Jan. 6, 1970 E. A. ANDERSON 3,488,765

METHOD AND ARRANGEMENT FOR SELECTIVELY CONTROLLING FLUID DISCHARGE FROM A DRILL BIT ON THE LOWER END OF A DRILL STRING

Filed Dec. 21, 1967 3 Sheets-Sheet 1

Fig. 1

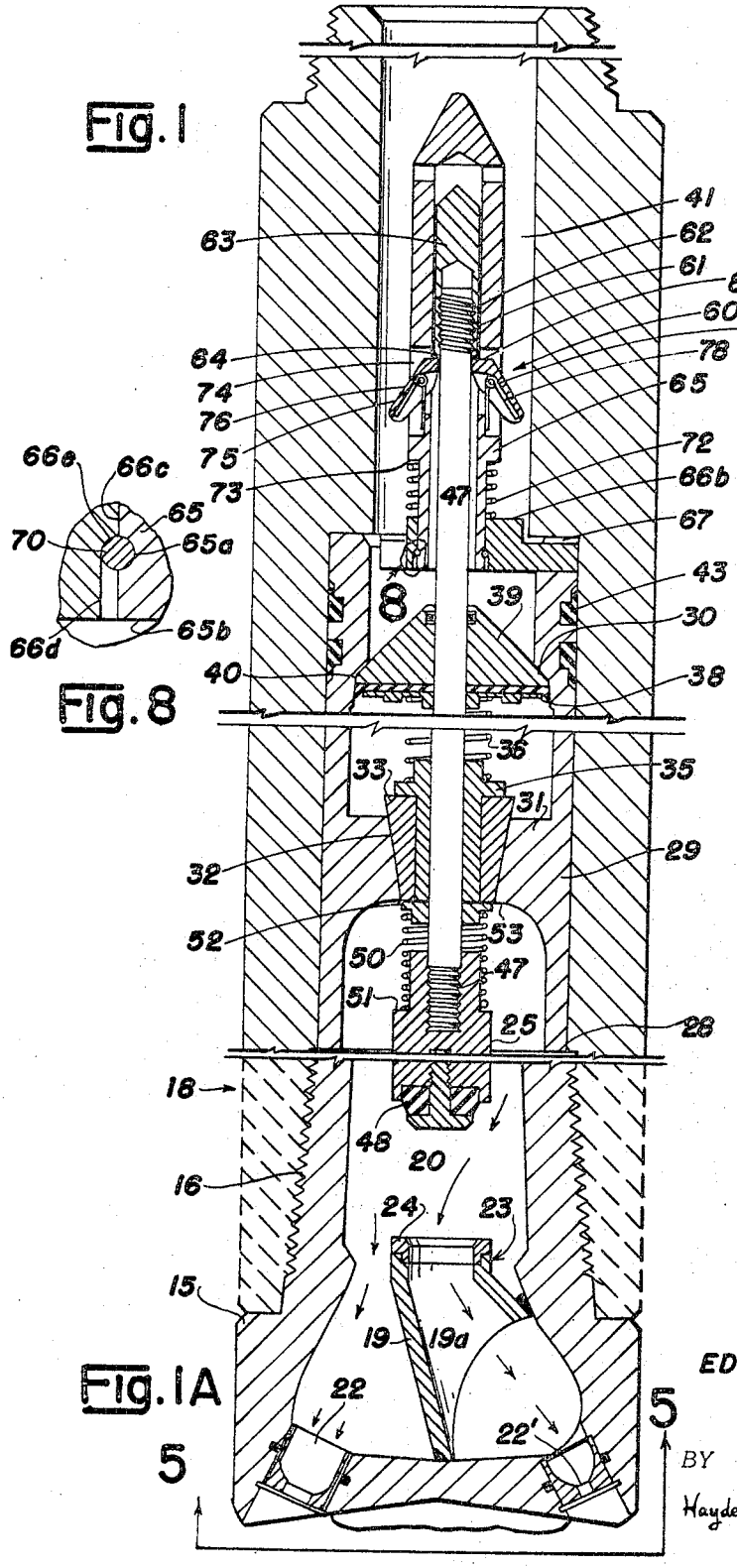


Fig. 8

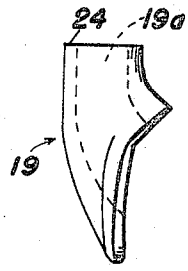


Fig. 9

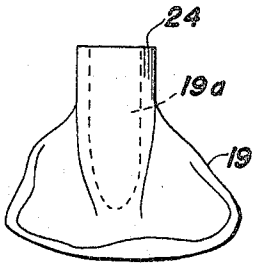


Fig. 10

Fig. 1A

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Filed Dec. 21, 1967 3 Sheets-Sheet 2

