The present invention relates to devices adapted to form part of casings, liners and similar conduits in well bores, and more particularly to side ported cementing devices for enabling conduits to be cemented in the well bores.

Well casings, liners and similar well conduits are sometimes secured in bore holes by discharging cementitious material through side ports in fittings forming part of the conduit structure. It is desirable to prevent return flow of the material through the ports into the casing. In addition, it is desirable to prevent fluids from passing outwardly through the ports during subsequent use of the conduit structure, as in connection with the flowing or pumping of oil or gas from a producing horizon in the well bore.

It is, accordingly, an object of the present invention to provide an improved ported apparatus, in which the ports may be opened to permit fluid passage therethrough, and then closed positively against passage of fluids through them in both directions between the interior and exterior of the apparatus.

Another object of the invention is to provide a ported collar, or similar device, adapted to form part of a casing or liner string, whose ports may be opened and then permanently closed against passage of fluids between the interior and exterior of the collar, and in which the overall length of the collar is held to a comparatively low value.

Inner alldable sleeve valve members are sometimes employed in controlling the passage of fluids through the ports of a collar, or similar device, designed to form part of a casing or liner string. The sleeve is shifted downwardly to control the ports through use of a plug member closing its central bore, which enables hydraulic pressure to be imposed on the plug and sleeve and move them within the collar. If a dead column of fluid is present in the casing or liner string below the sleeve, its downward hydraulic shifting is resisted thereby.

A further object of the invention is to provide improved means for minimizing or eliminating the resistance that would otherwise be offered by the dead column of fluid to downward shifting of the sleeve valve member.

Yet another object of the invention is to provide improved plugs for closing a conduit sleeve valve bore, to enable downward hydraulic shifting of the latter to occur within a ported conduit collar, or similar member.

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

Referring to the drawings:

Figure 1 is a longitudinal section through a ported casing apparatus, with its ports closed;

Fig. 2 is a view similar to Fig. 1, with the ports open;

Fig. 3 is a view similar to Fig. 1, with the ports reclosed;

Fig. 4 is an enlarged fragmentary longitudinal section of the apparatus, with parts located in a position intermediate their closed and open positions; and

Fig. 5 is an enlarged fragmentary longitudinal section of the latching portion of the apparatus.

As illustrated in the drawings, a casing collar A is provided at an intermediate point in a string of casing positioned in a well bore. The upper end of the collar may be threadedly attached to an adjacent upper casing section B, while its lower end may be similarly secured to the upper pin 10 of a lower casing section C. The collar is so positioned in the casing string as to insure its location in the well bore at the point where it is desired to eject cement slurry, or other cementitious material, from the casing string into the surrounding well annulus.

The main portion of the collar A consists of a tubular member 11, which, as disclosed in the drawings, is made of two parts 12, 13 to facilitate assembly of the apparatus. An upper threaded portion 12, which is secured to the upper casing section B, is suitably attached, as by means of coengaging threads 14 to the lower portion 13 of the tubular member. For the purpose of discharging fluids from the interior of the casing string and collar to the exterior thereof, the tubular member is provided with one or more lateral ports 15. These ports, however, are closed against passage of fluids when the casing string is run in the well bore. They can be opened to permit cement slurry and other fluids to be discharged therethrough; and they can be again closed to prevent further passage of fluids between the interior and exterior of the collar.

In order to accomplish the above noted purposes, a lower sleeve valve member 16 is disposed in the tubular member 11. This sleeve valve member is provided with spaced ring...
grooves 17, 18 carrying suitable side seals 19, 20 such as rubber O rings, for preventing leakage of fluids in both longitudinal directions around the exterior of the sleeve and out through the ports 15. The lower seal ring 26 is engageable with an intumescence flange 24 on the tubular member 14, whereas the upper seal ring 18 is engageable with the inner surface of an upper sleeve valve member 22, which is initially maintained above the ports 15, but which can be shifted downwardly to close these ports. This upper member is made of two parts, including a lower tubular sleeve 23, preferably made of a difficulty drillable material, such as steel, and a readily drillable upper portion 24, of magnesium, aluminum, and the like, piloted within the steel member, and having a shoulder 25 engaging the upper end of the latter. Leakage between these two portions is prevented by a suitable side seal 26, such as an O ring, located in an external groove 27 in the drillable portion and engaging the inner wall of the steel portion 23.

