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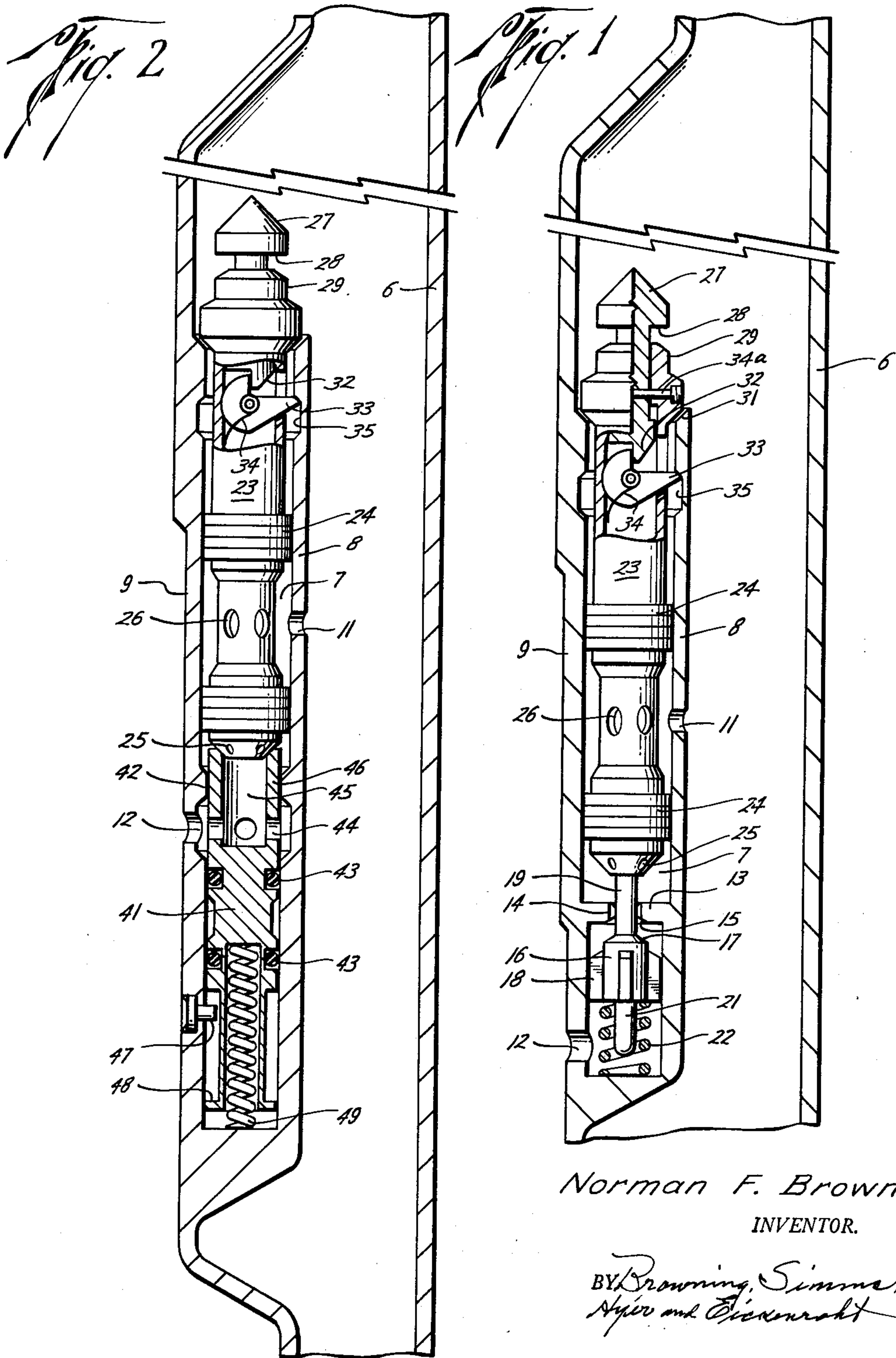
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Filed March 17, 1960