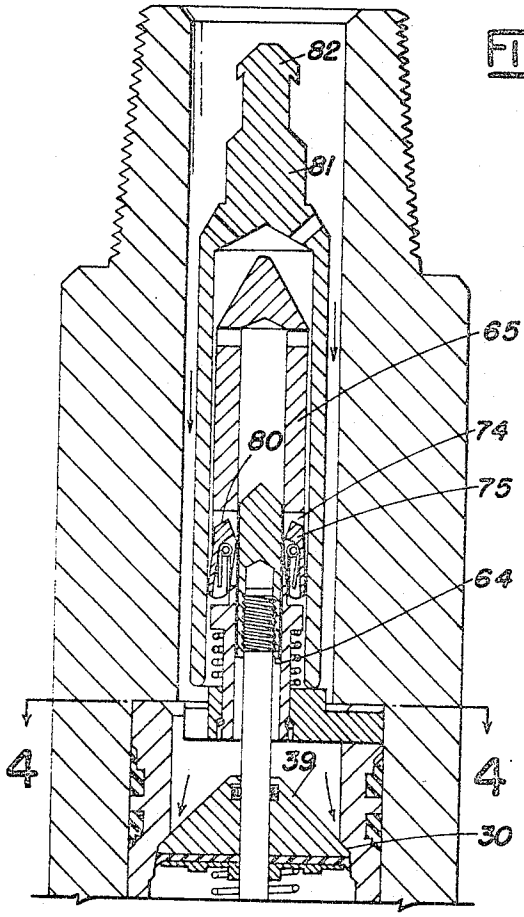


Fig. 2

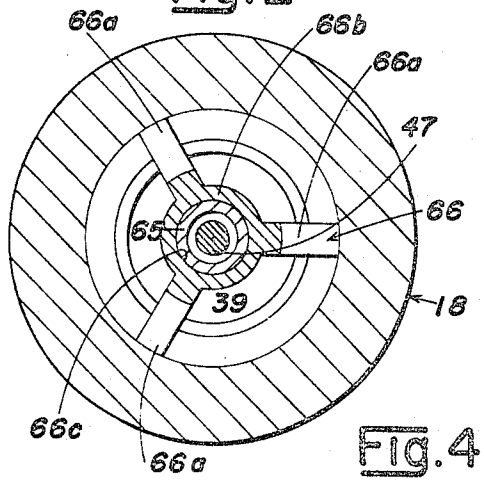


Fig. 4

Fig. 3

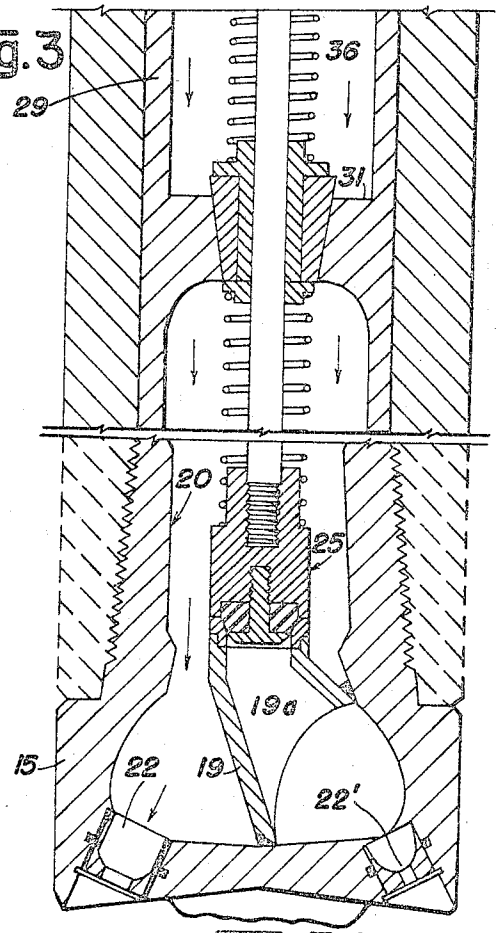


Fig. 3A

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Filed Dec. 21, 1967

3 Sheets-Sheet 3

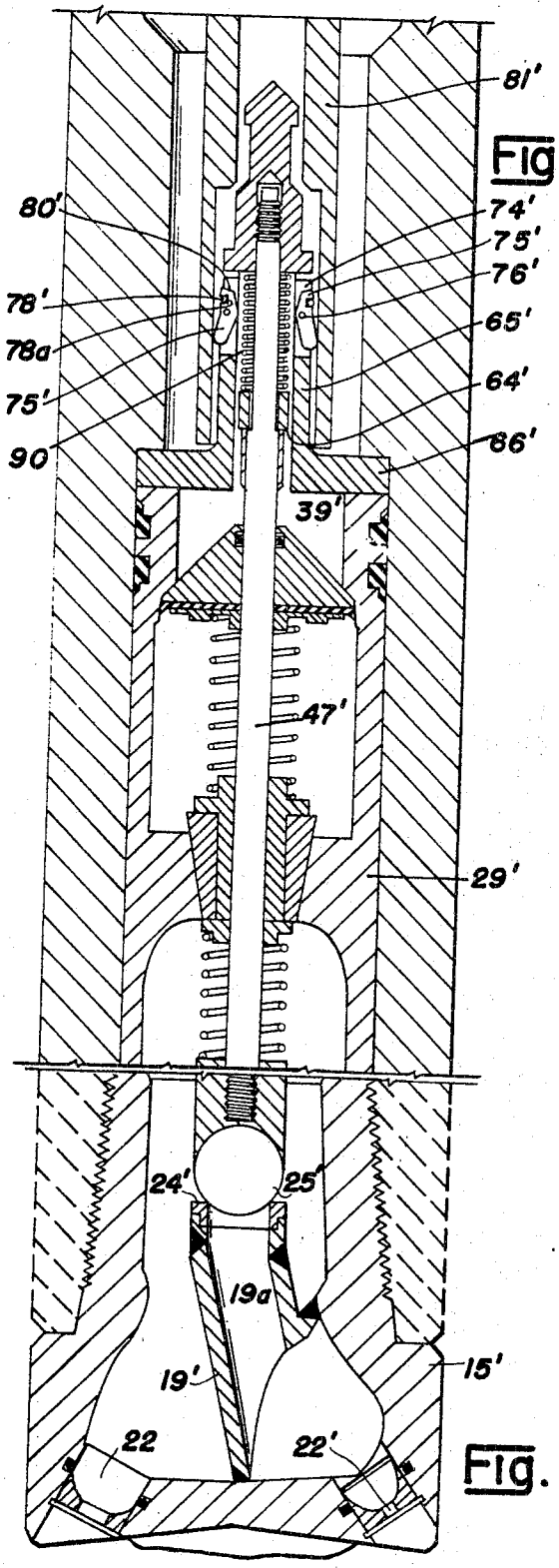


Fig. 6

Fig. 6A

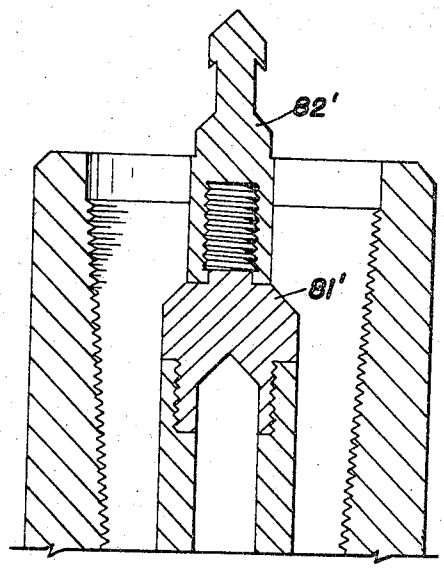


Fig. 7

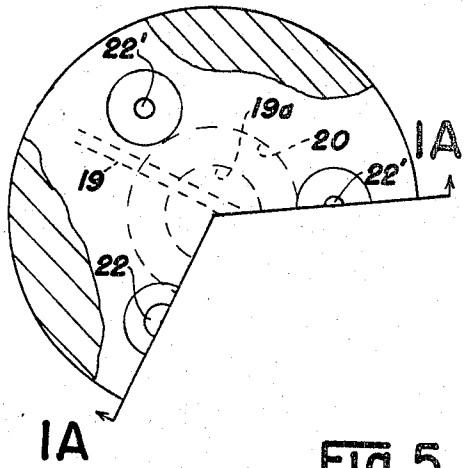


Fig. 5

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3,488,765

METHOD AND ARRANGEMENT FOR SELECTIVELY CONTROLLING FLUID DISCHARGE FROM A DRILL BIT ON THE LOWER END OF A DRILL STRING

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Int. Cl. E21b 7/04, 9/02, 9/34
U.S. Cl. 175—61 13 Claims

ABSTRACT OF THE DISCLOSURE

An arrangement to be connected in a drill string to selectively control fluid discharge from a drill bit on the lower end of the drill string so that the drilling fluid may be discharged through all of the nozzles of a drill bit or through only one of the nozzles of the drill bit, and a method for selectively discharging the hydraulic horsepower and drilling fluid through the nozzles of a drill bit.

CROSS REFERENCE TO RELATED APPLICATION

The present invention is directed to an arrangement for use with a directional bit, one form of which is illustrated in my United States Letters Patent No. 3,360,057 issued on Dec. 26, 1967.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention is directed to an arrangement and method to drill deviated bore holes such as oil, gas, or water wells and the like. More particularly, it relates to the method and arrangement for drilling deviated holes by the jetting action of drilling fluid discharged from the drill bit on the lower end of a drill string and selectively direct all of the drilling fluid through only one nozzle in the drill bit or to discharge the drilling fluid through all of the nozzles in the drill bit without removing the drill pipe from the well bore.