As indicated above, the upper sleeve valve member 22 is disposed initially in an upper position clear of the ports 15 (see Fig. 1). The two portions 23, 24 of this valve are held together and in their upper location by one or more frangible devices, in the form of shear screws 28, extending through them and through the tubular member 14. Disruption of the screws 28 enables the upper sleeve valve member 22 to be shifted downwardly to a position closing the ports 15.

The lower sleeve valve member 16 is nested or piloted within the upper sleeve valve member 22, with its side seals 19, 20 disposed on opposite sides of the ports 15. The lower member 16 is held in such position initially by one or more shear screws 29 extending through the tubular member 14 and threaded into the lower sleeve valve member. These shear screws dispose the lower seal ring 26 in contact with the intumescence flange 21, preferably a short distance above the lower end of the latter. Below the flange 21, the lower sleeve valve has an enlarged diameter portion 30 for slidably engagement with the enlarged bore 31 of the tubular member.

The upper portion 32 of the lower sleeve valve is reduced in external diameter to provide an annular space 33 in conjunction with the upper sleeve valve 22 through which cement slurry, and other fluent substances, may flow when the lower member 16 has been shifted downwardly to port opening position. The lower sleeve valve 16 preferably abuts the drillable portion 24 of the upper sleeve valve, in order to hold the overall dimensions of the combined sleeve valve structure to a minimum.

The central bore 34 through the upper drillable portion 24 of the upper sleeve valve is preferably tapered inwardly in a downward direction, merging smoothly into a corresponding bore 35 in the lower sleeve valve 16. In fact, the lower bore 35 forms a continuation of the upper bore 34.

The collar A is made up in the casing string with the parts occupying their initial position as disclosed in Fig. 1. The upper sleeve valve 22 is disposed above the ports 15, and the lower sleeve valve 16 is located in its upper position, with its seals 19, 20 on opposite sides of the ports. As a result, any fluids pumped down through the casing string will pass through the convergent bores 34, 35 in the upper and lower sleeve valve members to some lower point in the casing string, such as a casing shoe (not shown), from which the fluids are ejected into the well bore surrounding the casing. If the collar is employed in connection with a multiple stage cementing operation, a charge of cement slurry may be pumped down the casing string for ejection from the casing shoe. A flexible top cementing plug (not shown) of the character disclosed in my Patent 2,370,833 may be used at the upper end of the cement slurry, and this plug will be capable of passing through the convergent bores 34, 35 of the upper and lower sleeve members 24, 28 without cutting the screws 28, 29, or caving in the central portion of the bores 34, 35 facilitating inward compression of the flexible or rubber plug.

Following the discharge of the lower quantity of cement slurry from the casing, it is desired to open the ports 15 in the collar and discharge a second quantity of cement slurry through these ports for upward passage around the casing string. A trip device, in the form of a plug 36, is pumped down the casing string, or is allowed to gravitate through the fluid in the casing string into engagement with the tapered wall 35 of the lower sleeve (see Fig. 2). This plug is of such dimensions as to pass through the upper sleeve 24, but is of greater diameter than the minimum diameter through the lower sleeve 16, to insure its seating in the latter and its closing of the tapered bore 35. A specific form illustrated in the drawings, the lower plug 36 includes a lower head 37 having a lower, generally spherical surface 38 on which a spherical seal 39 of rubber, or similar material, is mounted. This seal is secured to the head 37 by disposing it upon the inner face of a companion external head groove 41, and by clamping its lower end between the upper end of a depending shell 42 and the head. The shell is threaded on to a depending pin or neck 43 of the head 37, an upward projection 45 of the shell engaging the lower seal portion against the head and confining its longitudinally extending terminal portion 36c between the extension 44 and the neck 43.

