

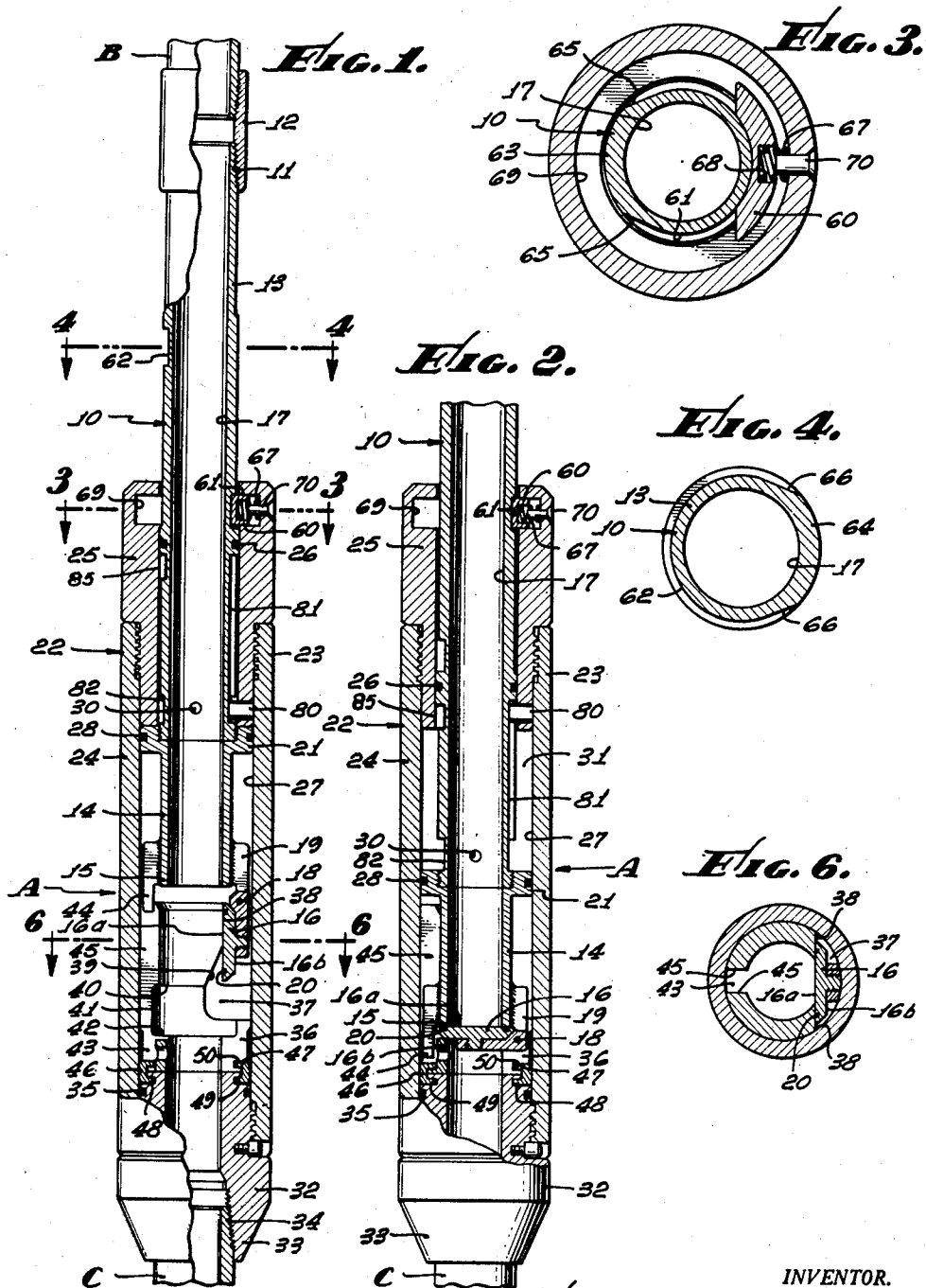
Sept. 23, 1958

E. H. CLARK, JR.
TELESCOPIC VALVE APPARATUS FOR
TESTING WELL BORE TUBING

2,853,265

Filed Aug. 12, 1955

2 Sheets-Sheet 1



INVENTOR.
EARNEST H. CLARK, JR.
BY
Mellin and Hanscom
ATTORNEYS

Sept. 23, 1958

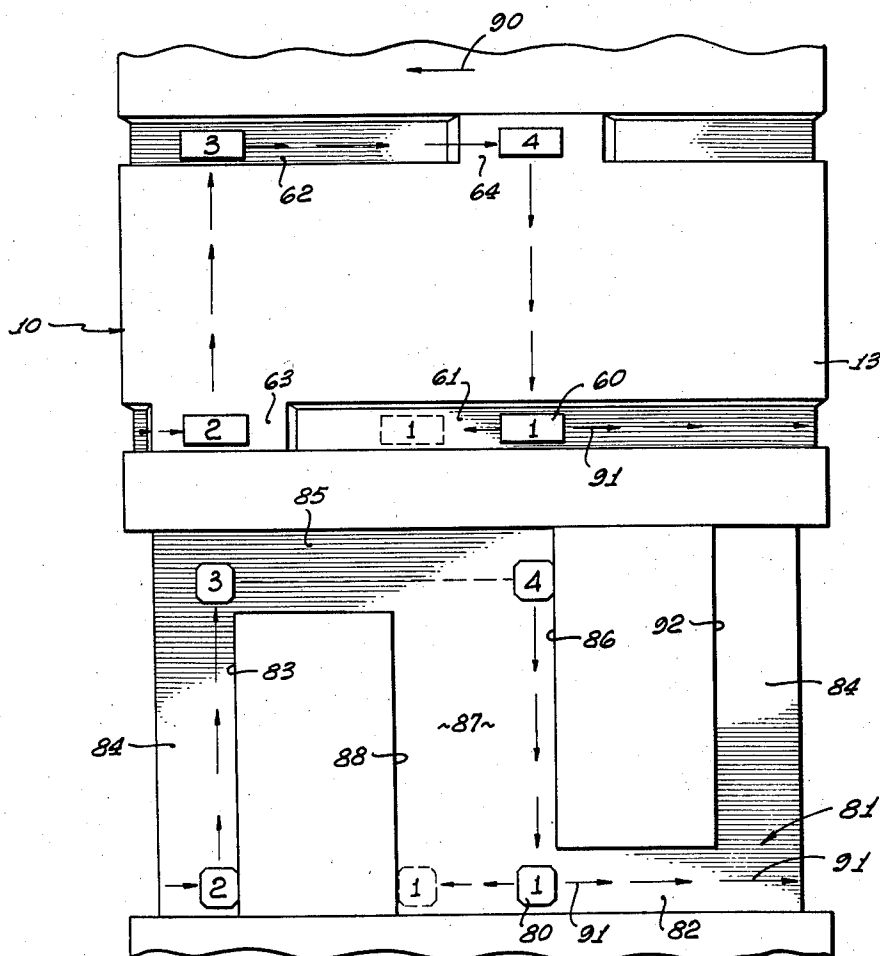
E. H. CLARK, JR
TELESCOPIC VALVE APPARATUS FOR
TESTING WELL BORE TUBING

2,853,265

Filed Aug. 12, 1955

2 Sheets-Sheet 2

FIG. 5.



INVENTOR.
EARNEST H. CLARK, JR.
BY
Mellin and Hanscom
ATTORNEYS

1

2,853,265

TELESCOPIC VALVE APPARATUS FOR TESTING WELL BORE TUBING

Earnest H. Clark, Jr., Downey, Calif., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Application August 12, 1955, Serial No. 527,990

15 Claims. (Cl. 251—106)

The present invention relates to valve apparatus particularly useful in a string of tubing, or the like, to be disposed in a well bore.

An object of the present invention is to provide a valve apparatus to be embodied in a tubular string for disposition in a well bore, in which manipulation of the tubular string effects the position of the valve apparatus in open or closed condition, and in which the valve apparatus can be locked in closed condition.

Another object of the invention is to provide valve apparatus of the character indicated, in which the valve apparatus can be locked in both closed and open conditions.

A further object of the invention is to provide a valve apparatus to be embodied in a tubular string for disposition in a well bore, in which right-hand rotation of the tubular string is required to place the apparatus in a position to be closed and locked in such closed condition, right hand rotation of the tubular string also being availed of to release the valve apparatus from its closed, locked condition.

An additional object of the invention is to provide a valve apparatus to be embodied in a tubular string for disposition in a well bore, which can be positively locked in both closed and open conditions, and in which the tubular string need only be rotated in a right-hand direction in shifting the valve apparatus between either of its locked conditions to a valve opening condition.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detail description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section, partly in side elevation, through a valve apparatus embodying the invention, the valve apparatus being locked in open condition;

Fig. 2 is a view similar to Fig. 1, disclosing the valve apparatus locked in closed condition;

Fig. 3 is an enlarged cross-section taken along the line 3—3 on Fig. 1;

Fig. 4 is an enlarged cross-section taken along the line 4—4 on Fig. 1;

Fig. 5 is a diagrammatic plan view illustrating the locking and locating portions of the apparatus disclosed in Figs. 1 and 2;

Fig. 6 is a cross-section taken along the line 6—6 on Fig. 1.

