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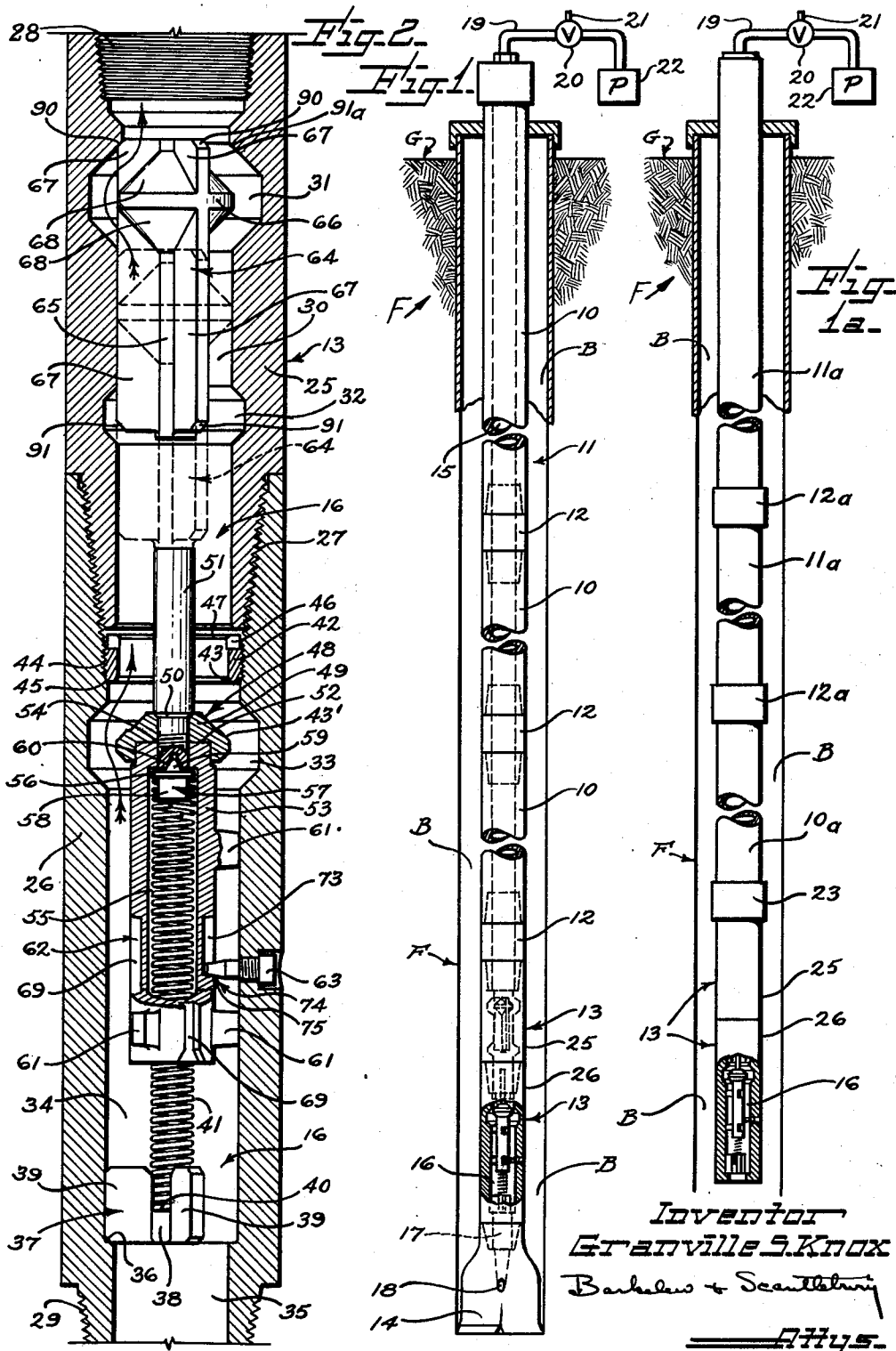
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2,518,795