In addition to its clamping of the spherical seal 39 to the plug head 37, the shell 42 serves to locate the lower end of the front of the casing string, such as a casing shoe, from which the fluids are ejected into the well bore. If the collar is employed in connection with a multiple stage cementing operation, a charge of cement slurry may be pumped down the casing string for ejection from the casing shoe. A flexible top cementing plug (not shown) of the character disclosed in my Patent 2,370,833 may be used at the upper end of the cement slurry, and this plug will be capable of passing through the convergent bores 34, 35 of the upper and lower sleeve members 24, 28 without cutting the screws 28, 29, or caving in the central portion of the bores 34, 35 facilitating inward compression of the flexible or rubber plug.

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annular space 33 between it and the upper sleeve 22, for discharge through the collar ports 15. After the desired quantity of cement slurry has been thus ejected through the collar, it is desired to close the ports by shifting the upper sleeve 22 downwardly. This latter purpose may be achieved by placing a top cementing plug 47 at the upper end of the charge of cement slurry, and causing it to engage the tapered wall 34 of the upper drillable portion 24 of the upper sleeve valve member 22, closing the bore through the drillable portion and allowing the fluid in the casing thereabove to be pressurized to an extent sufficient to shear the upper screws 28 and shift the upper sleeve 22 downwardly over the ports 15.

An upper seal 48 on the steel sleeve portion 23 will be disposed above the ports 15 to prevent passage of fluids between the ports along the upper portion of the sleeve 22, while downward passage of fluids along the sleeve 22 is prevented by a lead seal ring 49 carried by the sleeve and adapted to be forced against a shoulder 50 formed in the tubular member 11 between its flange 21 and the ports 15.

The lead seal ring 49 is soldered along the wall of the tubular member 11. Its inner surface being tapered in a downward and inward direction and engaged by a companion taper 51 on the upper sleeve valve member 22. The lead seal is prevented from removal from the sleeve valve member by an internal flange 52 on the ring fitting within a companion groove in the sleeve 22.

When the upper sleeve valve member is shifted downwardly, the lower end of the lead seal ring 49 engages the shoulder 50, which enables the tapered portion of the sleeve to wedge the ring firmly against the wall of the tubular member 11 and the shoulder 50, preventing leakage of fluids between the lower end of the sleeve 22 and the tubular member. As indicated above, the O-ring 48 will engage the tubular member 11 above the ports 15, in order to prevent leakage of fluid along the upper portion of the upper sleeve 22.

The upper sleeve valve 22 is held in its closed position across the ports 15 by a suitable latch device which may take the form of a split, inherently expansible, ring 53 disposed in an external groove 54 in the sleeve 22 and having teeth or wickers 55 adapted to engage companion internal teeth or wickers 56 formed in the side wall of the tubular member 11, (see Fig. 5). This latch arrangement prevents the sleeve 22 from moving upwardly after it has been shifted to port closing position.

The top cementing plug 47 may be of any suitable kind, as long as it is capable of closing the bore 34 through the upper sleeve valve member 22. As disclosed in the drawings, a spherical plug device 56 may be suitably secured to a standard top cementing plug 57, which may have the usual wooden body 58 and cup leathers 59 adapted to slideably seal with the wall of the casing string. The lower plug device may consist of a generally spherical body 60 of readily drillable material, such as magnesium, aluminum, synthetic resin and the like, which has a screw 61 cast within it. This screw is threaded into the wooden body 58 and serves to attach the standard plug to the wooden body. A seal is used against leakage between the lower plug 47 and the upper sleeve valve member 22, a spherical seal member 62 of rubber, or similar material, may be mounted on the body 60, the upper end of the seal having an inwardly directed flange 63 received within a companion groove in the body.

