April 9, 1940. J. L. KOFAHL 2,196,664

CONTROL VALVE

Filed Sept. 22, 1939

Fig. 1.

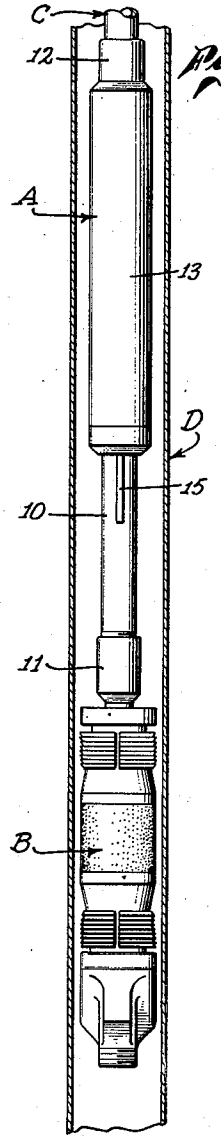


Fig. 2.

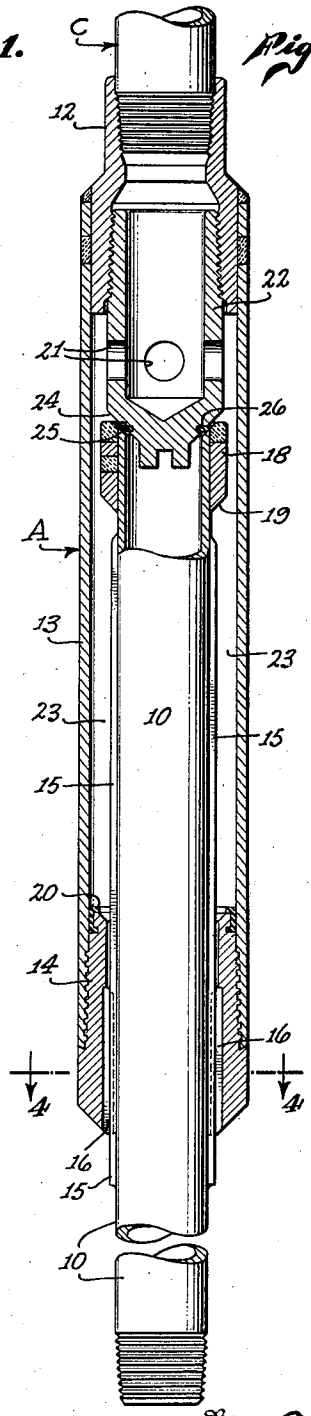


Fig. 3.

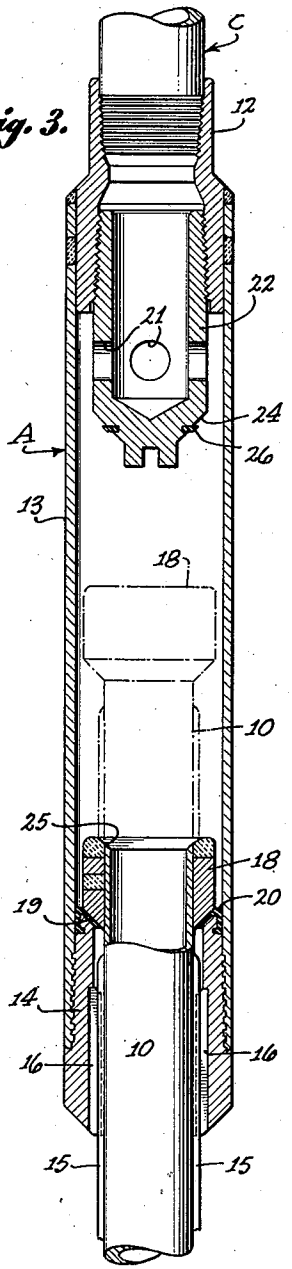
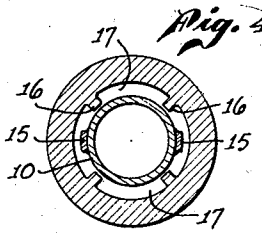


Fig. 4.