VALVE FOR DRILL STEMS AND THE LIKE

Filed Nov. 16, 1946

3 Sheets-Sheet 1



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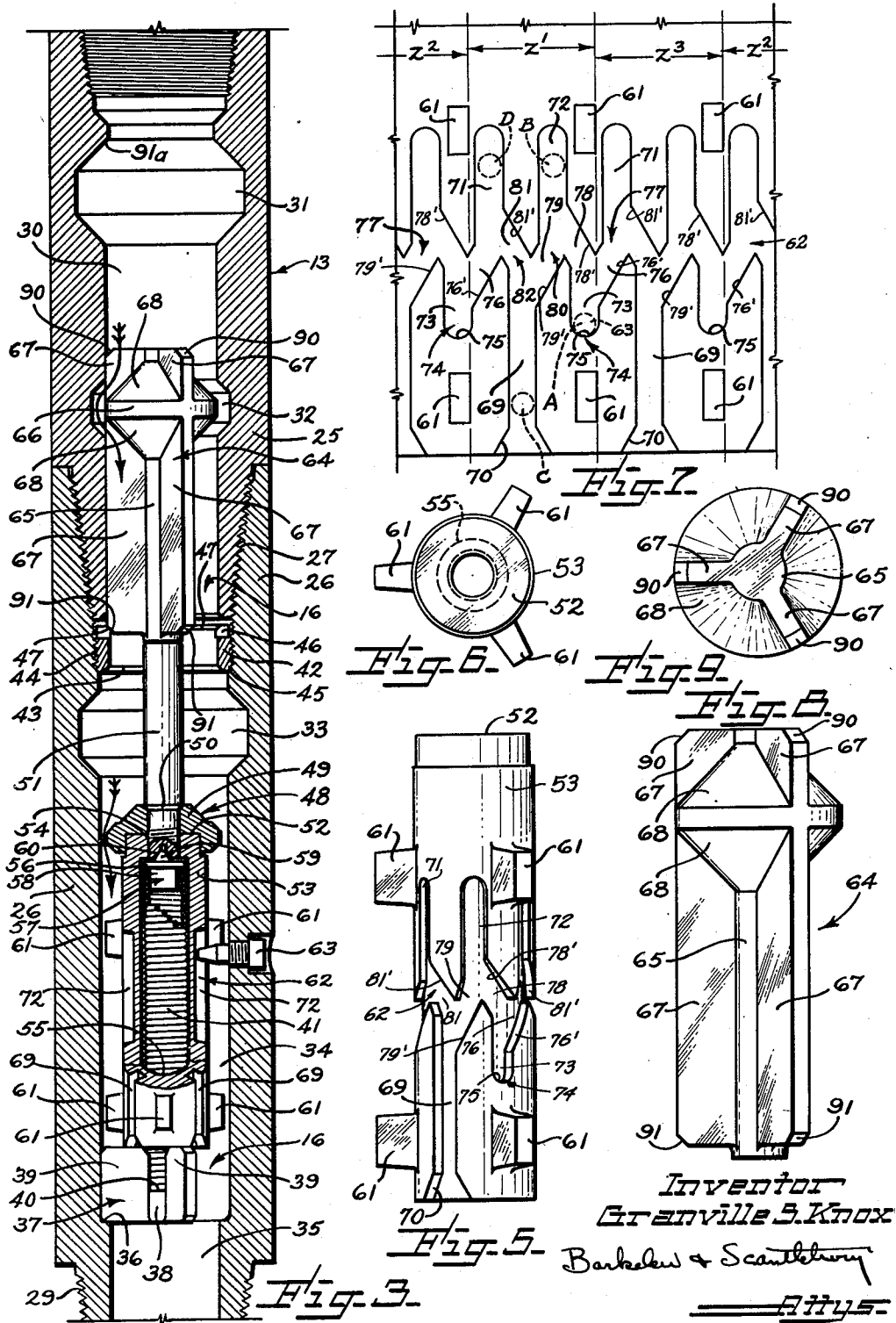
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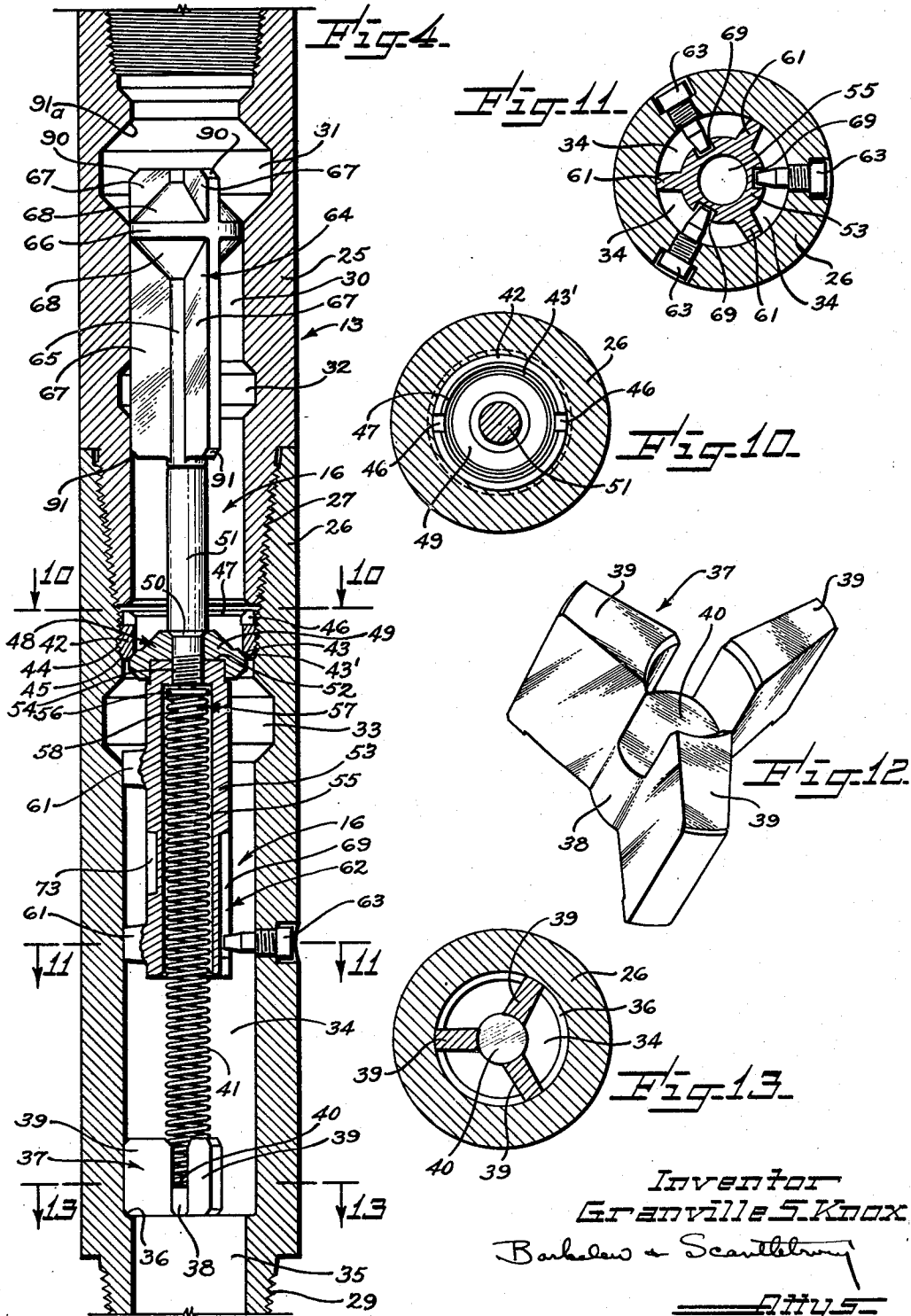
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VALVE FOR DRILL STEMS AND THE LIKE