In the event that the column of fluid below the lower sleeve valve is incapable of being displaced in a downward direction, as for example because of the presence of hardened cement in the well casing above the shoe, or of a top cementing plug used in performing a lower cementing operation, it would be difficult to move the lower sleeve valve 16 downwardly to open the ports 15. Provision is made for allowing the fluid to bleed in the casing below the lower sleeve valve to bleed from the casing string, and thus preclude the fluid from resisting downward movement of the sleeve valve to port opening position.

It is to be noted that the lower O-ring 20 engages the intimated shoulder 21 only a slight distance above the lower end of the latter. Accordingly, upon shearing of the lower screws 28 and downward shifting of the sleeve valve 16 to an extent in which the O-ring 20 is disposed slightly below the flange 21, the fluid in the collar below the sleeve can then be displaced upwardly through the small running clearance space around the sleeve 16, around the O-ring 20 and out through the ports 15 (see Fig. 4). Such upward flowing can take place since the O-ring 20 is then disposed within the enlarged diameter bore 31 of the tubular member without making sealing engagement therewith. No difficulty is encountered in moving the lower sleeve valve 16 the slight distance necessary to dispose the O-ring 20 below the flange 21, whereas considerable difficulty might be encountered in moving the lower sleeve valve 16 a substantial distance necessary to bring it into engagement with the stop 16a furnished by the upper end of the lower casing section C.

An additional seal ring 64 may be provided on the lower sleeve valve 16 below the shear screws 28. This seal ring fits within a groove 65 in the sleeve and has an upwardly directed lip 66. This lip will flex inwardly to allow bleeding of the casing fluid upwardly along the sleeve valve 16, in the manner described above. However, downward pressure imposed along the exterior of the sleeve valve 16 will force the lip 66 outwardly against the tubular member 11, and prevent downward flow of fluid along the lower sleeve valve. This last mentioned feature is provided in order to be assured that the fluid below the collar is not subjected to the pressure required to discharge the cement slurry outwardly through the ports 15. It is sometimes desired not to disturb the lower cementing operation that has been performed previously, especially when cement slurry is being discharged through the ports 15 before the lower charge of cement has taken its initial set. The lip seal ring 64 effectively prevents any fluid pressure from being imposed on the lower cement job.

One or more relatively small bleeder holes 67 may also be provided in the tubular member 11 immediately above the shoulder 50 against which the lead seal ring 49 is to be compressed. These bleeder holes may be necessary upon downward shift of the upper sleeve valve member 22 to prevent entrapment of the fluid in the annular space 68 between the lower sleeve 16 and tubular member 11 after the upper sleeve valve 22 passes the ports 15. The lead seal, however, will close the bleeder holes 67 upon being compressed between the tapered surface 51 on the upper sleeve valve member, the shoulder 50 and the inner cylindrical surface of the tubular member 11, as disclosed in Fig. 3.

It is, accordingly, apparent that apparatus has
been provided for properly controlling passage of fluids through the lateral ports. These ports are positively closed initially against passage of fluids in both directions between the interior and exterior of the collar A. Also, similar passage of fluids is prevented by the upper sleeve valve member 22 after the cementing operation has been performed. The necessity to compress the fluid in the well casing below the lower sleeve 16 is precluded, and the pressure incident to the performance of the cementing operation through the ports 15 is prevented from being imposed on the lower fluid in the casing and on the lower cement job. The parts are compactly arranged by virtue of the nesting of one sleeve valve member within the other.

It is evident that the lower plug 36 is so devised as to insure its rapid descent through the fluid in the well casing, while preventing its interference with proper seating of the lower extension 56 of the upper cementing plug 47 in the upper sleeve valve member 22.

Following setting and hardening of the cement ejected through the collar ports, the upper portion 24 of the upper sleeve valve member 22, the lower sleeve valve member 16, and the two plugs 36, 47 may be disintegrated by a drill bit to leave the casing bore free from obstructions or restrictions. The steel portion 23 of the upper sleeve valve 22 has an inside diameter not less than the inside diameter of the casing sections B, C, and of the least inside diameter of the tubular member 11, which prevents the drill bit from acting upon it and insures its retention as a permanent closure across the ports 15.