Description of the prior art

United States Letters Patent No. 2,873,092 discloses a form of bit which includes a boot therein to direct drilling fluid or discharge the drilling fluid from the drill string through only one nozzle in the drilling bit. This is disadvantageous in that it may be desired to deflect or deviate only a certain portion of the well bore and when the desired deviation has been accomplished it is then desirable to discharge the drilling fluid through all of the nozzles in the drilling bit. However, with the construction of the above mentioned patent, it can be appreciated that once the rubber boot has been removed from the bit, it cannot thereafter be reinserted in the bit without removing the entire drill string from the well bore. This procedure is time consuming and expensive.

Another common procedure is to blank off the jet nozzles in the drill bit except one which is larger and through which all of the drilling liquid is discharged. However, there are certain disadvantages in blanking the two small jet nozzles when normal drilling is resumed. For example, the penetration rate of the drill bit may be reduced because of the limited washing action available to clean the cones of the drill bit in the bottom of the hole.

Also, since all of the jet nozzles are closed off except the large one, the bit may ball-up more easily since the other nozzles are blanked off. A balled-up bit may not respond to variations of weight and rotary speed as effectively as a cleaner bit, and this affects drilling control.

Furthermore, should the drilling become too sticky and if the bit should ball-up, it may be necessary to remove the pipe from the well bore and install the small jet nozzles.

Another prior art form of deviating the well bore is to use, for example, a tricone rotary drilling bit with one large nozzle, such as, for example, one having a 5/8 inch to 3/4 inch discharge opening, and using two smaller nozzles such as, for example, each having a 1/4 inch to 5/16 inch discharge opening. There may be some disadvantages with this type of arrangement in that a greater length of time may be required to make a jet deflection run in the well bore since all of the mud flow is not localized in the desired direction.

Also, the two smaller nozzles may be detrimental to the jet deflection operation because the extra volume of mud that is required to feed the small nozzles may cause a higher friction loss in the drill pipe, and thus reduce the effective hydraulic horsepower across the bit. This in turn may reduce the hydraulic horsepower for the large jet nozzle.

Additionally, the mud pressure drop and velocity through the small nozzles are the same as that through the large nozzle; however, the volume through the smaller nozzles as compared with the volume through the large nozzle is not the same. Also, the flow of drilling fluid through the small nozzles may erode the natural shoulder or formation which serves as a "whipstock" to guide the bit entering the deviated portion of the well bore. There have been some cases in which the well bore has actually been deflected in the direction of the small jet nozzles instead of in the direction of the large nozzles, which is undesirable.

Another disadvantage may be that jet deflection cannot be accomplished at as great a depth because of the decreased hydraulic horsepower across the bit and the possible eroding action of the small jet nozzles in the opposite direction. This may necessitate resorting to more time consuming and expensive methods such as utilizing a whipstock or fluid motor drills, which may be more time consuming and expensive.

SUMMARY OF THE INVENTION

The present invention overcomes some, if not all, of the above objections encountered in jet deflection or jet deviation in that it provides an arrangement and a method so that the drilling fluid may be selectively discharged through all of the nozzles of the drilling bit during normal drilling operations, or the drilling fluid may be discharged only through one of the nozzles when it is desired to deviate the well bore.

Additionally, the present invention is constructed and arranged so that it may be easily actuated without removing the drill string and the drilling bit from the well bore. Also, it may be actuated as many times as desirable without necessarily removing the drill string from the well bore.

The use of what is termed a "float valve" in many areas is standard practice so as to prevent backflow in the drill string when a survey instrument is run and to eliminate lost time in equalizing the mud column. It may also be used to provide a shut-off or check valve against either high or low pressures from fluid or gas beneath the float valve which otherwise would flow into the drill string.

Another advantage of the present invention is that it is constructed and arranged so that it does not interfere with the normal use of a float valve in drilling operations.