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7 Claims. (Cl. 251-163)

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This invention relates generally to valves and is more particularly concerned with controllable back-pressure and/or reverse-circulation valves, irrespective of their environment. However, the valve is particularly useful in connection with well drilling and controlling operations, and I have therefore described it in that environment, without implying that its adaptability and use is thereby limited.

The valve is especially useful in controlling circulation through tubing or through a drill stem, but since it may be fully described when put to use in connection with a drill stem, it will be unnecessary to describe in detail its tubing adaptation. In connection with its use with tubing, it is adapted to be selectively operated to control, at the lower end of the tubing, the upward flow of oil from the production zone. When I later describe the operation of the bottom valve to control the upward flow of circulating fluid through a drill stem, it is obvious that this description may be considered as applicable to the control of upward flow of oil through a tubing, and therefore the description need not be repeated.

In describing the operation of the valve in connection with a drill stem, I will assume a particular situation where so-called "reverse-circulation" represents the normal condition, but this assumption is made solely for purposes of illustration, and is not to be considered as limitative on the broader aspects of the invention.

In reverse-circulation, the circulating fluid from around the outside of the drill stem enters the stem bore at the bottom of the string (ordinarily through passageways provided through the cutting tool) and thence passes upwardly through the stem bore to the ground surface, where its delivery is ordinarily valve-controlled. In this type of circulation, the upward flow of fluid is caused by pressure in the formation surrounding the well bore. This pressure is, of course, uncontrollable from the ground surface. Accordingly, if it be desired, for instance, to pull the drill-string from the well (which involves breaking the joints of the drill stem as the "stands" are removed) it is obviously highly desirable to shut off the flow of circulation fluid into the stem bore at its lower or tool end.

It is therefore an object of the invention to provide a valve at the bottom of the string whereby such a shut-off may be accomplished at the will of the operator, the valve being controlled remotely from the ground surface.

Generally, I provide an hydraulic control for

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this purpose, utilizing the fluid in the pipe bore as the control medium between the ground surface mechanism and the bottom valve mechanism, thus avoiding the necessity of providing separate control fluid and special conductors therefor.

Under certain well conditions, the operator need merely adjust a valve at the ground surface to cause movement of the bottom valve from open to closed position. If the bottom valve is to be reopened, there is then required the application of downwardly directed fluid pressure (that is, a pressure applied in the direction opposite to that of the reverse-circulation pressure) through the drill stem. Upon then relieving the fluid column of the downward pressure, the bottom valve is relatched in open position to allow a restoration of reverse circulation.