2 Sheets-Sheet 1



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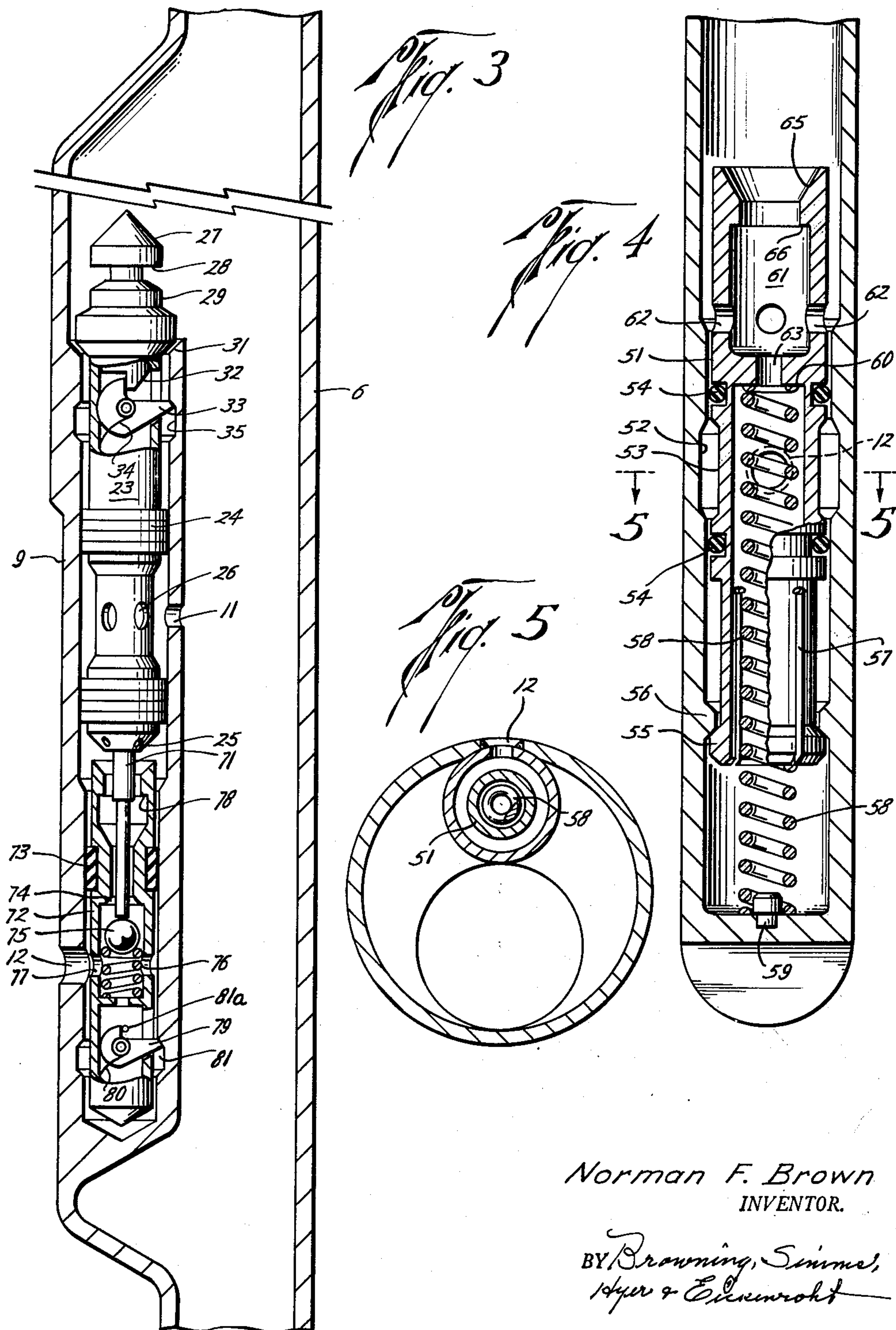
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## SIDE POCKET MANDREL WITH AN AUTOMATIC VALVE

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7 Claims. (Cl. 137-155)

This invention is an improved side pocket mandrel valve assembly. It is especially useful as a gas lift valve for producing oil wells, in the chemical treatment of oil wells, or in any other service where it is desirable to control transfer of fluid to or from a string of tubing in a well, from or to an annular space between the tubing and the wall of the well.

Side pocket mandrel valves have been used in the petroleum industry for many years. Such valves usually are of retrievable type, that is, they may be installed or removed at will by the use of wireline tools. The valves in common use for controlling flow between the tubing and the annular space in the well exterior of the tubing may be responsive to pressure within the tubing, to pressure within the casing outside the tubing, or to a differential between the two pressures. All of these types are of common use and each is advantageous in some particular application.