The inventor claims:

1. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member adapted to control fluid flow through said port, said valve members being piloted one within the other; means releasably securing said lower sleeve valve member in closed position over said port; means releasably securing said upper sleeve valve member in open position with respect to said port, both of said means being releasable to enable downward shifting of said lower sleeve valve member to port opening position and downward shifting of said upper sleeve valve member across said port to close the same; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member has been shifted downwardly across said port; said tubular member having a bleeder hole below said port in communication with the space between and interiorly of said valve member through which fluid can escape to the exterior of the tubular members upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

2. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member adapted to control fluid flow through said port, said valve members being piloted one within the other; means releasably securing said lower sleeve valve member in closed position over said port; means releasably securing said upper sleeve valve member in open position with respect to said port, both of said means being releasable to enable downward shifting of said lower sleeve valve member to port opening position and downward shifting of said upper sleeve valve member across said port to close the same; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member has been shifted downwardly across said port; said tubular member having a bleeder hole below said port in communication with the space between and interiorly of said valve member through which fluid can escape to the exterior of the tubular members upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

3. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member for controlling fluid flow through said port; said upper valve member being piloted within said upper valve member and slideable along said tubular member; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member is disposed across said port; means in communication with the space between and interiorly of said valve members for enabling fluid to escape to the exterior of said tubular member upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

4. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member for controlling fluid flow through said port; said upper valve member being piloted within said upper valve member and slideable along said tubular member; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member is disposed across said port; said tubular member having a bleeder hole below said port in communication with the space between and interiorly of said valve members through which fluid can escape to the exterior of the tubular member upon shifting of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

5. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a port; upper and lower sleeve valve members in said tubular member adapted to control fluid flow through said port, said valve members being piloted one within the other; means releasably securing said lower sleeve valve member in closed position over said port; means releasably securing said upper sleeve valve member in open position with respect to said port, both of said means being releasable to enable downward shifting of said lower sleeve valve member to port opening position and downward shifting of said upper sleeve valve member across said port to close the same; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper
valve member has been shifted downwardly across said port; said tubular member having a bleeder hole below said port in communication with the space between and interiorly of said valve members through which fluid can escape to the exterior of the tubular member upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port; said lower seal being located at least partly below said bleeder hole when said upper valve member comes to rest in a position closing said port.

6. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a port; upper and lower sleeve valve members in said tubular member for controlling fluid flow through said port; said upper valve member being slidable along said tubular member; said lower valve member being piloted within said upper valve member and slidable along said tubular member; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member is disposed over said port; said tubular member having a bleeder hole below said port in communication with the space between and interiorly of said valve members through which fluid can escape to the exterior of the tubular member upon shifting of said upper valve member to closed position over said port and while said upper valve member is disposed across said port; said lower seal being located at least partly below said bleeder hole when said upper valve member comes to rest in a position closing said port.

7. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member adapted to control fluid flow through said port; means releasably securing said lower sleeve valve member in open position over said port; means releasably securing said upper sleeve valve member in open position with respect to said port, both of said means being releasable to enable downward shifting of said lower sleeve valve member to port opening position and downward shifting of said upper sleeve valve member across said port to close the same; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member has been shifted downwardly across said port; and means in communication with the space between and interiorly of said valve means for enabling fluid to escape to the exterior of said tubular member upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

8. In apparatus of the character described: a tubular member adapted to form part of a conduit string, said member having a side port; upper and lower sleeve valve members in said tubular member for controlling fluid flow through said port; said lower valve member being slidable along said tubular member between port closing and port opening positions, said upper valve member being slidable along said tubular member toward said lower valve member between port opening and port closing positions; means effecting upper and lower seals between said upper valve member and tubular member on opposite sides of said port when said upper valve member is disposed over said port; and means in communication with the space between and interiorly of said valve members for enabling fluid to escape to the exterior of said tubular member upon downward movement of said upper valve member toward closed position over said port and while said upper valve member is disposed across said port.

REUBEN C. BAKER.

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