Generally speaking, the primary object of the present invention is to provide an arrangement and method whereby the drilling fluid which is conducted through the drill string and discharged through the drill bit at

the lower end thereof in drilling operations may be selectively discharged through only one of the nozzles of the bit to accomplish jet deflection when desired, or to discharge the fluid through all of the nozzles when desired without removing the well pipe and drill bit from the well bore while also providing the safety and convenience of a float valve. Such procedure can be repeated as many times as desired while drilling a well bore without removing the pipe and drill string from the well bore to accomplish the desired results as is required with some prior art arrangements.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a sectional view illustrating the upper part of one form of the present invention and shows the relationship of the various components when drilling liquid is being discharged through all of the nozzles in the bit, except the float valve is shown closed and it would be open when drilling fluid passes from the drill string to the bit;

FIG. 1A is a sectional view on the line 1A—1A of FIG. 5 and is a continuation of FIG. 1 and shows in greater detail the interior of a partitioned drill bit. The cutting cones of the bit have been omitted for clarity;

FIG. 2 is a sectional view of the upper part of the tool shown in FIG. 1 and illustrates the relationship of certain components when the device has been actuated so that all of the jet nozzles in the drilling bit are closed except one; again the float valve is shown closed, but would be open as stated with regard to FIG. 1;

FIG. 3 is a sectional view and a continuation of FIG. 2;

FIG. 3A is a sectional view similar to FIG. 1A and shows valve means seated on a partition means in the drilling bit so that all of the liquid is discharged through only one nozzle to accomplish desired deflection of the bore hole;

FIG. 4 is a sectional view on the line 4—4 of FIG. 2 to show one arrangement for supporting the upper portion of the device in a drill string;

FIG. 5 is a view on the line 5—5 of FIG.1A;

FIG. 6 is a sectional view of the upper part of another embodiment of the invention;

FIG. 6A is a sectional view similar to FIG. 1A and shows the device when it has been actuated so that all of the drilling liquid from the drill string is discharged through only one jet nozzle in the drilling bit, except the float valve would be unseated to accommodate fluid passage to the bit;

FIG. 7 is a sectional view of the uppermost end of the tool shown in FIG. 6;

FIG. 8 is an enlarged detail of the portion circled in FIG. 1;

FIG. 9 is a side view of a form of partition means for a drill bit; and

FIG. 10 is another view of the partition for use in a drill bit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is first directed to FIG. 1 of the drawings wherein a portion of a drill bit is illustrated at **15** which is connected by suitable means such as the threads **16** to the lower end of a drill string represented in dotted line generally at **18**.

The drill bit **15** is provided with a partition means **19** within the bore **20** of the drill bit **15**. The construction of the bit **15** and the arrangement of the partition means **19** therein may be as disclosed and claimed in my United States Letters Patent No. 3,360,057, issued on Dec. 26, 1967.

Since a portion of the bit **15** has been cut away, the partition means **19** is shown as covering only one jet nozzle; however, as disclosed in the above referred to patent, such partition means communicates with the two smaller jet nozzles in a three nozzle drilling bit so that the drilling fluid may be separated in the bore **20** and selectively directed to the larger bore jet nozzle represented at **22** when the invention assumes the relationship shown in FIG. 3 of the drawings or the fluid from the bore **20** will be conducted to all of the jet nozzles in the bit **15** when the relationship of the components is as shown in FIG. 1 of the drawings. FIG. 9 shows one form of a partition, and FIG. 5 shows the bottom of the partition **19** as well as jet deflection nozzle **22** and drilling or smaller discharge nozzles **22'**.

The partition means **19** may be of any suitable form and is preferably provided at its upper end **23** with a seat **24** for receiving valve means **25** as will be described in greater detail. Seated on the upper end **28** of the bit **15** is a housing **29** provided with a downwardly facing seat as illustrated at **30**. The housing **29** is also provided with a web support means **31** with the opening **32** therein. The opening **32** is provided with the member **33** which surrounds the bushing **35**. A spring **36** is seated on the bushing **35** and abuts the bottom **38** of the check valve **39** to normally urge it against the downwarly facing seat **30**. The check valve **39** may be provided with a suitable resilient material **40** to aid in sealing off when the check valve **39** is seated on seat **30**. The valve **39** is normally termed in the art a float valve and in some areas it is standard to use a float valve. It permits fluid to pass downwardly from the drill string bore **41** and thereabout to be discharged out the nozzles of the drilling bit **15**, but prevents passage of fluid from beneath the valve **39** back into the bore **41** of the drill string **18**. Suitable seal means as illustrated at **43** are provided between the housing **29** and the drill string **18** or sub in which the housing **29** is seated to inhibit leakage of fluid thereby.

A valve rod **47** is illustrated in FIG. 1 having the valve means **25** mounted on the lower end thereof by any suitable means such as the threads **47**. If desired, a suitable resilient material **48** may be provided to aid in sealing off with the seat **24** when the valve means **25** is abutted against the partition means **19** as shown in FIG. 3.

The valve rod **47** extends longitudinally of the drill string and is normally urged towards abutting relationship with the seat **24** on partition means **19** by reason of the spring **50** which rests on the shoulder **51** of the valve means **25** and abuts the bushing **52** which is seated on the bottom **53** of the web support **31**. Movement of the valve rod **47** longitudinally to seat the valve means on the partition means **19** is inhibited by reason of the restraining means referred to generally by the numeral **60** in the upper part of FIG. 1. It will be noted that the upper end **61** of the rod **47** is threadedly engaged as shown at **62** with the member **63**, thereby providing an annular shoulder **64** for a purpose to be described.