In most cases, however, each time the bottom valve is to be opened the control includes the initial build-up of the downward pressure and subsequent relief of that pressure, the pulsation thus set up first "unlatching" the open bottom valve and then leaving the bottom valve free to go to "shut-off" position. Then, when it becomes desirable or necessary to reopen the bottom valve, a second adjustment of the surface valve and a second pulsation of downwardly directed fluid pressure causes a reopening and relatching of the bottom valve.

Though, in its broader sense, the invention contemplates an arrangement wherein there may be provision for only one closing or one opening cycle of operation during the life of a given installation, the invention also includes provisions whereby a succession of identical surface-valve adjustments and downwardly directed pressure impulses, alternately closes and opens the bottom valve, thus making it possible for the operator to have full control of the bottom valve at all times.

As a special (though not limitative) feature, the arrangement is such that during periods when the bottom valve is in open condition, downward circulation through the stem bore and bottom valve may be maintained.

This hydraulic type of remote control has, of course, many advantages, as will be readily understood by those skilled in the art, it being particularly noteworthy that when the drill string is being lengthened or shortened in going into or out of the hole, respectively, there is no necessity of adding or removing lengths of control rod, as would be true were the valve to be controlled

by movement of a sectional stem extending from the valve to the ground surface.

The feature of being able, at will, to shut off upward flow of fluid through a well pipe, with the shut-off occurring at the bottom of the pipe, has great significance in connection with certain emergency situations, as well as in normal drilling operations. The emergency may be of an operational character, or it may be a war emergency wherein demand is made that flowing wells be shut-off far beneath the ground surface. Heretofore such shut-off has been accomplished by plugs which are depressed through the pipe bore and anchored in position at the lower end of that bore. This is not only a relatively slow, expensive, and often unsure procedure, but, if it be desired later to restore the well to service, the situation is aggravated by the necessity for retrieving the plug or otherwise clearing it from the bore.

In contra-distinction to this, my device permits a practically instantaneous shut-off at the bottom of the pipe by the mere adjustment of a ground-surface valve or the mere successive application and relief of fluid pressure downwardly through the pipe bore. Then, if the well is to be restored to service, it is only necessary again to adjust the ground-surface valve, or to create a second operative pulsation in the pipe-contained fluid, thus forcing re-opening of the bottom valve. The valve is then again releasably held in its open position and in a state of readiness to be reclosed by actuation of the surface valve or by a pressure pulsation, if and when the occasion arises.

Other features of novelty and objects of the invention will be made apparent in the following detailed description, reference being had to the accompanying drawings, in which,

Fig. 1 is an elevational view showing the position normally occupied by my device in a drill string;

Fig. 1a is a view similar to Fig. 1 except it shows the position occupied by the device when it is associated with tubing;

Fig. 2 is an enlarged, medial section, partly in elevation, showing the condition of the valve when it is arranged for circulation upwardly through the bore of the drill stem;

Fig. 3 is a view similar to Fig. 2 showing the condition of the valve during the "indexing" phase of operation, that is, while the valve has been moved to a position such that its next position must either be full open or full closed;

Fig. 4 is a view similar to Fig. 1 but showing the valve closed against upward circulation through the drill stem bore;

Fig. 5 is an enlarged, detached elevation of the cam sleeve making up a part of the device;

Fig. 6 is a top plan view of Fig. 5;

Fig. 7 is a developed elevation of the cam sleeve;

Fig. 8 is an enlarged, detached elevation of the valve actuating piston and plunger;

Fig. 9 is a top elevation of Fig. 8;

Fig. 10 is a section on line 10—10 of Fig. 4;

Fig. 11 is a section on line 11—11 of Fig. 4;

Fig. 12 is a detached, perspective view of a spring pedestal; and

Fig. 13 is a section on the line 13—13 of Fig. 4.

In Fig. 1 I have illustrated the preferred location of my improved valve in connection with a drill string 11 which is made up, in the main, of stands 10 of hollow drill pipe connected by hollow tool joints 12. The drill stem is shown as being positioned within well bore B, defined

by "formation" F, the ground surface being indicated at G. The valve 13 is ordinarily, but not necessarily, coupled into the drill string 11 intermediate the lowest stand of drill pipe and the cutting tool 14, the bore 15 of the drill stem being in communication with bore 16 of valve housing 13, and the housing bore 16 being in communication with the cutting-tool bore 17, the latter opening to well-bore B at 18.

At ground surface G, I have schematically indicated a control system made up of pipe 19 leading from stem bore 15 to valve 20; valve 20 being selectively operable to open pipe 19 to the discharge or outlet 21 or to circulating pump 22.

