July 7, 1953 F. H. LEE 2,644,526

CASING COLLAR FOR CEMENTING WELLS

Filed April 4, 1947

FIG. 1

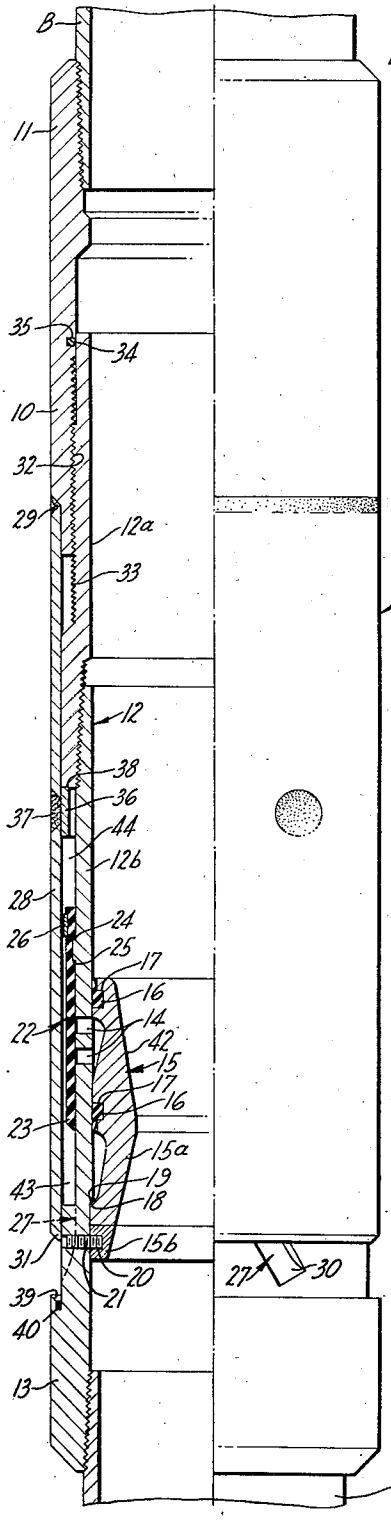


FIG. 2

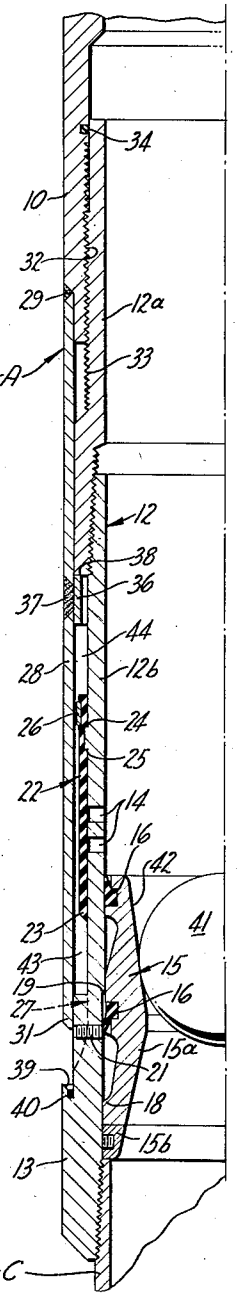
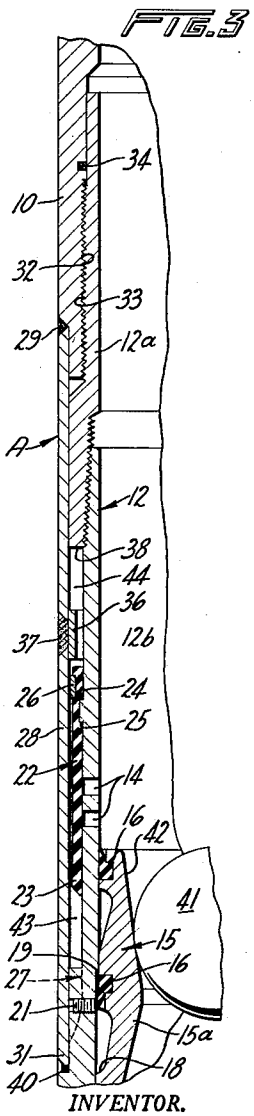


FIG. 3



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CASING COLLAR FOR CEMENTING WELLS

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16 Claims. (Cl. 166—1)

1

This invention relates to devices for cementing casings, liners and similar conduits in well bores.