The upper part of the valve rod **47** is telescopically received within the hollow sleeve **65** as shown in FIG. 1 of the drawings. The hollow sleeve **65** is in turn supported in any suitable manner in the drill string, and as illustrated is shown as being supported on the web member **66** which is seated within the grooves **67** formed in the upper end of the housing **29**.

As illustrated in FIG. 8, the lower end of sleeve **65** is provided with an annular groove **65*a*** spaced from the lower end **65*b*** of the hollow sleeve. The web member **66** includes the three legs **66*a*** and the central hub **66*b*** through which a bore **66*c*** extends. The bore **66*c*** is counterbored as shown in FIG. 8 at **66*d***, such counterbore extending up to the end of the annular groove **65*a*** in the hollow sleeve **65** and terminating in an arcuate manner as represented as **66*e*** which termination conforms with the curvature of the groove **65*a***. An annular ring **70** may be positioned in the groove **65*a***, and the hollow sleeve **65** then positioned within the bore **66*c*** of the hub **66*b***. Any other suitable arrangement could be provided to mount sleeve **65** slidably relative to web member **66**.

A spring **72** rests on the top of the hub **66***b* and abuts the shoulder **73** formed on the hollow sleeve **65** and functions as a shock absorber when the device is actuated as will be described hereinafter.

The hollow sleeve **65** may be provided with any suitable number of circumferentially spaced windows or slots **74** in which are pivotally mounted the members **75** by means of the pin **76** extending through each of the members **75** and into the adjacent wall of the slots or windows **74** of the hollow sleeve **65**.

It will also be noted that the pivotally mounted members **75** have a cutout portion to accommodate the spring **78** which fits around the pivot pin **76**, such spring means normally tending to urge the pivotally mounted members **75** radially outward relative to the hollow sleeve **65** and the valve rod **47**. The upper end **80** of each of the pivotally mounted members **75** is thereby engaged with the shoulder **64** and thus restrains longitudinal movement of the valve rod **47**. When in this position, the drilling fluid will pass through the bore **41** in the drilling fluid will pass through the bore **41** in the drilling string around the web **66** and around check valve **39** and around the web **31** into the bore **20** of the bit **15** and will be discharged through all of the nozzles in the drilling bit, both the large deflection jet nozzle and the two smaller drilling nozzles.

When it is desired to actuate the device, the hollow member **81** with a fishing neck **82** on the upper end thereof is dropped in the well string and moves to the position shown in FIG. 2 of the drawing so as to telescope over the hollow sleeve **65**.

When this occurs, the pivotally mounted members **75** are moved inwardly within the windows **74** as shown in FIG. 2 of the drawings whereupon the end **80** of each of the members **75** disengages from the shoulder **64** and the spring **50** urges the valve means **25** into engagement with the partition means **19** so that drilling fluid from the bore **41** of the drill string flows around member **81** to the bit bore **20** and is thereafter conducted only to the large deflecting nozzle represented at **22**, and prevented from flowing to nozzles **22'**. As previously noted, the partition means **19** is arranged as disclosed in United States Letters Patent No. 3,360,057 so as to communicate with the smaller drilling jet nozzles, one of which is not illustrated in the drawings.

From the foregoing description, it can be seen that all of the drilling liquid from the drill string is communicated through the bore **20** of the bit **15** and discharged only through the deflecting nozzle **22** for the jet deflection operation.

Following the jet deflection operation, it is customary to drill one or more joints before a directional survey is run, and of course during this period member **81** is in place and all of the drilling fluid flows through the large jet nozzle only.

Also, it should be further understood that a nonmagnetic drill collar equipped with orienting magnets is utilized in order that a survey may be taken in a manner well known in the art. A scribe line is affixed on the collar in alignment with the north magnets so as to predetermine the position of the large jet nozzle with respect to the north magnets before the bit is lowered into the well bore. This is done in a manner well known in the art.

It should be further understood that the combined length of member **81**, the wireline overshot, and the survey instrument assembly must be prespaced with suitable lengths of instrument sinker bars so when member **81** is resting on the top of **66***b*, the orienting compass in the survey instrument will be directly opposite the orienting magnets in the nonmagnetic drill collar.

After one or more joints have been drilled following the jet deflecting operation, the survey instrument is run along with the wireline overshot on the lower end thereof. The wireline overshot will latch on the fishing neck **82** of member **81**, and the survey picture is taken. When the survey instrument is removed, member **81** is also removed from the well bore. If the survey indicates that the well bore is not proceeding in the desired direction, then hollow member **81** is dropped back in the drill string and pumped down and further jet deflection continued. If, however, the survey indicates that the well bore is proceeding in the desired direction, then of course further deviation will not be desired.