Fig. 1a shows the housing 13 of my improved valve as being attached by coupling 23 to the lower end of tubing 10a which is made up of a number of tubing lengths 11a coupled together as at 12a. The schematic arrangement of piping, valve and pump, is the same as described in connection with Fig. 1. For purposes of illustration, it will be assumed that, in Fig. 1 the formation pressure is normally adapted to promote circulation of well fluid upwardly through opening 18 and the various bores of the valve and drill stem to the piping system at the ground surface, valve 20 normally being set so that delivery of this fluid is through outlet 21, and so the pump is ineffective. In Fig. 1a, it is assumed that formation pressure is causing upward flow of production oil through tubing 10a to the piping system at the ground surface, valve 20 being normally set so that delivery is through outlet pipe 21, and so the pump is ineffective.

It is to be understood, of course, that my improved valve is useful in other operational situations, and therefore the invention is not to be considered as limited by the particular choice made for illustrative purposes. Similarly, the fact that I shall hereinafter describe the detailed operation only in connection with the showing of Fig. 1, is not to be considered as limitative on the invention, for the structure and operation may be exactly the same for the tubing-applied valve as for the drill-stem-applied valve. The single difference is, that, in the case of Fig. 1 we are controlling circulating fluid during well drilling operations, while in connection with the showing of Fig. 1a, we are controlling the flow of well fluid during the production stage.

For convenience of assembly, tubular valve housing 13 is made up of sections 25 and 26 which are threadably coupled at 27. The upper end of section 25 is internally threaded at 28 for connection to the lowermost drill stem stand 10, while the lower end of housing section 26 is externally threaded at 29 for detachable connection to cutting tool 14, or to whatever element of the drill string may be positioned below the control valve. Of course, in the case of the tubing of Fig. 1a, the threaded zone 29 may be omitted.

The bore 16 of the valve housing includes, in housing section 25, a cylinder portion 30 and the upper and lower by-pass chambers 31 and 32, respectively, at opposite ends of the cylinder portion 30. In housing section 26, the bore 16 includes a by-pass chamber 33, a major bore portion 34, and a somewhat reduced diameter bore portion 35, there thus being provided an annular shoulder 36, adapted to support the spring pedestal 37, shown in detail in Figs. 12 and 13. This pedestal is made up of a central body portion 38 from which extend radial wings 39 adapted to rest on shoulder 36 and to center the pedestal within the bore portion 34. The inner ends

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of wings 39 define a socket 40 adapted to receive and center the lower end of spring 41 which is bottomed on body portion 38. The purpose of the spring will be presently described. The openings between wings 39 provide for the substantially unrestricted passage of fluid through the bore portions 34 and 35.

Immediately above annular chamber 33, bore 16 is somewhat restricted by ring 42 upon which is fashioned the downwardly facing, annular and conical valve seat 43. The ring 42 is threadably connected at 44 to housing section 26, being screwed home against the annular shoulder 45 of that housing section. The ring is provided with diametrically opposite notches 46 (see Fig. 10) whereby the ring may be screwed to and from its position of assembly with section 26 by the use of a special wrench when sections 25 and 26 are disconnected one from the other. The upper end of ring 42 is chamfered at 47 to provide an upwardly facing stop shoulder for a purpose to be described.

The valve stopper, generally indicated at 48, comprises a circular head or disk 49 having an annular, conical face adapted to seal on complementary seat 43. The head is clamped between shoulder 50 on valve stem 51 and the upper end 52 of the cam sleeve 53, the stem and sleeve being threadably connected at 54 to effect this clamping action.

Sleeve 53 is provided with a bore 55 adapted to receive the upper end of spring 41 which bears against the flange 56 of bearing member 57. The body portion 58 of member 57 nicely fits the upper end of the spring, while the upper, conical tip 59 is received in a complementary recess 60 provided in the lower end of stem 51. The conical bearing between tip 59 and the end of stem 51 centers the upper end of spring 41 and acts as a pivot to permit free relative rotation between spring 41 and cam sleeve 53 during certain stages of operation, namely, the rotational indexing of the vertically reciprocable valve assembly to cause it to assume pre-determined positions with relation to the valve seat.

Cam sleeve 53 is provided with radial wings 61, both at the bottom and near the top thereof, which center the sleeve within bore 34. The space between the wings allows practically uninterrupted flow of fluid upwardly or downwardly between housing section 26 and the sleeve.

The outer periphery of sleeve 53 is provided with a cam slot or groove generally indicated at 62, the particularities of which will be described later. Threadably supported in section 26 and projecting radially into bore 34 and cam slot 62, are the cam lugs or follower pins 63 (see Fig. 11).

Above stem 51 is arranged a "floating" dart or plunger generally indicated at 64 (Figs. 8 and 9) made up of a stem 65 carrying near its upper end a piston 66 which is adapted, at times, to have piston fit within cylinder 30, and at other times to occupy a non-fluid-interrupting position in by-pass chambers 31 or 32. Piston head 66 is reinforced by conical, filler portions 68 extending to stem 65.