The valve apparatus A disclosed in the drawings is adapted to be secured to the lower end of a tubular string B, such as drill pipe or tubing, extending to the top of a well bore, the lower portion of the apparatus, in turn, being secured to a lower tool C, such as a well packer, which

2

is to be anchored in packed-off condition in a string of well casing (not shown).

During the lowering of the apparatus in the well bore on the tubular string, it is desired to pressure test the tubular sections and their joints to determine the presence of any leaks. Accordingly, the valve apparatus A is one which can be closed whenever desired against downward flow of fluid through the tubular string B, which enables fluid pressure to be applied to the fluid therewithin. Following the pressure test, the valve is easily opened to permit the tubular string to automatically fill with the fluid in the well bore. When in open position, the valve can be locked in that operating condition, to preclude inadvertent shifting of the valve mechanism to closed position.

In the drawings, the valve apparatus A is disclosed as including an inner tubular mandrel 10 having an upper threaded end 11 threadedly secured to a collar 12 forming the lower end of the tubular string B that extends to the top of the well bore. The tubular mandrel consists of an upper section 13 threadedly secured within a lower section 14, having a lower valve seat 15 engageable by an upwardly movable valve head 16, to close the central passage 17 through the mandrel. This valve head 16 is also carried by the tubular mandrel, being secured to a fulcrum pin 18 that is rotatably or pivotally carried on a supporting leg 19 welded, or otherwise secured, to the lower portion of the lower mandrel section 14.

The pivoted valve head or flapper valve member 16 may swing relatively downwardly completely to one side of the central passage 17 through the mandrel 10, to avoid obstructing the passage 17. When the valve head 16 moves relatively upwardly, it is disposed in engagement with the valve seat 15 at the lower end of the mandrel. To insure against leakage between the valve seat 15 and the valve head 16, the latter may be provided with a rubber-like seal ring 20 that is engageable with and is adapted to seal against the transverse valve seat face 15 at the lower end of the mandrel 10.

The mandrel 10 includes an annular piston portion 21, which may be conveniently provided at the upper end of the lower section 14 at the region where it is threaded to the upper mandrel section 13. The mandrel 10, in annular piston 21, depending supporting leg 19, fulcrum pin 18, and valve seat 15 are contained within an outer housing 22, in which they are telescopically arranged. The outer housing includes a cylinder 23 consisting of a cylinder sleeve 24 slidably engaging the periphery of the annular piston 21, the upper end of the sleeve being threadedly secured to an upper head or member 25 adapted to slidably engage the periphery of the mandrel 10 above the piston. Fluid is prevented from leaking in an upward direction between the upper member 25 by a suitable seal ring 26 on the mandrel section 13 slidably engaging the inner surface of the upper housing member 25. Similarly, fluid leakage between the piston 21 and the wall 27 of the cylinder sleeve 24 is prevented by a suitable seal ring 28 mounted on the piston and slidably engaging the cylinder wall.

Fluid under pressure is capable of passing from the central mandrel passage 17 through one or more ports 30 provided through the mandrel into the annular cylinder space 31 between the upper cylinder member 25 and the annular piston 21, and between the periphery of the mandrel 13 and the wall 27 of the cylinder sleeve. Such fluid under pressure is prevented from leaking out of the cylinder space 31 by the respective seal members 26, 28.

The lower portion of the housing 22 is constituted by a lower head or member 32 threadedly secured within and to the lower end of the cylinder sleeve 24, this lower member having a lower threaded box 33 to receive the upper threaded pin end 34 of the tubular member or cen-

3

tral body of the lower tool C, such as a well packer that is to be anchored in packed-off condition against a well casing. The lower head 32 is tubular and has a passage with an internal diameter substantially the same as the internal diameter through the mandrel 10 and of the tubular string B thereabove, to provide for the unobstructed flow of fluid through the entire valve apparatus A, when the valve head 16 is in its fully open position, such as disclosed in Fig. 1. Leakage of fluid between the lower head 32 and cylinder sleeve 24 may be prevented by a rubber-like seal ring 35 on the head sealingly engaging the wall 27 of the cylinder sleeve.

Movement of the valve head 16 between open and closed positions is secured by the telescopic movement of the mandrel 10 with respect to the outer housing 22. As the mandrel moves upwardly and downwardly within the outer housing, it carries the flapper valve member 16 with it, inasmuch as the latter is secured on the fulcrum pin 18 mounted within the supporting leg 19 attached to the lower mandrel member 14. The relative longitudinal movement between the mandrel 10 and the outer housing 22 enables the valve 16 to be shifted to open position positively and held in such position positively. The positive shifting of the valve head 16 to open position is accomplished upon relative upward movement of the mandrel 10 within the outer housing 22, by causing a cam member, in the form of a sleeve 36 secured to the outer housing, to engage and shift the valve head to open position.