After the survey instrument and the hollow member have been retrieved to the surface, the slips are taken out of the rotary table in a manner well known in the art and the drill string is then lowered several feet before starting the pumps. The hydrostatic pressure below the float valve acting on the cross-sectional area of the valve stem will force the valve stem **47** up into the hollow sleeve **65** and when it is forced up in this manner the pivotally mounted members **75** re-engage the shoulder **64** to hold the valve rod **47** in the position shown in FIG. 1 of the drawing. The reengagement of members **75** with shoulder **64** may occur without lowering the drill string and merely by removing member **81** when the hydrostatic head below float valve **39** is greater than it is inside the drill string.

Thereafter, normal drilling operations may continue.

If further jet deviation or drilling is desired, the hollow member **81** is again dropped to release the valve rod and close off the drilling jet nozzles and conduct all of the fluid to the large deflecting nozzle to accomplish the desired deflecting operation. For example, the large jet deflecting nozzle may have a discharge opening ⅝ inch in diameter, and the two jet drilling nozzles may have a discharge opening ¼ inch in diameter. The nozzles may be held in the bit in any one of several ways, such as with an O-ring seal and snap ring as shown. In some instances, the deflecting jet may be brazed or welded in place, or it may be held in place with epoxy resin.

Referring now to FIGS. 6, 6A, and 7, the device in the form there illustrated is shown in its actuated position as the hollow member represented by the numeral **81'** when the fishing neck **82'** thereon has been lowered into the well bore. The drilling bit is again illustrated and represented by the numeral **15'** and is provided with partition means **19'** to accomplish the same function and purpose as that described with regard to FIGS. 1 through 4. The housing **29'** is similar to the housing **29** and the check valve **39'** is similar to the check valve **39** described in FIG. 1.

A slightly different form of seat **24'** is shown and a slightly different form of valve means **25'** is also shown on the valve rod **47'** which is similar to the valve rod **47** previously described.

In the form shown in FIGS. 6, 6A, and 7, the hollow sleeve **65'** is integral with the web member **66'** and the members **75'** which are pivoted on the pin **76'** within the slots **74** formed in the hollow sleeve **65'**. It will be noted that in the form of the invention shown in FIG. 6, the pivotally mounted members **75** are urged outwardly by reason of the spring means **78'** which fits around the hollow sleeve **65'** and is engaged within a groove **78***a* formed in each of the pivotally mounted members **75'**. The spring **78'** urges the pivotally mounted members **75'** outwardly relative to the hollow sleeve **65'** as described with regard to the form of the invention shown in FIGS. 1 and 1A, and the ring which is slidable on valve rod **47'** has shoulder **64'** on its lower end with which the ends **80'** of each of the pivotally mounted members **75'** engage when the valve rod **47'** is in up position.

Spring **90** which surrounds the upper end of the valve rod **47'** acts as a shock absorber for the pivotally mounted members **75'** when the valve rod **47'** is in its uppermost position.

In FIGS. 9 and 10, the partition means **19** is shown in greater detail, and when welded in the bit **15**, the bore **19***a* communicates fluid from the drill bit bore **20** to discharge nozzles **22'** when valve member **25** is not on seat **24**, and when valve member **25** is on seat **24**, fluid flow to discharge nozzles **22'** is prevented and all fluid dis-

charges through the larger discharge opening in nozzle 22.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. An arrangement to be connected in a drill string for selectively controlling fluid discharge from a drill bit on the lower end of the drill string to effect jet bit deflection comprising:

(a) a drill bit with a bore for receiving fluid from the drill string;

(b) nozzles mounted in said bit to discharge the fluid from the bit;

(c) partition means in said bit for separating fluid flow in the bit bore and selectively directing it to said nozzles;

(d) means operatively associated with said bit to abut the upper end of said partition means and close off fluid discharge through all of said nozzles except one, said means including:

(1) a housing carried within the drill string with a downwardly facing valve seat thereon;

(2) check valve means mounted in said housing to accommodate flow from the drill string to the bit bore, but preventing fluid flow from beneath the valve into the drill string;

(3) a valve rod movable longitudinally of said housing and through said check valve;

(4) valve means on the lower end of said rod for abutting said partition means and thereby close off fluid discharge through all of said nozzles except one;

(5) spring means normally urging said valve means to abutting relationship with said partition means;

(6) a hollow sleeve telescopically receiving the upper end of said valve rod;

(7) means pivotally mounted in said sleeve and engaging sad valve rod above said check valve to hold said valve rod against longitudinal movement within said housing and thereby inhibit engagement of said valve means and partition;

(8) spring means abutting said pivotally mounted means to normally urge said pivotally mounted means in holding relationship with said valve rod to thereby prevent longitudinal movement of said valve rod; and

(9) said pivotally mounted means projecting radially outward relative to said sleeve and being adapted to pivot inwardly by the insertion of a hollow member in the drill string.