Apparatus for cementing a string of casing, or a similar conduit, in a well bore may include a collar having side ports which are initially closed by an internal sleeve valve to enable fluids to be pumped downwardly through the casing and its collar without discharging through the side ports. When the ports are to be opened, a suitable device is pumped, or allowed to gravitate, down the casing string into engagement with the sleeve valve to close its central passage and allow hydraulic pressure to shift it to open position, whereupon the fluids may be pumped outwardly through the open ports.

For the purpose of preventing return flow of fluids, such as cement slurry, through the ports into the casing, a suitable back pressure valve is usually placed on the exterior of the collar over the ports. While this back pressure prevents return flow of fluids into the casing, it does not serve to prevent fluids from passing from the interior of the collar through the ports to the exterior of the collar, which is a desirable feature in some well bores.

Accordingly, an object of the present invention is to provide an improved device for positively preventing passage of fluids from the interior of the casing string, or its collar, to the exterior thereof after the inner sleeve valve has been shifted to port opening position.

Another object of the invention is to provide an improved device for positively preventing passage of fluids through side ports in a collar in both directions after the inner sleeve valve has been shifted to port opening position.

Still another object of the invention is to provide a side ported collar device embodying a sleeve valve for initially closing the ports against passage of fluids from the interior of the collar to the exterior thereof, and also having a back pressure valve adapted to be disposed over the ports to prevent return flow of fluid into the collar, in which a device is employed for protecting the back pressure valve against damage, and which is also capable of serving as a positive valve closure element for preventing fluid flow from the interior of the collar to its exterior after the sleeve valve has been shifted to port opening position.

A still further object of the invention is to provide a side ported device, embodying both inner and outer ports, in which the outer ports can be closed against fluid flow in both directions.

2

This invention has other objects and aspects 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 claims appended hereto.

Referring to the drawings:

Fig. 1 is a combined longitudinal elevational and sectional view of the apparatus, with the parts in their initial relative positions for running in a well bore.

Fig. 2 is a partial longitudinal section, disclosing the parts in the positions they occupy upon opening of the side ports through the apparatus for the purpose of permitting fluid flow between its interior and exterior.

Fig. 3 is a view similar to Fig. 2, disclosing the parts in position for preventing lateral fluid flow in either direction between the interior and exterior of the apparatus.

In the form of the invention disclosed in the drawings, a collar A constitutes part of a string of casing by connecting upper and lower casing sections B, C in longitudinal spaced relation. Although specific reference is made in this specification to casing and a casing string, it is to be understood that the invention is applicable to other specific uses, as, for example, in connection with liner and other conduit strings positioned in well bores.

The collar A includes an upper outer tubular member 10 having an upper threaded box 11 adapted to be secured to the upper casing section B and also a lower inner tubular member 12 having a lower threaded box 13 adapted to be secured to the lower casing section C. As specifically disclosed in the drawings, the lower tubular member 12 includes an upper section 12*a* and a lower section 12*b* threadedly secured together to achieve economy in manufacture, and facility in assembly of certain parts of the device. In the operation of the device, however, these sections 12*a*, 12*b* function as a unit.

The lower section 12*b* of the lower member has a plurality of circumferentially arranged side ports 14 through its side wall through which fluid may be pumped between the interior and exterior of the collar. Initially, these ports are closed against passage of fluid from the interior of the apparatus to the exterior by disposing a sleeve valve 15 thereover. As specifically disclosed in the drawings, such sleeve valve may consist of

an upper section 15a carrying side seals 16 in external grooves 17 and disposed on opposite sides of the ports 14 to prevent leakage of fluids between the lower member 12 and the sleeve valve in either direction. The upper section 15a is also provided with a suitable shoulder 18 adapted to engage a companion shoulder 19 formed in the lower member 12 for the purpose of preventing upward travel of the sleeve valve 15 within the lower tubular member. Downward travel of the upper sleeve valve member 15a is prevented by its resting upon a lower valve ring 15b having a circumferential groove 20 adapted to receive one or more shear screws 21 threaded through the lower member 12.