The term "side pocket mandrel" is used in this specification and claims to mean a mandrel connected at each end to tubing, said mandrel having a flowway therethrough axially aligned with the bore of said tubing, and having an enlargement on one side thereof substantially parallel to said flowway and an interior wall defining a side of said flowway in a lower part of the mandrel and cooperating with an interior wall of said enlargement to form a pocket adapted to receive a control valve in a lower part of said enlargement. Such mandrels are old in the art and are illustrated in the composite catalog of Oil Field and Pipeline Equipment, 1960-1961 edition, pages 1093 to 1094.

The side pocket mandrels ordinarily used have an opening through the exterior wall communicating with the interior of the pocket and a space outside the tubing at one level and an opening in the interior wall of the pocket communicating with the interior of the pocket and a space inside the tubing at a different level. A flow control valve of the type desired is introduced into the side pocket by the use of a suitable kickover tool handled by a wireline and are locked into place in the side pocket. Flow between the interior of the tubing and the space exterior of the tubing in the well then takes place as a fluid enters through an opening in the side pocket at one level, flows through the pocket and control valve contained therein, to the other level and out of the pocket. The valves used may vary the rate of continuous flow, but more commonly snap fully open or shut at suitable intervals to permit a rate of flow predetermined by the size of an opening through the valve.

All such valves need occasional repair or adjustment. When service of this type is necessary, it is presently customary to retrieve the valve from the side pocket with suitable wireline tools and bring it to the surface for service. During the time the control valve is out of the side pocket, it is obvious that there will be continuous flow through the openings in the pocket communicating with the exterior of the tubing when pressure differential exists. Since this flow is uncontrolled, it interferes seriously with operation of the well until the control valve is serviced and replaced in the side pocket.

It is an object of this invention to provide an improved side pocket mandrel valve assembly which enables continuation of well operations when a control valve, nor-

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mally present in the side pocket mandrel, is withdrawn.

Another object is to provide an improved side pocket mandrel valve assembly in which the control valve normally present in the side pocket of the mandrel may be removed for repair or service without loss of pressure in the well.

Another object is to provide an improved side pocket mandrel valve assembly which enables continuation of production from a well by gas lift through gas introduced by other valves when a control valve, normally controlling flow of gas through the mandrel is removed for repair or service.

Another object is to provide an assembly of this type which will prevent a well from running wild with uncontrolled flow between casing and production tubing when a valve normally controlling such flow is removed.

Another object is to provide an assembly of this type in which flow of fluid through a side pocket mandrel is permitted when a control valve is in place in the side pocket and flow is automatically cut off when the control valve is removed.

Another object is to provide an improved cut-off valve which may be installed or retrieved by the use of wireline tools.

Another object is to provide an improved string of production tubing including a side pocket mandrel and a valve for controlling flow therethrough in which the control valve may be removed at will without necessity for shutting down production from the well.

Still another object of this invention is to provide an improved side pocket mandrel valve assembly in which a control valve cooperates with a cut-off valve to permit flow through the side pocket mandrel when the control valve is present and to stop flow through the mandrel when the control valve is removed.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon a consideration of the written specification, the attached claims and the annexed drawings.

I have found that in most instances well operations may be continued while a side pocket mandrel valve is withdrawn for service. In order to continue well operations during service of a valve, I have provided a side pocket mandrel valve assembly in which a cut-off valve, separate from but cooperable with the control valve, is placed in the side pocket mandrel and automatically cuts off flow of fluid through the pocket when the control valve is withdrawn for service.

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 illustrates diagrammatically one type of side pocket mandrel valve assembly of the present invention partly in vertical section;

FIG. 2 illustrates another modification of an assembly constructed according to principles of the present invention, employing a sleeve-type cut-off valve and shown partly in vertical section.

FIG. 3 illustrates still another modification of a valve assembly of the present invention in which a conventional control valve is modified by addition of a stem thereto serving to unseat a ball in a ball-type cut-off valve.

FIG. 4 illustrates diagrammatically another modification of a valve assembly comprising a pressure balanced cut-off valve installed in a lower part of a side pocket mandrel.

FIG. 5 is a section through the device of FIG. 4 on the line 5-5, and through the mandrel used therewith.

In FIG. 1, the reference numeral 6 designated a tubing mandrel having a side pocket designated generally as 7 separated from the bore of the mandrel by an inner wall 8 and having an exterior wall 9 forming a part of



the outside wall of the mandrel. An opening 11, through the inner wall 8, provides communication between the main bore of the mandrel and with the interior of pocket 7. An opening 12 in the outside wall of the mandrel and pocket 9 also provides communication between the interior of pocket 7 and space in the well surrounding the tubing and mandrel.

