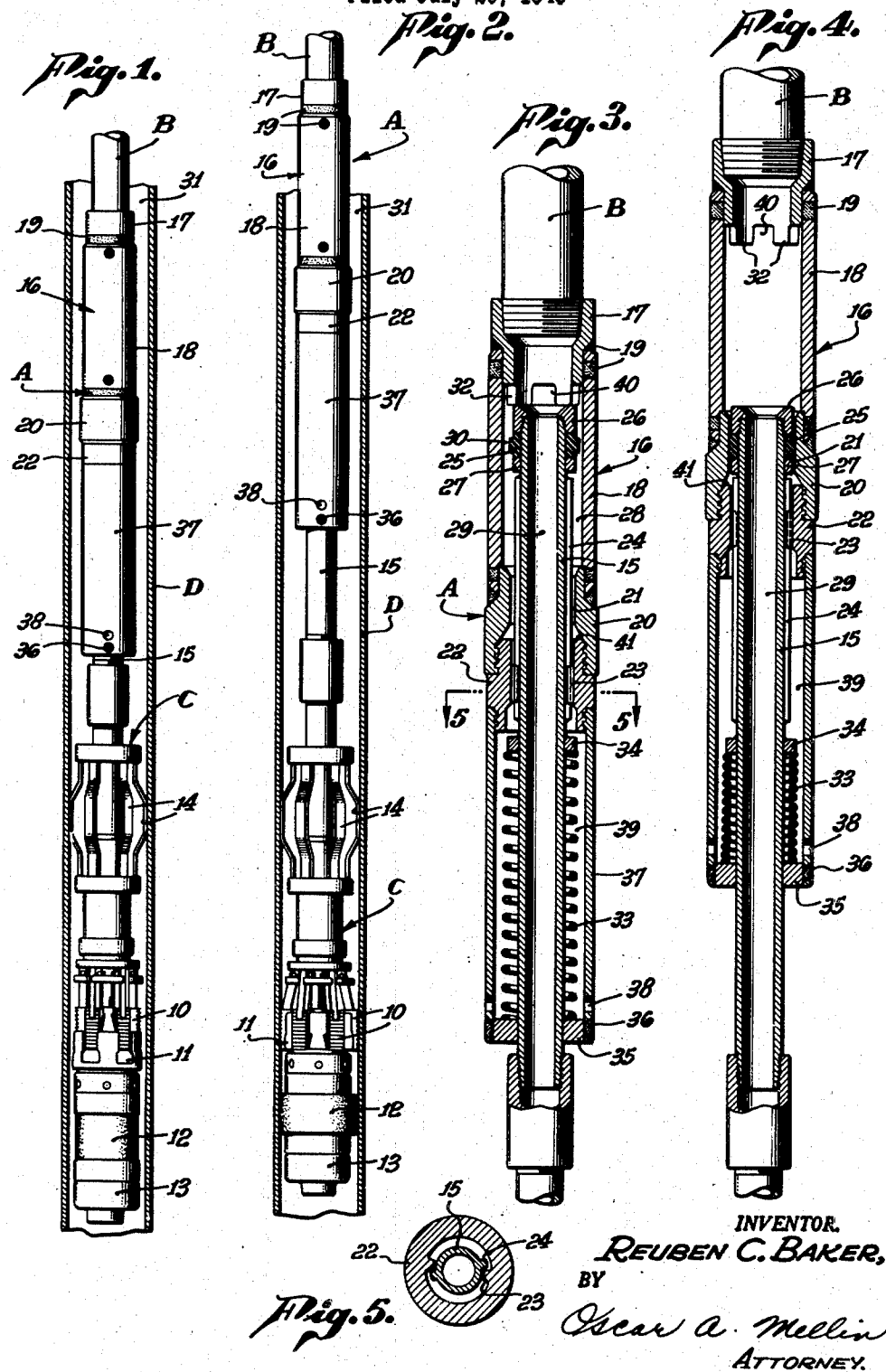


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CONTROL VALVE

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CONTROL VALVE

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This invention relates to control valves, and more particularly to valves especially designed for operation in connection with well devices, such as well packers and the like.

It is an object of the present invention to provide an improved control valve capable of incorporation in a tubular well string, and which normally tends to remain in open position.

A further object of the invention is to provide a valve adapted for incorporation in a tubular string and designed to resist the valve closing tendencies of fluid pressure to which it, or devices to which it may be attached, might be subjected.

Another object of the invention is to provide a control valve adapted for incorporation in a tubular string, and having parts tending to hold the valve in open position which may be readily assembled and dismantled for the purpose, among others, of facilitating cleaning and maintenance of the valve parts.