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CONTROL VALVE

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7 Claims. (Cl. 166—1)

The present invention relates to control valves, and more particularly to valves of the type forming part of a running-in tubular string connected to a well device, as a cement retainer. Such control valves are incorporated in the running-in string near the well device to provide selective control of the passage of fluid from the string through the device, or between the annular space around the string and its interior.

Where the well device is employed in cementing, it is desirable to flush excess cement from the tubular string immediately after the cementing operation has been performed. This can be accomplished by opening the control valve and forcing any excess cement slurry downwardly from the string and thence upwardly through the annular space between it and the casing; or if a more rapid disposal is required, the fluid can be reversely circulated to force the excess upwardly through the running-in string to the surface of the bore. Where this latter method is employed, pressure must be applied to the fluid around the tubing of a relatively high magnitude in view of the frictional resistance to flow offered by the sides of the relatively small diameter tubing. This frictional resistance is aggravated when quick setting cementitious material is used, the viscosity of which increases very rapidly, making it imperative that any excess be washed out immediately after the cementing operation has been performed.

However desirable the rapid disposal of excess cement may be, it has heretofore been accompanied by the subjection of the formation to high pressures, which tend to displace the cementitious material from its region of deposition. An object of the present invention is, therefore, to permit circulation of fluid in either direction through or around the tubular string without subjecting the formation to the pressure action of the circulating fluid.

A further object of the invention is to provide a control valve particularly designed for use in connection with well devices, having several selective positions of operation: (1) to prevent passage of fluid through the device while permitting circulation between the tubular string and casing, or (2) to prevent circulation between the tubing and casing while directing passage of the fluid between the tubing and device, or (3) to allow simultaneous passage of fluid between the tubing and both the casing and well device.

The invention has other objects that will become apparent from a consideration of an embodiment shown in the drawing 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 drawing:

Figure 1 is an elevation of a control valve in association with a well packer;

Figure 2 is a longitudinal sectional view of the control valve with its parts in one position of adjustment;

Figure 3 is a view similar to Figure 2 with the control valve parts in another position of adjustment; and

Figure 4 is a transverse section taken along the line 4—4 of Figure 2.

In Figure 1, a control valve A is shown in conjunction with a cement retainer B, to illustrate one of its specific applications. Its mandrel 10 is connected to the retainer through the agency of a sub 11, while its tubing connection 12 is threadedly attached to a running-in tubular string of tubing or drill pipe C, by means of which the cement retainer is lowered to its desired setting position within a well casing D.

The valve mandrel 10 is telescopically related to an enclosing cylinder or barrel 13 carrying a valve seat 14 at its lower end, and which is welded or otherwise secured to the tubing connection 12 at its other end. The mandrel and cylinder can slide with respect to each other, but they are positively interconnected for rotation by the engagement of splines 15 on the exterior of the mandrel with internal ribs 16 formed on the valve seat 14. However, it is to be noted that annular spaces 17 remain between the splines and ribs to provide a circumferential passage for fluid between the seat and mandrel.

A head 18 is welded or otherwise secured on the upper end of the valve mandrel 10, its lower surface 19 being engageable with a sealing ring 20 carried by the valve seat. When these parts 19, 20 are in contact (as shown in Figure 3), fluid must pass directly between the tubing C and well device B, and no flow can occur externally of the tubing.

The lowering of the cylinder 13 with respect to the mandrel 10 (see dotted position in Figure 3) will disrupt this contact and permit fluid to pass between the tubing C and the casing D by flowing through ports 21 in a nipple 22 threaded to the tubing connection 12, through an an-

nular passage 23 intermediate the cylinder and valve mandrel and head, and through the circumferential spaces 17 defined between the ribs 16 and splines 15. When the parts are in this last-mentioned position, circulation between the casing D and tubing C can take place in either direction; but in so doing, the well device B and formation are also subjected to the pressure applied to the circulating fluid, due to the communication of this fluid with the interior of the valve mandrel 10.