As specifically disclosed, the cam sleeve 36 extends only part way around the entire circumference of the apparatus, its internal diameter being slightly greater than the external diameter of the lower mandrel portion 14, to allow the latter to slide therinto. The cam sleeve 36 is cut away on opposite sides of the supporting leg 17 depending from the lower mandrel section, to provide an arcuate space 37 allowing the leg to move downwardly and upwardly along the adjacent longitudinal ends 38 of the cam sleeve. These end surfaces 38 of the cam sleeve actually are only present in the upper portion of the latter, being adapted to engage the sealing face 16a of the valve head to hold the latter in its open position completely out of the path of the fluid moving through the mandrel and the lower head passage 17. From the longitudinal holding surfaces 38, the cam sleeve has downwardly and inwardly directed inclined cam surfaces that are engageable with the sealing face 16a of the valve head to shift it to open position as the mandrel moves upwardly relative to the housing and the sleeve 36, secured thereto. These cam surfaces 39 terminate in a transverse shoulder 40 provided by a bore 41 of the sleeve therebelow of larger diameter. When the valve head 16 is disposed within this enlarged diameter portion 41, it can engage the valve seat 15 at the lower end of the mandrel 10. When in this closed position, the lower surface 16b of the valve head rests upon a supporting shoulder 42 provided on the sleeve 36, this shoulder extending part way around the axis of the apparatus and engaging the valve head at its peripheral marginal portion, as shown in Fig. 2. The valve head 16 itself has a substantially greater diameter than the outside diameter of the lower peripheral portion of the mandrel valve seat 15 so that the marginal portions of the inner face 16a of the valve head are capable of engaging the cam surfaces 39 on the sleeves 36 to be shifted thereby to open position.

The guide or cam sleeve 36 is made in two parts, the portion in alignment with the valve head 16 being cut away, as described above, to allow the valve head to engage the cam surfaces 39 and holding surfaces 38 thereon, and also to permit relative downward movement of the valve head with respect to the valve sleeve 36 upon downward movement of the mandrel 10 within the housing 22. Similarly, the diametrically opposite portions of the valve sleeve are spaced apart to provide a region

4

43 into which an aligned leg 44 secured to the lower mandrel section 14 can shift. This aligning leg 44 will always extend below the upper end of the sleeve 36, the leg being in sliding engagement with the ends 45 of the sleeve, so as to locate the valve head 16 in appropriate position with respect to the cam and holding surfaces 39, 38.

For purposes that will be described hereinbelow, the guide sleeve 36 is secured against longitudinal movement with respect to the outer housing 22, but is rotatable with respect thereto. To provide this action, a swivel type of connection is arranged between the lower end of the guide sleeve 36 and the lower housing member 32. This swivel type of connection consists of a two-piece swivel ring 46, the outer portion of which is engageable with the inner wall 27 of the cylinder sleeve 24, and which has upper and lower inwardly directed flanges 47, 48, the lower flange being disposed within a companion external groove 49 in the lower housing member 32, and the upper flange 48 being disposed in an external groove 50 formed in the guide sleeve 36. The lower end of the guide sleeve 36 itself may rest upon the upper end of the lower housing member 32. By virtue of the swivel connection just described, the mandrel 10 may be moved upwardly and downwardly within the outer housing 22 without securing corresponding movement of the guide sleeve 36. However, rotation of the mandrel 10 will be transmitted to the guide sleeve 36 by virtue of the continued disposition of the aligning leg 44 between the confronting ends 45 of the guide sleeve 36 defining the slot 43. The mandrel 10 is rotated with respect to the outer housing 22, for the purpose of releasably locking the valve in a desired condition, such as in the open condition illustrated in Fig. 1.

During the upward movement of the mandrel 10 with respect to the housing 22, the valve head 16 is shifted along the sleeve cam surfaces 39 to the position shown in Fig. 1, in which the valve head is held in its fully open position by the holding surfaces 38 at the upper end of the cam surfaces, these holding surfaces being substantially parallel to the axis of the apparatus. When the mandrel 10 is moved downwardly with respect to the housing 22, then the valve head 16 is shifted below the holding surfaces 38 and may swing inwardly until it occupies the horizontal position disclosed in Fig. 2, with its lower surface 16b engaging the supporting shoulder 42 on the sleeve, and its upper sealing face 16a, as well as its seal ring 20, firmly engaging the valve seat 15 at the lower end of the mandrel 10.