2. The invention of claim 1 including seal means between said housing and drill string.

3. The invention of claim 1 including seal means between said valve rod and check valve means.

4. The invention of claim 1 wherein said partition means includes a seat on its upper end for receiving said valve means on the lower end of said rod.

5. The invention of claim 1 including shoulder means on said valve rod for abutting with said pivotally mounted means to hold said valve rod against longitudinal movement.

6. The invention of claim 1 including a spring support means in said housing and a spring carried thereon and abutting said check valve means to normally urge it to closed position.

7. The invention of claim 1 including support means carried by said housing to support said hollow sleeve.

8. The invention of claim 7 including latch means to latch said support and sleeve together.

9. The invention of claim 7 including a shoulder on said sleeve and spring means abutting said support and said should to accommodate any shock on said sleeve where said hollow member telescopes thereover.

10. An arrangement to be connected in a drill string for selectively controlling fluid discharge from a drill bit on the lower end of the drill string to effect jet bit deflection comprising:

(a) a drill bit with a bore for receiving fluid from the drill string,

(b) nozzles mounted in said bit to discharge the fluid from the bit;

(c) partition means in said bit for separating fluid flow in the bit bore and selectively directing it to said nozzles;

(d) means operatively associated with said bit to abut the upper end of said partition means and close off fluid discharge through all of said nozzles except one, said means including:

(1) a valve rod supported in the drill string for longitudinal movement;

(2) valve means on the lower end of said rod for abutting said partition means and thereby close off fluid discharged through all of said nozzles except one;

(3) spring means normally urging said valve means to abutting relationship with said partition means;

(4) means for restraining said valve rod against longitudinal movement; and

(5) means operatively associated with said restraining means to release said restraining means from said rod whereupon it moves longitudinally to abut said valve means against said partition.

11. The method of selectively discharging from the drill string all the hydraulic horsepower in drilling fluid through only one nozzle of a drill bit during jet bit deflection and through all nozzles of a drill bit when not jet bit deflecting, without removing the drill string from a well bore, comprising the steps of:

(a) partitioning the bore of a drill bit having discharge nozzles thereon for separating fluid flow in the bit more to selectively direct it to the discharge nozzles;

(b) inserting a spring loaded valve means in the drill string;

(c) connecting the partitioned drill bit to the lower end of a drill string beneath the spring loaded valve means;

(d) restraining the valve means in spaced relation to the partition in the bit whereby the hydraulic horsepower in the drilling fluid is discharged through all of the nozzles; and

(e) releasing the restraining means so that the valve means engages the partition and closes off all nozzles except one whereby all the hydraulic horsepower is discharged therethrough.

12. The method of selectively discharging from the drill string all the hydraulic horsepower in drilling fluid through only one nozzle of a drill bit during jet bit deflection and through all nozzles of a drill bit when not jet bit deflecting, without removing the drill string from a well bore, comprising the steps of:

(a) partitioning the bore of a drill bit having discharge nozzles thereon for separating fluid flow in the bit bore to selectively direct it to the discharge nozzles;

(b) inserting a spring loaded valve means in the drill string;

(c) connecting the partitioned drill bit to the lower end of a drill string beneath the spring loaded valve means;

(d) restraining the valve means in spaced relation to the partition in the bit whereby the hydraulic horse-

power in the drilling fluid is discharged through all of the nozzles;

(e) releasing the restraining means so that the valve means engages the partition and closes off all nozzles except one whereby all the hydraulic horsepower is discharged therethrough; and

(f) recovering the releasing means from the well bore whereupon the drilling fluid may be discharged through all the nozzles.

13. The method of selectively discharging from the drill string all the hydraulic horsepower in drilling fluid through only one nozzle of a drill bit during jet bit deflection and through all nozzles of a drill bit when not jet bit deflecting, without removing the drill string from a well bore, comprising the steps of:

(a) partitioning the bore of a drill bit having discharge nozzles thereon for separating fluid flow in the bit bore to selectively direct it to the discharge nozzles;

(b) inserting a spring loaded valve means in the drill string;

(c) connecting the partitioned drill bit to the lower end of a drill string beneath the spring loaded valve means;

(d) restraining the valve means in spaced relation to the partition in the bit whereby the hydraulic horse-

power in the drilling fluid is discharged through all of the nozzles;

(e) releasing the restraining means so that the valve means engages the partition and closes off all nozzles except one whereby all the hydraulic horsepower is discharged therethrough;

(f) recovering the releasing means from the well bore; and

(g) lowering the drill string to recock the restraining means and open the valve means whereupon the drilling fluid may be discharged through all the nozzles.

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