Still another object of the invention resides in the provision of a tubular control valve having a spring device tending to maintain the valve in open position, and which does not obstruct the central bore through the valve.

Yet a further object of the invention is to provide a tubular control valve embodying a spring device tending to hold the valve in one operative position, and which may be removed readily from the valve, if desired, without impairing the ability of the valve to function.

The invention has other objects which will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation of the control valve, in open position, secured to a retrievable packer whose parts are retracted from a well casing in which the apparatus is disposed;

Figure 2 is a view similar to Figure 1, with the control valve closed and the packer anchored in packed off condition within the well casing;

Figure 3 is a longitudinal section of the control valve in open position;

Figure 4 is a longitudinal section through the control valve is closed position; and

Figure 5 is a cross-section taken along the line 5—5 in Figure 3.

In the drawings, a tubular valve A, embodying

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the invention, has its upper end connected to the lower end of a string of tubing or drill pipe B, and its lower end to a packer C of the retrievable type, specifically described in my Patents 2,368,400 and 2,368,401, and designed for anchoring to a casing D.

The well packer C includes a plurality of slips 10 cooperable with a tapered expander 11, below which is located a packing sleeve 12 abutting the lower end of the packer body 13. As explained in the above patents, a drag device 14 tends to resist movement of the slips along the casing, which enables upward movement of the tubing string B and its connected control valve A to move the expander 11 upwardly within the slips 10 and shift the latter outwardly into anchoring engagement with the casing D. A continuation of this upward strain moves the body portion 13 of the well packer toward the expander 11 and compresses the packing sleeve 12 into firm sealing engagement with the casing wall.

The tubular control valve A includes telescopically arranged inner and outer members 15, 16. The outer member has an upper collar 17 threaded on the lower end of the tubular string B, to which a depending tubular cylinder or barrel 18 is secured, as by welding material 19. The lower end of this barrel or housing is welded to a depending sleeve 20 having an inner cylindrical valve seat 21, which, in turn, is threadedly secured to a rotary coupling member 22 having spaced internal longitudinally extending splines 23 adapted to cooperate with external longitudinally extending splines 24 secured on the inner member or tubular mandrel 15, threaded in the upper end of the packer C. The splines 23, 24 serve as a coupling for transmitting rotary movement of the outer member 16 to the inner member 15.

A packing ring or sleeve 25 of rubber or rubber-like material is suitably secured on the upper end of the mandrel 15, as by being clamped between a head 26 threaded on the mandrel and a lower ring 27 welded thereto. The external diameter of this sleeve 25 is substantially the same as the internal diameter of the cylindrical valve seat 21 so as to close the annular passage 28 between the cylindrical housing 18 and mandrel 15 when the packing sleeve 25 is disposed within the seat 21.

In the operation of the combination of apparatus described, elevation of the tubular string B and control valve A not only effects setting of the removable packer C, but also moves the outer member 16 upwardly along the mandrel 15 and

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disposes the sleeve 20 over the resilient packing 25, to prevent passage of fluid down through the tubular string B, between the mandrel 15 and housing 18, and between the cooperable splines 23, 24, to the exterior of the valve device. When the packing ring 25 is disposed in sealing engagement with its seat 21, the fluid must pursue a path through the central passage 29 of the telescopic valve device, flowing down through the tubular string B, cylinder 18, mandrel 15, and packer C to a point below the packer.

When the tubing string B is lowered, in order to open the valve A and release the packer C from its anchored position within the casing D, a clearance space 30 exists between the packing ring 25 and the inner wall of the cylinder 18, allowing the fluid to pass in either direction between the tubular string B and tubing-casing annulus 31 around the tubing, by flowing through the annulus 28 between the mandrel 15 and cylinder 18. Downward movement of the tubing string B and tubular cylinder 18 with respect to the mandrel 15 is limited by engagement of the mandrel head 26 with depending lugs 32 on the upper collar 17, between which fluid may flow into the annulus 28 between the mandrel and cylinder when the valve device is in collapsed position.

The valve device is normally maintained in open position by a spring device, consisting of a compressed helical spring 33 having its upper end bearing against a retainer or abutment 34 welded on the exterior of the mandrel 15 and its lower end against a ring 35 slidable along the mandrel 15 and suitably secured, as by welding material 36, to the lower end of a spring enclosing sleeve or housing 37, whose upper end is threaded onto the lower end of the spline sleeve 22. Side ports 38 are provided in the sleeve housing adjacent its lower end for the passage of fluid from the tubular mandrel and cylinder annulus 28 and the tubular mandrel and housing annulus 39 to the exterior of the device A.