An annular shoulder 13 having a central opening 14 therethrough is disposed in the lower part of the side pocket between openings 11 and 12. Although this shoulder is shown integral for simplicity in illustration, it is not intended to exclude construction as an annulus attachable to the walls of the pocket, as for example, by threads on its external lateral surface with matching threads on the interior of the pocket walls. Shoulder 13 has its lower surface shaped to form a tapered valve seat 15 surrounding the central bore 14.

A poppet-type valve closure member 16 having a tapered shoulder 17 adapted to fit and seal against valve seat 15 is disposed for reciprocating movement in the part of side pocket 7 below shoulder 13. Valve closure member 16 is equipped with centering vanes 18 and has a central axial pin 19 extending from its upper end and reciprocable through opening 14 in shoulder 13. A spring guide member 21 is attached to the lower end of valve closure member 16 and a resilient member, preferably a spring as illustrated at 22, is disposed to urge the valve closure member toward seated position.

A flow control valve, designated generally as 23, is disposed in the upper part of side pocket 7 to rest upon pin 19. Valve 23 is equipped with sealing means 24 to make sealing contact with the wall of the side pocket above and below opening 11 in the interior pocket wall 8. Valve 23 has openings 25 and 26 communicating with a passageway through the valve adapted to be closed by a suitable valve closure means, not illustrated.

Control valves of this general type are old in the art and a great many of them are illustrated in the Composite Catalog of Oil Field and Pipeline Equipment, for the years 1954 and following, under the headings of "Valve, Wireline, Valves, Gas Lift, and Valves, Pressure Charged Standing Valve for Gas Lift," and also under various other headings. Although many types of conventional control valves are useable in the assembly of my invention, a preferred type is made wireline retrievable with use of a suitable wash-over type tool, by having a tapered head 27 and a shoulder 28 adapted to be engaged by suitable pulling tool. Head 28 is made integral with a shaft part 29 which has a shoulder 31 adapted to engage a lower part of a body member 32. Shaft 29 carries, and preferably is made integral with a cam 32 adapted to stop movement of a latch 33 in one direction. Reciprocation of cam 32 out of contact with latch 33 is prevented by a shear pin 34a. Latch 33 is urged in horizontal direction by spring 34.

In use, the cut-off valve portion of this assembly, comprising valve closure member 16, carrying pin 19, is assembled in the side pocket before the tubing is run in the well. Control valve 23 may be placed in the side pocket at the same time or may be inserted by use of wireline tools later, as may be convenient. In any case, the control valve 23 is introduced into the side pocket until latch 33, urged outward by spring 34, is caught and held in a detent recess 35. In this position, pressure from the control valve on the end of pin 19 forces the valve closure member 16 into open position and thus provides a channel for flow of fluid between the interior and exterior of the line of tubing through a passageway comprising openings 12, 25, 26 and 11, and since openings 26 and 25 communicate with a passageway in which there is an internal valve member of desired type, the flow is controlled by control valve 23.

If it is necessary to remove the control valve for any reason, a wireline tool is run down and attached to head 27 by means of shoulder 28. An upward pull is exerted sufficient to break shear pin 34a and thus cam

32 is moved upward to release latch 33 which rotates and permits the control valve to be drawn to the surface.

As pressure from the control valve is relieved on pin 19, spring 22 thrusts valve closure member 16 upward to seat firmly on valve seat 15, thus closing flow between openings 12 and 11. A quick and positive closure against flow is attained. Pressure can then be maintained outside or inside the tubing string as desired without interference by uncontrolled flow through openings 12 and 11.

In the assembly shown in FIG. 2, a cut-off valve is illustrated which is more easily insertable into a side pocket mandrel. This cut-off valve comprises a sleeve 41 slidably disposed within a lower part of the side pocket and sized to fit snugly within the bore of the pocket formed by shoulder 42 and the walls of the pocket below opening 12. Sleeve 41 has a pair of annular grooves in its external surface adapted to receive O-ring seals 43 which make sealing contact with the walls of the side pocket. The upper part of the sleeve is formed as a hollow shell having openings 44 therein communicating with the central bore of the shell 45.

To insert the cut-off valve shown in FIG. 2, the retaining screw 47 is merely retracted and the cut-off valve is inserted into the side pocket and the retaining screw is advanced so that it will engage flange 49 and prevent withdrawal of the valve. The loading of spring 49 is chosen so that when the control valve 23 is not present in the side pocket, the uppermost O-ring seal 43 will make sealing contact with shoulder 42 of the side pocket wall and the lower O-ring will make sealing contact with the wall of the pocket below opening 12. With the valve in this position, there is no tendency for pressure of fluid admitted through opening 12 to move the valve in either direction, as such pressure is exerted in opposite direction upon equal areas of the valve sleeve.