The dart or plunger 64 is provided with radial wings 67, both above and below piston head 66, which center the plunger within bore 16, even during such times as piston 66 occupies by-pass chambers 31 or 32. Dart stem 65 is axially aligned with valve stem 51 and is, at times, adapted to engage therewith. As will appear, plunger 64 is, at times, vertically movable independently of

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valve stopper 48, at other times is adapted to engage the stem 51 to move stopper 48 downwardly, and, at still other times, is adapted to be thrust upwardly under the impetus of upward movement of stopper 48.

Cam groove 62 extends continuously around sleeve 53, preferably being made up of three camming zones Z1, Z2 and Z3 (Figs. 5, 6 and 7) which are identical in contour and therefore are adapted, one each, to receive, at equivalent points therealong, one of the cam pins 63, the latter being spaced 120° apart. The three groove zones being identical, it will be necessary to describe only one in detail. Each groove zone (for instance, zone Z1) includes a vertical leg or course 69, opening with a flare 70 to the lower end of the sleeve, the flare being provided only to facilitate assembly of the sleeve and cam pins, since the pins never pass out through the open ends of courses 69 during operation of the valve. Above the upper end of course 69 are two vertical courses 71 and 72 which are spaced 60° apart, being located 30° distant from opposite sides of the center line of course 69. Below courses 71 and 72 and spaced 60° from course 69 and therefore 30° from course 71, is a vertical course 73 which terminates in a "latching" pocket 74. The upwardly facing wall 75 of this pocket forms a stop-shoulder, as will presently appear.

Leading from the course 71 of zone Z3 to latching course 73 of zone Z1, is an inclined course 76, the mouth 77 of course 76 lying directly beneath course 74 of zone Z3. Leading from latching course 73 and opening to the side of course 72 of zone Z1 is an inclined course 78. Leading from course 72 of zone Z1 to course 69 of zone Z1, is an inclined course 79, the mouth 80 of the latter course being disposed directly beneath course 72. An inclined course 81 leads from course 69 of zone Z1 to course 71 of zone Z1, the mouth 82 of course 81 opening directly over course 69 of zone Z1. Inclined course 76 of zone Z1 opens to latching course 73 of zone Z2.

Now referring to Fig. 2, the valve is shown in the condition prevailing during reverse circulation, which is here considered as normal circulation. That is, the circulating fluid is flowing upwardly through the drill stem. Cam pins 63 are in latching pockets 74 (positions A of Fig. 7) shoulders 75 engaging the pins to limit upward movement of sleeve 53 under the influence of spring 41, which constantly is compressed in a manner tending to bias valve stopper 48 to closed position against seat 43. With pins 63 thus holding sleeve 53 in a relatively depressed position, valve stopper 48 is held spaced below seat 43, the valve thus being maintained in open condition to permit the upward flow of fluid, as indicated by the arrows.

At this time the kinetic energy of the upwardly flowing fluid acts against the under side of plunger or dart 64 to hold it in its uppermost position (full-line position) the engagement of the upper ends 90 of wings 67 with housing shoulder 91a limiting the upward movement of the dart. Piston head 66 now lies in by-pass chamber 31, so there is ample space for the upwardly flowing fluid to pass around head 66 and thence flow upwardly through the drill stem.

If it now be desired to close valve 48—43, the operator first closes valve 20 which is "downstream" with relation to valve 48—43. The fluid column within the drill stem and valve housing 13 thereupon becomes static, and dart 64 drops to the dotted line position of Fig. 2, the dart

Coming to rest when it engages the upper end of valve stem 51, at which time piston head 66 lies within the cylinder portion 30 of the housing bore.

Pump 22 is then actuated to build up the fluid pressure above head 66, forcing the latter downwardly through cylinder 30. The consequent depression of dart 64 acts through stem 51 to depress valve head 48 and sleeve 53 against the force of spring 41. During the initial portion of the depressive movement, cam pins 63, in effect, leave pockets 74, traveling through courses 73. The inclinations of courses 78 then cause a 30° rotation of the cam sleeve through the engagement of cam faces 78' with pins 63, whereupon continued depression of the sleeve causes, in effect, pins 63 to pass upwardly into vertical courses 72 (Fig. 3).

The downward movement of the sleeve continues until ends 91 of dart-wings 67 engage ring-shoulder 47. Cam pins 63 are now in positions B of Fig. 7. By this time piston head 66 has entered by-pass chamber 32, so downward circulation may be promoted and maintained through the entire length of valve housing 13 (see arrows in Fig. 3).