The apparatus A can be locked in its closed condition and it can also be locked in its open condition, remaining in such conditions despite the flow, even under pressure, or lack of flow of fluid through the inner mandrel 10 and the outer housing 22. As specifically disclosed, the locking portions of the apparatus are provided between the upper member 25 of the outer housing and the inner mandrel 10. Thus, the upper member has a lock segment or shoe 60 carried therein and adapted to move radially of the inner mandrel into and out of an arcuate lower groove 61 or an arcuate upper groove 62 contained therein, each of these grooves extending only part way around the circumference of the mandrel. The circumferential ends of the lower groove 61 terminate in a lower bridge segment or cam member 63 of arcuate extent whose outer surface coincides with the periphery of the inner mandrel member 13. Similarly, the circumferential ends of the upper groove 62 terminate in an upper bridge segment or cam 64 having an outer surface that conforms to the periphery of the inner mandrel member 13. The base of the lower groove 61 merges into inclined cam ends 65 of the lower bridge segment 63 that extend to the outer surface of the latter. The base of the upper groove 62 likewise merges into inclined ends 66 of the upper bridge segment 64, which extend to

5

the outer surface of the latter. For a purpose to be described hereinbelow, the lower groove 61 and its bridge segment 63 are angularly offset with respect to the upper groove 62 and the upper bridge segment 64, the extent of offsetting of their respective center lines being approximately 180 degrees.

The lock segment or shoe 60 is urged inwardly of the mandrel 10 by a helical compression spring 67 located within an outer socket 68 in the segment 60 and bearing against the base of the socket, the outer portion of the spring bearing against the base of an internal groove 69 in the upper member 25 that contains the segment. A centering and guide pin 70 is secured to the upper member 25 projecting into its groove and into the spring 67, to maintain the spring 67 and the shoe segment 60 substantially radial of the axis of the apparatus.

When the mandrel 10 is disposed in its upward position with respect to the outer housing 22, in which the valve head 16 is locked in open position, the lock segment 60 can be urged by its spring 67 into the lower arcuate groove 61, the width of this groove being substantially equal to the longitudinal width of the segment, so that the upper and lower sides of the groove engage the segment to positively lock the inner mandrel 10 to the outer housing 22 against relative longitudinal movement in both directions. When the inner mandrel 10 is rotated with respect to the outer housing 22, the lower bridge segment 63 will engage and cam the lock segment 60 outwardly completely out of the lower lock groove of the inner mandrel, releasing the inner mandrel from the outer housing and permitting the inner mandrel to be moved downwardly relative to the outer housing, to place the valve head 16 in engagement with the valve seat 15, the valve then being in its closed condition. When the valve head 16 engages the valve seat 15 and its underside 16b engages the shoulder 42 of the two-part guide and cam sleeve 36, the shoe 60 can move within the upper arcuate lock groove 62, which has a width substantially equal to the longitudinal extent of the lock segment. When the lock segment 60 is in the upper groove 62, the inner mandrel 10 is again locked to the outer housing 22 against longitudinal movement in both directions, the valve being held in its closed condition, such as disclosed in Fig. 2.

When it is desired to release the lock segment 60 from the upper groove 62, the mandrel 10 is rotated with respect to the outer housing 22 to cause the upper bridge segment 64 of the mandrel to engage the lock shoe 60 and cam it outwardly to the periphery of the inner mandrel 13, which will release the inner mandrel 10 from the outer housing 22 and permit the inner mandrel to again be elevated with respect to the housing to shift the valve head 16 to open position, and into the position shown in Fig. 1.

From the foregoing description, it is apparent that the valve can be locked in both its open condition and its closed condition. It is preferred that it be necessary to rotate the inner mandrel 10 to the right only by rotating the tubing string B attached thereto to the right in effecting the release and locking of the shoe 60 to the mandrel, when the mandrel is in both its upper position with respect to the housing 22, as well as in its lower position with respect to the housing. Moreover, it is desired to positively locate the shoe 60 with respect to the lower bridge segment 63 and lower groove 61, and also with respect to the upper bridge segment 64 and the upper groove 62, to offer assurance to the operator that the valve apparatus is locked in the valve opening position, released from the valve opening position, locked in the valve closing position, or released from the valve closing position. Such positive locating and indication to the operator is secured by rotating the inner mandrel 10 to the right, to avoid inadvertent unthreading of the threaded tubing joints, and also by appropriate longitudinal movement of the tubing string B and mandrel 10

6

with respect to the outer housing 22. It is not necessary to the operation of the apparatus disclosed for the tubing string B and member 10 to be rotated to the left, which might effect unthreading of the tubing string joint.