When the control valve 23 is introduced, the bottom of the valve makes contact with the upper end of sleeve 41 at 46 and the weight of valve 23 is sufficient to overcome pressure from spring 49 and depress the valve piston into the position illustrated in FIG. 2. In this position, fluid flow is permitted through a passageway comprising opening 12, openings 44 in the sleeve, central bore 45 of the sleeve, openings 25 and 26 in valve 23, and then through opening 11 in the side pocket wall. The control valve illustrated is identical with that shown in FIG. 1. It may be of any design desired, responsive to pressure in the casing or to pressure in the tubing, or responsive to the differential between the two pressures.

The cut-off valve illustrated in FIG. 4 is particularly desirable for use when a balanced valve, unaffected by casing or tubing pressure is desired. The side pocket wall has a recess 52 which cooperates with a recess 53 in the outer surface of the sleeve to form an annular space between the sleeve and the side pocket wall when the valve is in the cut-off position, as illustrated. A pair of O-ring seals 54 are singly disposed in grooves around the sleeve to seal between said sleeve and the pocket walls, and are sufficiently spaced from each other so as to seal on the opposite sides of the annular space formed by recesses 52 and 53 when the valve is in cut-off position.

An opening 12, best shown in FIG. 5, extends through the exterior wall of the side pocket and mandrel thereby providing communication of this annular space with the space in the well outside the mandrel. It will be noted that when the valve is in cut-off position, pressure from space outside the tubing is exerted upon equal areas of the valve between the two O-ring seals in opposite directions and will be ineffective in moving the valve from the cut-off position.

Sleeve 51 is hollow, and is retained in the side pocket by a suitable retaining shoulder 55 which cooperates with shoulder 56 on the interior wall of the side pocket. The lower end of sleeve 51 contains a number of slots 57 of such size and length to permit the retaining shoulder 55 to be compressed enough to be inserted behind shoulder 56 on the side pocket wall.



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A spring 58 is disposed upon a spring centering member 59 at the lower end of the side pocket and extends upward into the hollow bore of sleeve 51 and bears upon a shoulder 60, if desired, and is of such strength so that the insertion of a control valve, shown in FIGS. 1 and 2, depresses the sleeve sufficiently to bring the upper O-ring 54 substantially into the position occupied by the lower O-ring in the illustration. The central bore 61 of the sleeve will then communicate with the annular space formed by recess 52 through openings 62 in the piston wall.

The central bore 61 also communicates with the lower bore of the piston through an opening 63 in shoulder 60. In the depressed position, a flow passageway is provided through opening 12, recess 52, openings 62 and the central bore 61 of the sleeve, and from thence, through a control valve (not shown) in the upper part of the side pocket and through an opening in the side pocket wall to the interior of the mandrel. It will be observed that in the flow position, pressure equivalent to that on the outside of the mandrel is exerted through opening 12, openings 62, central bore 61 and openings 60, and the bore of the sleeve on equal surfaces of this valve in opposite directions, and therefore, is ineffective in cutting off the flow through the valve.

When the valve is in cut-off position, as illustrated, it will also be obvious that pressure from within the mandrel is exerted through bore 61, opening 63 and the lower bore of the valve upon equal surfaces on the valve in opposite directions. The pressure within the mandrel also is entirely ineffective in opening or closing the cut-off valve.

The upper end of the bore of the sleeve is coned to provide a sloping surface 65 adapted to guide a spear or other wireline retrieving tool into the bore and a shoulder 66 is provided on the interior of the sleeve to give a point for attachment of such tools. When the spring 58 is secured to shoulder 60, the entire cut-off valve is easily removable or insertable by wireline tools.

FIG. 3 illustrates a modification of the assembly of my invention in which a retrievable ball-type cut-off valve is used. The control valve shown in this figure is similar to that of FIGS. 1 and 2 but is modified by the addition of a pin 71 to its lower end. The cut-off valve in this assembly comprises a substantially cylindrical body 72 having an annular sealing member 73 disposed around it and held in a suitable recess in the body to make sealing contact with the walls of the side pocket. The hollow interior of the cylinder body 72 is constricted to form a conical valve seat 74 adapted to receive ball 75 to cut off fluid flow through the interior of the body. The body is somewhat smaller in diameter than the diameter of the side pocket into which it is placed and has a number of openings 77 through the wall of the body communicating with the space between the valve body and side pocket wall thus providing a passageway for flow of fluid when the valve is in open position, as illustrated, through opening 12 in the side pocket wall, opening 77 in the hollow interior of the body, openings 25 and 26 in the control valve and through opening 11 to the interior of the mandrel.