To avoid this condition, the nipple 22 is threaded in the tubing connection 12, with its lower end entirely closed and formed as a valve head 24 adapted to cooperate with a valve seat 25 provided at the upper end of the mandrel and its head 18. A rubber or similar ring 26 is carried by the nipple head to provide a leak proof seal between the mandrel interior and cylinder whenever the tubing string C has been lowered so as to engage the head 24 with its seat 25 (see Figure 2). With the parts arranged in that manner, fluid cannot pass through the well device for action upon the formation, its flow between the tubing C and casing D being confined to the passages 23, 17 between the mandrel and cylinder and the ports 21 provided in the side walls of the nipple. Circulation of fluid reversely or otherwise is therefore accomplished without subjecting the formation to the pressure of the circulating fluid.

Not only is the flow control device or valve mechanism A useful in cementing operations, but it can be employed wherever selective flow control in a well is desirable. Another application is in connection with a production packer employed in multiple zone wells. By considering the device B as such a packer set in the casing between producing zones, its associated control valve incorporated in the tubing string will permit selective control of the well production through the string from either the zone below the packer, the zone above the packer, or simultaneously from both zones. In the first two conditions of operation one or the other of the zones will be positively shut off from communication with the interior of the tubing.

I claim:

1. A flow control device, including an outer member, an inner member slidable longitudinally within said outer member and forming a fluid passage therewith, cooperable means for preventing flow of fluid through both of said members while permitting its movement through said passage, and cooperable means for preventing flow of fluid through said passage while permitting its movement through both of said members.

2. A flow control device, including an outer member, an inner member slidable longitudinally within said outer member and forming a fluid passage therewith, valve means cooperable with said members adapted to prevent flow of fluid through both of said members while permitting its movement through said passage when said members are in one relative longitudinal position, and valve means cooperable with said members adapted to prevent flow of fluid through said passage while permitting its movement through both of said members when they are in another relative longitudinal position.

3. A flow control device adapted to form part of a tubular string, including an outer member, an inner member slidable longitudinally within said outer member and forming a fluid passage therewith, a valve head on one of said members engageable with a valve seat on the other of said members to prevent flow of fluid through said passage, and a valve head cooperable with one of said members engageable with a valve seat cooperable with the other of said members to prevent flow of fluid through both of said members.

4. A flow control device adapted to form part of a tubular string, including an outer member, an inner member slidable within said outer member, a valve head on one of said members engageable with a valve seat on the other of said members to prevent flow of fluid between the interior and exterior of said outer member, and a valve head cooperable with one of said members engageable with a valve seat cooperable with the other of said members to prevent flow of fluid between said members.

5. A flow control device adapted to form part of a tubular string, including an outer member, an inner member slidably splined to said outer member for longitudinal movement with respect thereto, valve means cooperable with said members to prevent flow of fluid between the interior and exterior of said outer member when said inner member is in its outermost longitudinal position, and valve means cooperable with said members to prevent passage of fluid therebetween when said inner member is in its innermost longitudinal position within said outer member.

6. A flow control device, including a connection for coupling said device in a tubular string, an outer tubular member attached to said connection, an inner tubular member slidably splined to said outer member for longitudinal movement with respect thereto and forming a passage therewith providing communication between the interior and exterior of said outer member, a valve seat carried by said outer member engageable with a valve head on said inner member to prevent flow of fluid through said passage when said inner member is in its outermost longitudinal position, and a nipple attached to said connection, said nipple having a valve head engageable with a valve seat on said inner member to prevent flow of fluid between said outer and inner members when said inner member is in its innermost longitudinal position.

7. A flow control device as defined in claim 6, said nipple being ported to allow fluid passage between its interior and said outer member.

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