer means and thereafter continuing normal rotary drilling operations.

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