The lock segment 60 is located appropriately with respect to the bridge segments 63, 64 and the lock grooves 61, 62 by a locating device provided between the outer housing 22 and the inner mandrel 10, and preferably below the lower groove 61 and bridge segment 63. As disclosed, the upper housing member 25 has a pin disposed therein which extends radially inward into a slot arrangement 81 provided in the outer portion of the inner mandrel member 13. The pin 80 is disposed in longitudinal alignment with the center line of the lock segment or shoe 60, whereas the slot is so designed that certain of its portions positively locate the pin in a predetermined fashion to locate the lock segment 60, disposed immediately thereabove, in appropriate relation with respect to the lock grooves 61, 62 and the bridge segments 63, 64.

The lock slot 81 formed in the inner mandrel contains a lower horizontal path 82 which extends around the mandrel, terminating at a vertical stop wall 83 defining the right end of a vertical path 84 extending upwardly to an upper horizontal path 85. This upper horizontal path 85 extends to the right (as seen in Fig. 5), and terminates at a vertical stop wall 86 defining the right side of a second vertical path 87 extending downwardly to the lower horizontal path 82 (as seen in Fig. 5) along the lower horizontal path until it engages the vertical stop wall 83. When the pin 80 is in the lower horizontal path 82, the lock shoe 60 is located within the lower lock groove 61 (position "1" in Fig. 5). As the pin 80 approaches the end wall 83 of the lower horizontal path, the lock segment 60 will ride up upon the lower bridge segment 63 and completely out of the groove 61. The fact that the lock segment is out of the groove is determined by the engagement of the locating pin 80 with the vertical stop wall 83 (position "2"). The mandrel 10 is now released from the outer housing 22, which will permit downward movement of the mandrel to valve closing position, the lock shoe 60 merely riding relatively up along the periphery of the mandrel until it shifts inwardly into the upper lock groove 62. This condition obtains when the valve has been fully closed, the locating pin 80 and the lock shoe 60 now occupying the No. "3" position shown in Fig. 5. When the lock shoe 60 is in the No. "3" position, the locating pin is in the upper horizontal path 85, which will then permit the tubular string B and mandrel 10 to be rotated to the right to relatively shift the locating pin and the shoe toward the No. "4" position shown in Fig. 5, this position being definitely determined by engagement of the locating pin 80 with the vertical stop wall 86, at which time the lock segment has ridden up on the upper bridge segment 64 completely out of the upper lock groove 62. The mandrel 10 can then be elevated with respect to the housing, the locating pin 80 moving down through the vertical path 87 toward the lower horizontal path 82, the lock segment 60 sliding down along the periphery of the mandrel and into the lower lock groove 61, to again lock the valve in open position, such position being designated by the numeral "1" in Fig. 5.

The tubular string B and the mandrel need only be rotated in the clockwise direction designated by the arrow 90 in Fig. 5, to place the lock shoe 60 positively in a released condition with respect to the mandrel, or in a condition in which it can be relocked to the mandrel, for the purpose of positively securing the valve in its fully open position or in its fully closed position. The rotation of the mandrel 10 to the right effects relative angular motion or rotation of the locating pin 80 and the lock shoe 60 to the left, as indicated by the arrows 91 in Fig. 5. The tubular string B and mandrel 10 can also be rotated to

the left, if desired. However, such rotation may not positively locate the shoe 60 in a desired position with respect to the bridge segments 63, 63 and the upper and lower grooves 61, 62. Rotation to the left may be required for the purpose of appropriately manipulating the lower tool C to which the outer housing 22 is secured, the rotation of the mandrel 10 being transferred to the outer housing 22 through the locating pin 80. Thus, assuming that the locating pin 80 and the shoe 60 are disposed in the No. "1" position illustrated in Fig. 5, the rotation of the mandrel to the left will cause the left wall 88 of the vertical path 87 to engage the locating pin 80, continued left-hand turning of the mandrel 10 being transmitted through the pin to the housing 22. When the locating pin is in the position illustrated, which is designated by broken lines in Fig. 5, the shoe 60 will still be disposed in its locked condition within the lower groove 61, or in the position indicated in broken lines in Fig. 5. Similarly, assuming that the valve is locked in its closed position, the rotation of the mandrel 10 to the left will have the effect of causing the locating pin 80 to engage the left-hand wall 92 of the vertical path 84, the angular motion of the mandrel to the left being transmitted through the pin 80 to the outer housing 22, with the valve in the closed condition. Of course, when the pin is engaging both of the other vertical stop walls 83, 86 continued right-hand rotation of the inner mandrel 10 will be transmitted through the pin 80 to the outer housing 22, for the purpose of appropriately manipulating the lower tool C secured to the outer housing.