When the operator subsequently relieves the fluid pressure from above, spring 41 acts to urge sleeve 53 and valve stopper 48 upwardly. Pins 63 first pass through vertical courses 72 and then through inclined courses 79 into vertical courses 69; the passage through the inclined courses rotating the cam stem 53 through 30° due to the engagement of cam faces 79' with pins 63. With the cam pins in courses 69, spring 41 is free to urge valve stopper 48 to fully seated or closed condition (Fig. 4) all upward circulation being thereby shut off. Of course, the upward pressure of the well fluid acts against the under side of the cam sleeve and stopper 48 in a manner tending to seat the valve stopper more firmly. At this time the piston head 66 lies in cylinder 30 near its upper end, and pins 63 are at positions C in Fig. 7.

If, now, the operator wishes to return the valve to latched-open position (Fig. 2) he first applies downwardly directed fluid pressure to head 66, the pressure being sufficient to overpower spring 41. As sleeve 53 is pressed downwardly, pins 63 first pass through vertical courses 69 and then through inclined courses 81 into vertical courses 71; the sleeve being rotated 30° due to the engagement of pin 63 with the cam faces 81' of inclined courses 81. All parts of the device are thus returned to the condition of Fig. 3, except that pins 63 lie in courses 71 instead of 72. They occupy positions D in Fig. 7.

When the operator subsequently relieves head 66 from downwardly directed fluid pressure, spring 41 acts to lift the sleeve, causing pins 63 first to travel through vertical courses 71 and then through inclined courses 76 into vertical courses 73; the passage of the pins through the inclined courses giving a 30° rotation to the valve stem due to the engagement of cam faces 76' with pin 63. Pins 63 thus find their way into latching pockets 74 and, once more the device is returned to the condition of Fig. 2, with valve 48 latched open and dart 64 movable upwardly to allow reverse circulation.

Thus, by alternately applying downwardly directed fluid pressure and then relieving that pressure, the shut-off valve 48 is caused to be moved alternately from latched-open condition to closed condition, and vice-versa. The step-

by-step indexing of the valve to bring about this sequential action may be considered as being accomplished under remote control by successive fluid-pressure pulsations sent down through the drill stem fluid.

It will be seen that, by following the above procedure, an operator may easily and almost instantly close or open fluid flow through a valve located clear at the bottom of a well pipe, whether it be drill stem or tubing, all to the advantageous ends spoken of at the forepart of this specification.

In some wells the formation pressure is of such high and even value that it is feasible to omit spring 41 from the valve assembly, provided the operator does not object to—or other operational demands do not preclude—the movement of an open bottom valve to closed position the instant the surface valve is opened and then closed. In this case, dependence is had solely on the kinetic energy of the upwardly flowing fluid to urge valve stopper 48 and sleeve 53 upwardly in all phases of the operation described above wherein the spring has been specified as the source of the urging force.

With the spring omitted, the need for dart 64 ceases and therefore this element, also, may be omitted under the conditions specified just above. Then, assuming the valve is being held open by virtue of engagement of cam pins 63 with shoulders 75, if occasion arises for closing the bottom valve, the operator merely closes surface valve 20. The fluid column becomes static and the stopper 48 and sleeve 53 drop by gravity to cause a 30° indexing of sleeve 53 so, when valve 20 is reopened, the kinetic energy of the now moving fluid column elevates the valve stopper to shut-off position, there being a 30° indexing of the sleeve during its upward movement.

If the bottom valve is to be re-opened, it is first necessary to unseat stopper 48 by closing valve 20 and then creating preponderant downwardly directed fluid pressure by operation of pump 21. Once the bottom valve is "cracked open," stopper 48 will drop by gravity to the position of Fig. 3, the sleeve 53 being indexed through 30°. Upon stopping pump operation and reopening surface valve 20, the kinetic energy of the upwardly flowing well-fluid elevates stopper 48; sleeve 53 being indexed through an additional 30°. It follows that stopper 48 is releasably held open in the position of Fig. 2, and reverse-circulation is restored.

While I have shown and described preferred embodiments of my invention, various changes in design, structure and arrangement may be made without departing from the spirit and scope of my broader claims.

I claim:

1. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, an extension carried by the stopper and rotatable with respect to the housing, a stop member carried by the housing, an upwardly facing stop shoulder on said extension and vertically aligned and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced

Below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, and an upwardly extending, angular cam face on the extension above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upwardly into engagement with the valve seat.

2. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, an extension carried by the stopper and rotatable with respect to the housing, a stop member carried by the housing, an upwardly facing stop shoulder on said extension and vertically aligned and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, an upwardly extending, angular cam face on the extension above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate in a given direction, the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat, a second angular cam shoulder on the extension and aligned with the said stop member when the valve is closed and effective, when the stopper is subsequently depressed, to further rotate the extension in said given direction with relation to the housing, and a third angular cam shoulder on the extension and aligned with said stop member after the stopper has been so depressed and effective, upon subsequent upward movement of the stopper, to rotate the extension in a manner to vertically align said stop shoulder with a stop member on the housing which stop member is adapted to halt subsequent upward movement of the stopper before it reaches said seat.

3. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, an extension carried by the stopper and rotatable with respect to the housing, a stop member carried by the housing, an upwardly facing stop shoulder on said extension and vertically aligned and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, an upwardly extending, angular cam face on the extension above and engageable with the stop member when the stopper is subsequently vertically de-

pressed, said cam face being effective, during such depression, to rotate, in a given direction, the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat, a second stop member on the housing and in the transverse plane of and angularly displaced from the first stop member, a second angular cam shoulder on the extension and aligned with the first stop member when the valve is closed and effective, when the stopper is subsequently depressed, to further rotate the extension in said given direction with relation to the housing, and a third angular cam shoulder on the extension and aligned with the first stop member after the stopper has been so depressed and effective, upon subsequent upward movement of the stopper to further rotate the extension in said given direction to an extent vertically aligning said stop shoulder with said second stop member.

4. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, a spring applied between the housing and stopper and urging said stopper towards said seat, an extension carried by the stopper and rotatable with respect to the housing, a stop member carried by the housing, an upwardly facing stop shoulder on said extension and vertically aligned and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, and an upwardly extending, angular cam face on the extension above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat, a plunger movable vertically through the housing bore above the valve seat, means on the housing limiting upward movement of the plunger, said plunger, at its upward limit of movement, being spaced vertically from the stopper, and said plunger being movable downwardly to engage the stopper in a manner whereby subsequent depression of the plunger depresses the stopper, and a piston on said plunger and having piston fit with the housing bore when the plunger is between its limits of vertical movement, there being a pair of by-passages in the housing around the piston which are positioned to be effective, one when the plunger is at its upper limit of movement and the other when the stopper has been depressed by the plunger to a predetermined extent.

5. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from

the seat for respectively closing and opening the valve, a spring applied between the housing and stopper and urging said stopper towards said seat, an extension carried by the stopper and rotatable with respect to the housing, a stop member carried by the housing, an upwardly facing stop shoulder on said extension and vertically alined and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, an upwardly extending, angular cam face on the extension above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate, in a given direction, the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat, a second stop member on the housing and in the transverse plane of and angularly displaced from the first stop member, a second angular cam shoulder on the extension and alined with the first stop member when the valve is closed and effective, when the stopper is subsequently depressed, to further rotate the extension in said given direction with relation to the housing, and a third angular cam shoulder on the extension and alined with the first stop member after the stopper has been so depressed and effective, upon subsequent upward movement of the stopper, to further rotate the extension in said given direction to an extent vertically alining said stop shoulder with said second stop member, a plunger movable vertically through the housing bore above the valve seat, means on the housing limiting upward movement of the plunger, said plunger, at its upward limit of movement, being spaced vertically from the stopper, and said plunger being movable downwardly to engage the stopper in a manner whereby subsequent depression of the plunger depresses the stopper, and a piston on said plunger and having a piston fit with the housing bore when the plunger is between its limits of vertical movement, there being a pair of by-passages in the housing around the piston which are positioned to be effective, one when the plunger is at its upper limit of movement and the other when the stopper has been depressed by the plunger to a predetermined extent.

6. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, an extension carried by the stopper and rotatable with respect to the housing, said extension being in the form of an axial sleeve depending from the stopper, a helical compression spring within the sleeve bore and interposed between a downwardly facing shoulder on the

stopper and an upwardly facing shoulder on the housing whereby the spring urges the stopper towards said seat, a stop member carried by the housing, an upwardly facing stop shoulder on said sleeve and vertically alined and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, and an upwardly extending, angular cam face on the sleeve above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat.

7. In a device of the character described, a vertically arranged valve housing having a bore therethrough, a valve within the housing and including a downwardly facing valve seat and a valve stopper in the bore below the seat and movable vertically through the bore to and from the seat for respectively closing and opening the valve, an extension carried by the stopper and rotatable with respect to the housing, said extension being in the form of an axial sleeve depending from the stopper, a helical compression spring within the sleeve bore, a rotational bearing between the upper end of the spring and a downwardly facing shoulder on the stopper, the lower end of the spring engaging an upwardly facing shoulder on the housing, all in a manner whereby the spring urges the stopper towards said seat, a stop member carried by the housing, an upwardly facing stop shoulder on said sleeve and vertically alined and engaged with said stop member when the housing and extension have been relatively rotated to one position of angular relationship and when the valve stopper is vertically spaced below the seat, said stop shoulder and stop member, when so engaged, holding said stopper against upward vertical movement, and an upwardly extending, angular cam face on the sleeve above and engageable with the stop member when the stopper is subsequently vertically depressed, said cam face being effective, during such depression, to rotate the extension with relation to the housing and thereby vertically dis-align the stop member and stop shoulder, whereby, upon relief of depressive force, the stopper is movable vertically upward into engagement with the valve seat.

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