Return flow of fluids through the inner set of ports 14 is prevented by a back pressure valve in the form of a rubber sleeve 22 disposed over the ports, with its free end 23 located a substantial distance below the ports. The other upper end of the rubber valve is secured to the lower member 12 in any suitable fashion, as by means of the interlocking flanges 24, 25 on the sleeve 22 and lower tubular member 12 and by a suitable strap 26 clamped around the upper end of the rubber member. This sleeve valve 22 may flex outwardly under the action of fluid under pressure flowing through the ports 14 to permit the fluid to discharge from its lower free end 23 and then pass outwardly of the collar device.

After passing outwardly through the ports 14, the fluid preferably flows through a plurality of circumferentially spaced outer ports 27 formed between the lower member 12 and a rigid sleeve 28, of suitable material such as steel, disposed completely around the rubber sleeve valve 22 and the inner ports 14 and secured to the upper outer tubular member 10 in any suitable manner, as by the use of welding material 29. This sleeve 28 is spaced laterally from the rubber sleeve valve 22 to permit outward flexing and opening of the latter, extending downwardly for disposition over an enlarged portion on the lower member 12, having a plurality of grooves 30 formed therein which are inclined to a substantial extent from the vertical, but still disposed predominantly in a downward direction. The lower end 31 of the outer sleeve 28 is initially disposed part way over the grooves 30 to form, in effect, a plurality of passages, ports or nozzles 27, through which fluent substances pumped through the inner ports 14 can pass and be given a "whirling" motion, which is advantageous in assuring the obtaining of uniform disposition of cement around the collar and the casing string.

The upper tubular member 10 has straight internal threads 32, preferably of right hand, engageable with companion external threads 33 on the upper section 12a of the lower tubular member 12, thus effecting a coupling therebetween. Leakage along and between such threads is prevented by a suitable seal ring, such as a round rubber seal 34, disposed within a suitable groove 35 in the upper member 10 adapted to engage the cylindrical periphery of the lower member 12 in leakproof relation. The initial position between the upper and lower tubular members 10, 12 is determinable by a suitable stop ring 36 secured within the outer sleeve 28, as by the use of plug welds 37, such stop ring engaging the end 38 of the upper section 12a of the lower tubular member 12 and disposing the lower end 31 of the sleeve 28 part way over the inclined grooves 30 in order to provide the proper nozzle effect on the fluid issuing therefrom.

Upon rotation of the upper tubular member 10 with respect to the lower tubular member 12, the former is threaded downwardly along the latter, carrying the outer sleeve 28 with it and moving its lower head end 31 toward a companion annular seat 39 formed on the lower tubular member 12 below the inclined grooves 30. When such head 31 engages the seat 39, the inclined grooves or "whirler" ports 30 will be closed against passage of fluids in both directions, and, as assurance against such passage of fluids, a suitable lead seal ring 40 may be provided in the seat adapted to be engaged by the head end 31 of the sleeve 28 in order to be wedged firmly thereagainst.

The collar device is assembled in the manner disclosed in Fig. 1, in which the inner sleeve valve 15 is disposed in closed position over the ports 14, being held in such upper position by the frangible pins or shear screws 21 engaged within the groove 20 of its lower ring 15b. The upper outer tubular member 10 occupies an upper position with respect to the lower tubular member 12 to dispose the head end 31 of the outer sleeve 28 above the valve seat 39 and above the lower end of the grooves 30 in order that the external whirler ports or passages 27 are open. Such position may be determined by engagement of the stop ring 36 with the lower end 38 of the upper tubular section 12a.

The collar A is connected to the upper and lower casing section B, C and the entire casing string is lowered in the well bore until the location has been reached in which the casing is to be cemented in place. The first batch of cement slurry may then be pumped downwardly through the casing string, passing through the sleeve valve 15 and through the lower section of the casing C until its discharge at some lower point in the casing string, as, for example, from a casing shoe (not shown), after which the cement slurry will travel through the annulus around the lower casing sections toward the collar A. Following the displacement of the lower charge of cement slurry, a suitable tripping device, such as a heavy ball 41, may be allowed to gravitate downwardly through the fluid in the well casing into engagement with a companion seat 42 in the sleeve valve 15, closing the central passage through the latter and allowing the pressure of the fluid in the casing and collar thereabove to be increased sufficiently to shear the screws 21 and force the sleeve valve 15 and ball 41 downwardly to a position determined by engagement of the sleeve valve with a suitable stop, such as supplied by the upper end of the lower casing section C, in which position the sleeve valve 15 is disposed below the ports 14 in order to allow fluid to pass outwardly therethrough (see Fig. 2). Circulating fluid, followed by the desired quantity of cement slurry, may now be pumped directly into the casing, passing outwardly through the open ports 14, flexing the rubber back pressure valve 22 outwardly, and passing down through the annulus 43 between the outer sleeve 28 and the lower member 12 for discharge through the "whirler" ports 27, thence flowing upwardly through the annulus around the casing and the upper casing sections. After the required amount of cement slurry has been so discharged through the side ports 14 and "whirler" ports 27 of the collar, the pressure at the surface of the well may be bled off and the rubber sleeve valve 22 allowed to seal back over the ports 14 to prevent return flow of the cement slurry through them into the collar and casing.