It is, therefore, apparent from the foregoing description that a valve apparatus has been devised which can be locked in closed condition, or open condition, or in both open and closed condition. Such conditions are definitely known to the operator of the equipment, and can be made to occur as a result of rotating the tubular string B in the right-hand direction only, which is highly desirable to preclude inadvertent unthreading of one or more of the tubing string joints. In addition, the angular motion of the mandrel 10 can be transferred to the outer housing 22 whenever desired, for purposes of manipulating a tool C secured to the lower end of the apparatus A.

The inventor claims:

1. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; a valve seat on one of said members; a valve element movable with respect to said members into and out of engagement with said seat; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element with respect to said seat; releasable lock means engageable with said tubular members to releasably lock said members together with said valve element engaged with said seat to prevent telescopic movement of said tubular members with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement and to disengage said valve element from said seat; and means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position.

2. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; a valve seat on one of said members; a valve element movable with respect to said members into and out of engagement with said seat; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element with respect to said seat; releasable lock means engageable with said tubular members to releasably lock said members together with said valve element engaged with said seat to prevent telescopic movement of said tubular

members with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement and to disengage said valve element from said seat; means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position; and locating means on said tubular members operable upon relative rotation between said members for selectively locating said lock means in its released or locked position.

3. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; releasable lock means engageable with said tubular members to releasably lock said members together with said valve elements coengaged; means responsive to rotation in one direction of one of said members relative to the other of said members for releasing said lock means to permit such telescopic movement and to disengage said valve elements from each other; means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position; and locating means on said tubular members operable upon relative rotation between said members for selectively locating said lock means in its released or locked position.

4. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; releasable lock means engageable with said tubular members when said tubular members are in one telescoped position to releasably lock said members together with said valve elements coengaged, said lock means being engageable with said tubular members when said tubular members are in another telescoped position to releasably lock said members together with said valve elements disengaged; means responsive to rotation in one direction of one of said members relative to the other of said members for releasing said lock means to permit telescopic movement between said members; means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position; and locating means on said tubular members operable upon relative rotation between said members for selectively locating said lock means in released position, in position to lock said members together in said one telescoped position, or in position to lock said members together in said another telescoped position.

5. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; one of said tubular members having longitudinally spaced arcuate grooves; a lock member movable laterally on said other tubular member into and out of said grooves to selectively prevent and permit relative telescopic movement between said tubular members; arcuate bridge means on said one member at the ends of each arcuate groove engageable with said lock member in response to predetermined relative rotation in one direction between said tubular members for shifting said lock member out of said grooves to released position, said lock member being disengaged from both of said bridge means for reentry into a selected groove in response to continued relative rotation between said members in said

one direction; and means on said tubular members for selectively limiting the extents of relative rotation between said tubular members to place said lock member in a position for selective entry into one of said grooves or in a position for engagement with one of said bridge means.

6. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; said inner member having longitudinally spaced arcuate grooves; a lock member movable laterally on said outer tubular member into and out of said grooves to selectively prevent and permit relative telescopic movement between said tubular members; arcuate bridge means on said inner member at the ends of each of said arcuate grooves engageable with said lock member in response to predetermined rotation in one direction of said inner member within said outer member to shift said lock member out of said grooves to released position, said lock member being disengaged from each of said bridge means for reentry into one of said grooves in response to continued relative rotation between said members in said one direction; said outer member having a locating pin; said inner member having a locating slot thereon receiving said pin, said slot being defined by walls engageable with said pin for selectively limiting the extents of relative rotation between said tubular members to place said lock member selectively in alignment with each of said bridge means or in alignment with each of said grooves.

7. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; a valve seat on one of said members; a valve element movable with respect to said members into and out of engagement with said seat; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element with respect to said seat; releasable lock means engageable with said tubular members to releasably lock said members together to hold said members in an extended position and prevent their telescopic movement with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement; and means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position.

8. In valve apparatus adapted to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other and having a fluid passage there-through; a valve seat on one of said members surrounding said passage; a valve element movable laterally of said members into engagement with said seat and out of engagement from said seat to a position substantially completely to one side of said passage; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element to such position; releasable lock means engageable with said tubular members to releasably lock said members together to hold said members in an extended position and prevent their telescopic movement with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement; and means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position.

9. In a valve apparatus to be incorporated in a tubular

string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; a valve seat on one of said members; a valve element movable with respect to said members into and out of engagement with said seat; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element with respect to said seat; releasable lock means engageable with said tubular members to releasably lock said members together to prevent their telescopic movement with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement; means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position; and locating means on said tubular members operable upon relative rotation between said members for selectively locating said lock means in its released or locked position.

10. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; releasable lock means engageable with said tubular members to releasably lock said members together to prevent their telescopic movement with respect to each other; means responsive to rotation in one direction of one of said tubular members relative to said other tubular member for releasing said lock means to permit such telescopic movement; means operable in response to rotation of said one tubular member in said one direction for shifting said lock means from released to locked position; and locating means on said tubular members operable upon relative rotation between said members for selectively locating said lock means in its released or locked position.

11. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; one of said tubular members having an arcuate groove; a lock member movable laterally on said other tubular member into and out of said groove to selectively prevent and permit relative telescopic movement between said tubular members; means on said one tubular member operable in response to predetermined relative rotation between said tubular members for shifting said lock member out of said groove to released position; and means on said tubular members for determining such predetermined relative rotation.

12. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; one of said tubular members having an arcuate groove; a lock member movable laterally on said other tubular member into and out of said groove to selectively prevent and permit relative telescopic movement between said tubular members; bridge means on said one tubular member at one end of said groove engageable with said lock member in response to predetermined relative rotation between said tubular members for shifting said lock member out of said groove to released position; and means on said tubular members for determining such predetermined relative rotation.

13. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; coengageable valve elements on said members for controlling flow of fluid through said members in re-

sponse to relative telescopic movement between said members; one of said tubular members having an arcuate groove; a lock member movable laterally on said other tubular member into and out of said groove to selectively prevent and permit relative telescopic movement between said tubular members; arcuate bridge means on said one tubular member at the ends of said arcuate groove engageable with said lock member in response to predetermined relative rotation in one direction between said tubular members for shifting said lock member out of said groove to released position, said lock member being disengaged from said bridge for reentry into said groove in response to continued relative rotation between said members in said one direction; and means on said tubular members for selectively limiting the extent of relative rotation between said tubular members to place said lock member in alignment with said bridge means or in alignment with said groove.

14. In a valve apparatus to be incorporated in a tubular string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other; co-engageable valve elements on said members for controlling flow of fluid through said members in response to relative telescopic movement between said members; said inner member having an arcuate groove on its periphery; a lock member movable laterally on said outer member into and out of said groove to selectively prevent and permit relative telescopic movement between said tubular members; arcuate bridge means on said inner member at the ends of said arcuate groove engageable with said lock member in response to predetermined relative rotation in one direction between said tubular members for shifting said lock member laterally out of said groove to released position, said lock member being disengaged from said bridge for lateral return movement into said groove in response to continued relative rotation between said members in said one direction; said outer member having a locating pin; said inner member having a circumferentially continuous groove therein receiving said pin, said pin and continuous groove coacting with each other to selectively limit the extent of relative rotation between said tubular members to place said lock member in alignment with said bridge means or in alignment with said arcuate groove in response to continued relative rotation between said tubular members in the same direction.

15. In a valve apparatus to be incorporated in a tubu-

lar string to be disposed in a well bore: inner and outer tubular members telescopically arranged with respect to each other and having a fluid passage therethrough; a valve seat on one of said members surrounding said passage; a valve element movable laterally of said members into engagement with said seat and out of engagement from said seat to a position substantially completely to one side of said passage; means engageable with said valve element in response to relative telescopic movement between said members to shift said valve element to such position; said inner tubular member having an arcuate groove; a lock member on said outer tubular member movable into said groove to prevent relative telescopic movement between said tubular members to hold said valve element in its position substantially completely to one side of said passage, said lock member being movable laterally out of said groove to permit relative telescopic movement between said tubular members; arcuate bridge means on said inner tubular member at the ends of said arcuate groove engageable with said lock member in response to predetermined relative rotation in one direction between said tubular members for shifting said lock member laterally out of said groove to released position, said lock member being disengaged from said bridge for lateral return movement into said groove in response to continued relative rotation between said members in said one direction; said outer member having a locating pin; said inner member having a circumferentially continuous groove therein receiving said pin, said pin and continuous groove coacting with each other to selectively limit the extent of relative rotation between said tubular members to place said lock member in alignment with said bridge means or in alignment with said arcuate groove in response to continued relative rotation between said tubular members in the same direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,698,490	Bovey	Jan. 8, 1929
2,053,602	Coberly	Sept. 8, 1936
2,101,160	Weber	Dec. 7, 1937
2,178,540	McNeese	Nov. 7, 1939
2,543,509	Sandberg	Feb. 27, 1951
2,585,706	Ware	Feb. 12, 1952

FOREIGN PATENTS

361,913	Germany	1922
665,797	Great Britain	1952