The spring arrangement is such that the spring member 32 tends to hold the tubular mandrel 15 in an elevated position with respect to the cylinder 18, in which position the packing ring 25 is disposed above its cooperable cylindrical seat 21, placing the valve in open position. It is apparent that the upper end of the spring exerts an upward force on the tubing mandrel 15 through its attached abutment 34, and that the lower end of the spring exerts a lowering force on the cylinder 18 through the attached cylindrical housing 37 and spline connection 22. Thus, the spring 33 tends to urge and maintain the valve member in open position, to permit flow of fluid in either direction between the interior of the tubular string B and the tubing-casing annulus 31.

In the operation of the device in conjunction with the retrievable packer disclosed, the valve remains in open position while the mechanism is being run in the well casing to the desired setting point. Fluid can pass upwardly through the well packer C and the central passage 29 of the valve device into the tubing string B, and it may also pass around the retracted packer and enter the valve device through the side ports 38, the mandrel and spring housing annulus, between the cooperable splines on the mandrel and sleeve 39, and through the mandrel and cylinder annulus 28, around the elevated packing ring 25, into and through the spaces 40 between the lugs 32 into the interior of the upper collar 17, from where it flows up into the tubular string.

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When the point in the casing is reached at which the retrievable packer is to be set, the tubular string B is moved upwardly, to elevate the tubular mandrel 15 through the intermediary of the compressed spring 33. At first, the valve remains in open position until the slips 10 are engaged against the casing D and sufficient force has been exerted to expand the packing 12 against the casing, which holds the mandrel 15 in fixed position and permits the continued upward movement of the tubular string B to elevate the cylinder 18 and its attached sleeve 22 and housing 37 with respect to the mandrel, compressing the spring 33 and raising the parts until the cylindrical sleeve seat 21 is disposed completely over the packing ring 25, as determined and limited by engagement of the ring 27 with a stop shoulder 41 at the upper end of the spline sleeve 22. When in this position (Figure 4), the valve is closed, and fluent materials, such as cement slurry, acid, liquid synthetic resin, and the like, may be pumped down through the string B and through the central passage 29 of the extended valve member A and packer C, for ejection from the lower end of the latter.

As soon as the strain is removed from the tubular string B, as by lowering it slightly, the spring 33 tends to immediately lower the cylindrical seat 21 with respect to the packing 25, moving the two parts relatively to a collapsed position in which the valve member is open (Figure 3). Thereafter, circulating or other fluid may be pumped down the tubular string B, through the space 40 between the lugs 32, and down along the mandrel 15, exiting through the side ports 38 in the housing 37 to the exterior of the device, from where it may flow upwardly through the tubing-casing annulus 31 to the top of the well bore. If desired, the circulating or washing fluid may be pumped in the reverse direction by being forced initially into the tubing-casing annulus 31, entering the valve device through the side ports 38, flowing upwardly through the annulus 39, 28 around the tubular mandrel 15 and around the packing ring 25, and over the top of the mandrel head 26, back into the cylinder 18, 17 for passage to the top of the well bore.

The spring arrangement insures that any excess cement slurry or other fluids in the tubing string may be washed therefrom, even though the well packer C has not or does not release completely from the well casing as the result of lowering the tubing string. The spring exerts enough force to break the sealing engagement between the packing ring 25 and its cooperable cylindrical seat 21. Moreover, when reverse circulation takes place, the tendency of the fluid pumped down through the tubing-casing annulus 31 to act on a partly retracted packing 12 and move the packer C downwardly, and with it the tubular mandrel 15 downwardly, to position the packing ring 25 in valve closing position back within the cylindrical sleeve 21, is offset or overcome, by the elevating force exerted by the compressed spring 33. As a result, assurance is had that any undesired remaining fluid or fluid-like substances may be washed from the well casing and tubing to the top of the well bore, for appropriate disposal.

The spring device does not affect the normal operation of the valve mechanism, as described in United States Patent 2,275,938. For that matter, the spring mechanism may be removed from the valve device, if desired, by unscrewing

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the housing 37 from the spline sleeve 22 and removing the housing 37, its lower ring 36 and spring 33 from assembled position around the mandrel 15. Thereafter, the valve device may be used without the spring force being available tending to hold it in open position.

The facility with which the spring portion of the mechanism may be removed makes it relatively easy and simple for the valve device to be assembled at the well location. The housing 37, ring 35 and spring 33 need only be moved over the lower end of the tubular mandrel 15 and the upper end of the housing threaded onto the spline sleeve 22. Conversely, the members just described are readily removed by unthreading the housing from the spline sleeve, which allows any cementitious or other hardenable materials that may have been deposited around the spring to be cleared away easily.