The upper end of the body is formed into a shoulder 78 adapted to be caught and held by a spear or similar wireline fishing tool and to be pulled out of the side pocket thereby.

The ball 75 in the valve rests upon a spring 76 of such strength that it is compressed by the weight of control valve 23 when the control valve is present, opening the cut-off valve by lowering ball 75. The body 72 is equipped with a latching means for retaining it in the pocket. This latching means comprises a latch member 79, a spring 80, a recess 81 in the body wall adapted to receive the end of latch 79, and a shear pin 81a which normally prevents release of latch 79 from the recess 81.

Both the control valve and cut-off valve of this as-

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sembly are thus made retrievable and insertable by the use of usual wireline tools.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A side pocket mandrel valve assembly comprising in combination a tubing mandrel having a side pocket adapted to receive a flow control valve, said pocket having an opening communicating with the exterior of the tubing at one level and an opening through its interior wall communicating with the interior of the tubing at another level; a retrievable flow control valve disposed in said side pocket; and a cutoff valve including a housing having passage means and a valve seat, the housing being removably mounted and located in the side pocket below the flow control valve and in normal operative position coacting with the side pocket so that it provides communication between the two side pocket openings through the housing passage means and valve seat, the housing having tool engaging means to facilitate removal of the cutoff valve housing from the side pocket, a valve-closure member disposed to seat upon said valve seat and close said passage means, a resilient member disposed to urge said valve closure member toward seating position, and a pin disposed to transmit contact pressure from said control valve to said valve closure member to urge said valve closure member away from said valve seat.

2. The assembly of claim 1 wherein the pin is carried by the control valve body.

3. The assembly of claim 1 wherein the valve closure member is a ball urged toward seating position by a spring.

4. The side pocket mandrel valve assembly of claim 1 wherein the means for detachably locking the cutoff valve in the side pocket comprises a pivoted latch disposed to engage a detent recess in a side pocket wall.

5. The side pocket mandrel valve assembly of claim 1 wherein the tool engaging means of the cutoff valve housing comprises an inwardly coned surface and a shoulder below said surface adapted to be caught and held by a fishing tool.

6. A side pocket mandrel valve assembly comprising in combination a tubing mandrel having a side pocket adapted to receive a flow control valve, said side pocket having an opening communicating with the exterior of the tubing at one level and an opening through its interior wall communicating with the interior of the tubing at another level; a retrievable flow control valve disposed in the side pocket to control flow between said openings; and a cutoff valve including a housing having passage means and a valve seat, the housing being removably mounted and located in the side pocket below the flow control valve and in normal operative position coacting with the side pocket so that it provides communication between the two side pocket openings through the housing passage means and valve seat, the housing having tool engaging means to facilitate removal of the cutoff valve housing from said side pocket, a vertically reciprocable valve closure member disposed to cooperate with said valve seat to close said passage means when in raised position and to open said passage means when in lowered position, means for lowering the valve closure member responsive to contact pressure from said flow control



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valve, a resilient member disposed to urge the valve closure member upward, and means for detachably locking the cutoff valve housing in the side pocket.

7. A side pocket mandrel valve assembly comprising in combination a tubing mandrel having a side pocket adapted to receive a flow control valve, said side pocket having an opening communicating with the exterior of the tubing at one level and an opening through its interior wall communicating with the interior of the tubing at another level; a flow control valve operable to control flow between said openings disposed in said side pocket; a cutoff valve including a housing having passage means, said passage means having a valve seat, the housing being removably mounted and located in the side pocket below the flow control valve and in normal operative position coacting with the side pocket so that it provides communication between the two side pocket openings through

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the housing passage means and valve seat, the housing having tool engaging means to facilitate removal of the cutoff valve housing from the side pocket, a valve closure member cooperable with said seat to close said passage means and responsive to mechanical pressure from said retrievable flow control valve to open the valve, and a resilient member disposed in the pocket to urge the valve-closure member constantly toward closed position.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

912,073	Christenson	Feb. 9, 1909
1,226,175	Bibleheiser	May 15, 1917
2,361,718	Taylor	Oct. 31, 1944
2,375,578	Pankrantz	May 8, 1945
2,963,036	Surles	Dec. 6, 1960