After the cement slurry has been displaced through the collar, the portion of the casing string running from the upper tubular member 10 to the top of the well bore may be rotated to the right for the purpose of threading and telescoping the upper tubular member 10 down along and over the lower tubular member 12, shifting the outer sleeve 28 downwardly into firm sealing engagement with the seat 39 and lead seal ring 40 in the lower member, closing off the ports 27 in the collar against passage of fluids in either direction between the interior and exterior of the casing string (see Fig. 3). Such rotation of the upper portion of the casing string and upper tubular member 10 may occur immediately after displacement of the cement slurry, or at any reasonable time thereafter, since the back pressure valve 22 will prevent return flow of cement slurry into the casing.

It is to be noted that the stop ring 36 provides a manner of positively locating the lower end 31 of the outer sleeve 28 with respect to the inclined grooves 30, in order that they may function as ports 27 during the discharge of the cement, as well as during the pumping of circulating fluid prior to such discharge for appropriately conditioning the well bore. The fluid will issue through such ports 27 in a direction inclined to the vertical and substantially tangent to the collar for the purpose of washing drilling mud from the wall of the formation and thereby assist in conditioning of the bore hole. The "whirling" action given the cement slurry causes it to travel circumferentially or helically around the collar and the upper casing sections, insuring a uniform sheath of cement around the casing string, devoid of channels or other leakage paths.

The outer sleeve 28 offers protection to the rubber back pressure valve 22, insuring against its damage during running of the collar on the casing string into the well bore. Not only does it insure against its damage, but it functions as the valve device for closing the outer "whirler" ports 27 upon telescoping of the upper tubular member 10 down along the lower tubular member 12. It is also to be noted that the stop ring 36 not only acts as a positive locating device for insuring the proper initial relationship between the lower end 31 of the outer sleeve 28 and the inclined grooves 30, but also acts as a safety device, preventing unscrewing of the lower tubular member 12 from the upper tubular member 10 and possible separation between the upper and lower casing string portions during running of the entire casing string in the well bore. The stop ring 36 positively prevents any unscrewing action from taking place while permitting the upper tubular member 10 and the outer sleeve 28 to be threaded downwardly along the lower tubular member 12, in view of the ample longitudinal space or distance 44 which is provided between the stop ring 36 and the upper end of the rubber back pressure valve sleeve 22.

The components of the sleeve valve 15 and the trip ball 41 are preferably made of readily drillable materials to enable such parts to be disintegrated under the action of a drill bit after the cementing operation has been completed, leaving an unobstructed bore through the collar whose inside diameter is preferably no less than the inside diameter of the casing sections B, C comprising the remainder of the casing string.

It is, accordingly, apparent that a collar device has been provided which can initially and positively prevent fluids from passing outwardly through the ports 14, which ports can be opened readily without manipulation of the casing string, through the simple expedient of hydraulically shifting the sleeve valve 15 downwardly, and in which the casing string may be manipulated for the purpose of positively closing the outer ports or passages 27 to prevent flow of fluids from the interior of the casing string to the exterior thereof.

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

1. Apparatus of the character described, including a first tubular member, a second tubular member, said tubular members being adapted to form part of a casing string positionable in a well bore, means providing a connection between said members so that relative rotation therebetween effects their longitudinal movement with respect to each other, said first member having a side port, a sleeve valve within said first member disposable over said port to close the same, said first member having an external valve seat thereon, a second sleeve valve on said second tubular member disposed initially in open position with respect to said port, and means operatively connecting said second sleeve valve and second tubular member to effect engagement of said second sleeve valve with said valve seat in response to relative rotation between said first and second members to prevent flow of fluid between the interior and exterior of said members.

2. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said tubular members being adapted to form part of a casing string positionable in a well bore, said lower member having a side port, a first sleeve valve within said lower member disposable over said port to close the same, means providing an outer fluid passage on said lower member communicable with said port, an external valve seat on said lower member below said fluid passage, and a second sleeve valve secured to said upper tubular member and disposed around said port and initially in open position with respect to said passage, said second sleeve valve being adapted to engage said seat to close said outer fluid passage in response to rotation and downward threading of said upper tubular member along said lower tubular member.

3. Apparatus of the character described, including tubular means having a side port and adapted to form part of a casing string positionable in a well bore, a portion of said tubular means being movable, a valve within said tubular means for closing said port, a back pressure valve disposed over said port to prevent flow of fluid therethrough from the exterior to the interior of said tubular means, means on said tubular means providing an outer fluid passage through which fluid from said port may flow to the exterior of said tubular means, an outer valve member movable on said tubular means and disposed over said back pressure valve for closing said outer fluid passage, and means providing a connection between said outer valve and said movable portion of said tubular means which disposes said outer valve initially in open position with respect to said fluid passage and which shifts said outer valve to a position closing said fluid passage upon movement of said movable portion of said tubular means.

4. Apparatus of the character described, including a first tubular member, a second tubular

member, said tubular members being adapted to form part of a casing string positionable in a well bore, means providing a connection between said members so that relative rotation therebetween effects their longitudinal movement with respect to each other, said first member having a side port, a sleeve valve within said first member disposable over said port to close the same, a back pressure valve disposed over said port to prevent flow of fluid therethrough from the exterior to the interior of said first tubular member, means on said first member providing an outer fluid passage through which fluid from said port may flow to the exterior of said apparatus, and a sleeve valve on and movable with one of said tubular members disposed over said back pressure valve and disposed initially in open position with respect to said passage and adapted to close said outer fluid passage in response to relative rotation between said first and second members.

5. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said tubular members being adapted to form part of a casing string positionable in a well bore, said lower member having a side port, a first sleeve valve within said lower member disposable over said port to close the same, a back pressure valve disposed over said port to prevent flow of fluid therethrough from the exterior to the interior of said lower tubular member, means on said lower tubular member providing an outer fluid passage through which fluid from said port may flow to the exterior of said apparatus, an external valve seat on said lower member below said fluid passage, and a second sleeve valve secured to said upper tubular member and disposed around said back pressure valve, said second sleeve valve being disposed initially in open position with respect to said passage and adapted to engage said seat to close said outer fluid passage in response to rotation and downward threading of said upper tubular member along said lower tubular member.

6. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said lower member having a side port, a first sleeve valve within said lower member disposable over said port to close the same, a back pressure valve disposed over said port to prevent flow of fluid therethrough from the exterior to the interior of said lower tubular member, said lower member having an external groove below said back pressure valve and communicable with said port, an external valve seat on said lower member below said groove, and a second sleeve valve secured to said upper tubular member and disposed around said back pressure valve, said second sleeve valve occupying an initial position partly over said groove and adapted to be moved into engagement with said seat to close said groove in response to rotation and downward threading of said upper tubular member along said lower tubular member.

7. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said lower member having a side port, a first sleeve valve within said lower member disposable over said port to close the same, said lower member having an external groove below said port and communicable with said port, and a second sleeve valve secured to said upper tubular member and disposed around said port, said second sleeve valve occupying an initial position partly over said groove and adapted to be moved completely over said groove to close the same in response to rotation and downward threading of said upper tubular member along said lower tubular member.

8. Apparatus of the character described, including a first tubular member, a second tubular member, said tubular members being adapted to form part of a casing string positionable in a well bore, means providing a connection between said members so that relative rotation therebetween effects their longitudinal movement with respect to each other, said first member having a side port, a sleeve valve within said first member disposable over said port to close the same, one of said members having an external groove spaced longitudinally from said port and communicable with said port, and a sleeve valve on and movable with the other of said members disposed around said port and occupying an initial position partly over said groove and adapted to be moved completely over said groove to close the same in response to relative rotation between said first and second members.