The disposition of the spring in the annulus around the mandrel not only tends to maintain the valve in open position, but it leaves the central bore or passage 29 through the valve device completely unobstructed, avoiding impedance to the free flowing of the cementitious materials or other fluids down through the valve passage, and leaving no obstruction to the gravitation of bridging or valve members, or the like, through the valve A.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A control valve adapted for connection to a tubing string or the like, including an inner tubular member movable longitudinally with respect to an outer member and spaced from the outer member to form a passage therebetween through which fluid may flow between the interior of said inner member and the exterior of said outer member, valve elements carried by said members and engageable with one another upon relative axial movement of said members to prevent such flow of fluid, and spring means around the exterior of said inner member urging said valve elements to disengaged position.

2. A control valve adapted for connection to a tubing string or the like, including an inner tubular member movable longitudinally with respect to an outer member, valve elements carried by said members and engageable with one another upon relative axial movement of said members to prevent fluid flow between the interior and exterior of said control valve, and elastic means around the exterior of said inner member urging said valve elements to disengaged position.

3. A control valve adapted for connection to a tubular string or the like, including an inner tubular member movable longitudinally with respect to an outer member, valve elements carried by said members and occupying one position upon relative axial movement of said members, in engagement with one another to prevent fluid flow between the interior and exterior of said control valve and another position out of engagement with one another permitting such fluid flow, and elastic means around the exterior of said inner member urging said valve elements to one of said positions.

4. A control valve adapted for connection to a tubing string or the like, including an inner tubular member movable longitudinally with respect to an outer member, valve elements carried by said members and engageable with one another upon relative axial movement of said members to prevent fluid flow between the interior and exterior of said control valve, and spring

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means around the exterior of said inner member and bearing against said inner and outer members to urge said valve elements longitudinally of one another to disengaged position.

5. A control valve adapted for connection to a tubing string or the like, including telescopically arranged inner and outer tubular members, valve elements on said members engageable with one another when said members are in extended position to prevent flow of fluid between the interior and exterior of said control valve, and spring means around the exterior of said inner member and bearing against said inner and outer members to urge them to contracted position and said valve elements to disengaged position.

6. A control valve adapted for connection to a tubular string or the like, including telescopically arranged inner and outer tubular members spaced from one another to form an annular passage therebetween through which fluid may flow between the interior of said inner member and the exterior of said outer member, valve elements on said members engageable with one another when said members are in extended position to close said annular passage, and spring means around the exterior of said inner member for urging said members to contracted position and said valve elements to disengaged position.

7. A control valve adapted for connection to a tubular string or the like, including telescopically arranged inner and outer tubular members spaced from one another to form an annular passage therebetween, valve elements on said members engageable with one another when said members are in extended position to close said annular passage, a housing detachably secured to said outer member to one side of the valve element on said outer member, and a spring in said housing bearing against said housing and inner member and tending to urge said members to contracted position and said valve elements to disengaged position.

8. A control valve adapted for connection to a tubular string or the like, including telescopically arranged inner and outer tubular members spaced from one another to form an annular passage therebetween, valve elements on said members engageable with one another upon relative axial movement of said members to close said annular passage, a housing detachably secured to said outer member and extending along said inner member to one side of said valve elements, and a spring in said housing bearing against said housing and inner member and tending to urge said valve elements to disengaged position.

9. A control valve adapted for connection to a tubular string or the like, including telescopically arranged inner and outer tubular members spaced from one another to form an annular passage therebetween, valve elements on said members engageable with one another when said members are in extended position to close said annular passage, a housing detachably secured to said outer member and extending along said inner member to one side of said valve elements, said housing conducting fluid between said passage and the exterior of said control valve, an abutment secured to said inner member, and a spring bearing against said abutment and housing for urging said members to contracted position and said valve elements to disengaged position.

10. A control valve adapted for connection to a tubular string or the like, including telescopically arranged inner and outer tubular members spaced from one another to form an annular passage

therebetween, an internally splined coupling member secured to said outer member, splines on said inner member engageable with the splines of said coupling member, valve elements on said members engageable with one another when said members are in extended position to close said annular passage, a housing detachably secured to said coupling member, and a spring in said housing bearing against said housing and inner member and tending to urge said members to contracted position and said valve elements to disengaged position.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,356,580	Witman	Oct. 26, 1920
1,639,004	Riley	Aug. 16, 1927
1,756,499	Allen	Apr. 29, 1930
2,048,858	Gibbs	July 28, 1936
2,196,664	Kofahl	Apr. 9, 1940
2,245,638	Baker	June 17, 1941
2,275,938	Baker	Mar. 10, 1942