9. Apparatus of the character described, including a first tubular member, a second tubular member, said tubular members being adapted to form part of a casing string positionable in a well bore, means providing a connection between said members so that relative rotation therebetween effects their longitudinal movement with respect to each other, said first member having a side port, a sleeve valve within said first member, frangible means securing said sleeve valve over said port to close the same, means adapted to be sent down said casing string into engagement with said sleeve valve to enable hydraulic rupturing of said frangible means and shifting of said sleeve valve to port opening position, one of said members having an external groove spaced longitudinally from said port and communicable with said port, and a sleeve valve on and movable with the other of said members disposed around said port and occupying an initial position partly over said groove and adapted to be moved completely over said groove to close the same in response to relative rotation between said first and second members.

10. Apparatus of the character described, including a first tubular member, a second tubular member, said tubular members being adapted to form part of a casing string positionable in a well bore, means provding a connection between said members so that relative rotation therebetween effects their longitudinal movement with respect to each other, said first member having a side port, a sleeve valve within said first member initially disposable over said port to close the same, means on said first member providing an outer fluid passage communicable with said port and the exterior of the apparatus, and a sleeve valve on one of said tubular members disposed initially in position maintaining said outer fluid passage open and operable for closing said outer fluid passage in response to relative rotation between said first and second members.

11. Apparatus of the character described, including a first tubular member, a second tubular member threadedly connected to said first tubular member, said tubular members being adapted to form part of a casing string positionable in a well bore, said first member having a side port, a sleeve valve within said first member initially disposable over said port to close the

same, means on said first member providing an outer fluid passage communicable with said port and the exterior of the apparatus, and a sleeve valve on said second tubular member mounted over said port and disposed initially in position maintaining said outer fluid passage open and operable to close said outer fluid passage in response to relative rotation between said first and second members.

12. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said tubular members being adapted to form part of a casing string positionable in a well bore, said lower member having a side port, a first sleeve valve within said lower member initially disposable over said port to close the same, means on said lower member providing an outer fluid passage communicable with said port and the exterior of the apparatus, and a second sleeve valve secured to said upper tubular member and located around said port for disposition initially in position maintaining said outer fluid passage open, said second sleeve valve being adapted to close said outer fluid passage in response to rotation and downward threading of said upper tubular member along said lower tubular member.

13. Apparatus of the character described, including an upper tubular member, a lower tubular member threadedly connected to said upper member, said tubular members being adapted to form part of a casing string positionable in a well bore, said lower member having a side port, a first sleeve valve within said lower member initially disposable over said port to close the same, means on said lower member providing an outer fluid passage communicable with said port and with the exterior of the apparatus, an external valve seat on said lower member below said fluid passage, and a second sleeve valve secured to said upper tubular member and disposed around said port, said second sleeve valve being disposed initially in position above said seat to maintain said outer fluid passage open and being adapted to move downwardly into engagement with said seat to close said outer fluid passage in response to rotation and downward threading of said upper tubular member along said lower tubular member.

14. Apparatus of the character described, including tubular means having a side port and adapted to form part of a casing string positionable in a well bore, a portion of said tubular means being movable, a valve within said tubular means for closing said port, means on said tubular means providing an outer fluid passage communicable with said port, said passage having an outlet below said port, a second valve on said tubular means for closing said outlet, and means providing a connection between said second valve and said movable portion of said tubular means which disposes said second valve initially in open position with respect to said outlet and which enables said second valve to be shifted downwardly to outlet closing position in response to manipulation and movement of said movable portion of said tubular means.

15. Apparatus of the character described, including tubular means having a side port and adapted to form part of a casing string positionable in a well bore, a portion of said tubular means being movable, a sleeve valve within said tubular means disposable over said port to close the same, means on said tubular means providing an outer fluid passage communicable with said port, said passage having an outlet below said port, a second sleeve valve on said tubular means for closing said outlet, and means providing a connection between said second sleeve valve and said movable portion of said tubular means which disposes said second sleeve valve initially in open position with respect to said outlet, and which enables said second sleeve valve to be shifted in response to manipulation and movement of said movable portion of said tubular means to a position closing said outlet.

16. Apparatus of the character described, including a first tubular member, a second tubular member threadedly connected to said first tubular member by a right-hand threaded connection, said tubular members being adapted to form part of a casing string positionable in a well bore, said first member having a side port, a sleeve valve within said first member disposable over said port to close the same, means on said first member providing an outer fluid passage communicable with said port and having an outlet below said port, and a sleeve valve on said second tubular member disposable over said port and movable downwardly to close said outlet in response to relative rotation between said first and second members.

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