

Dec. 14, 1965

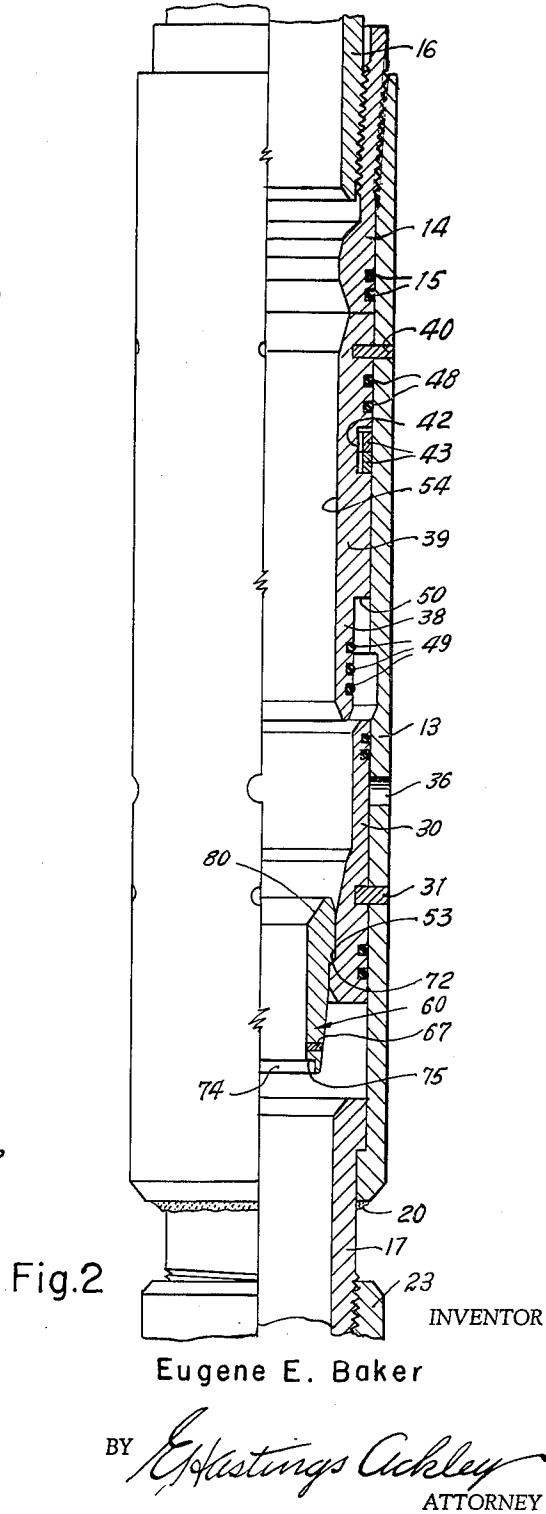
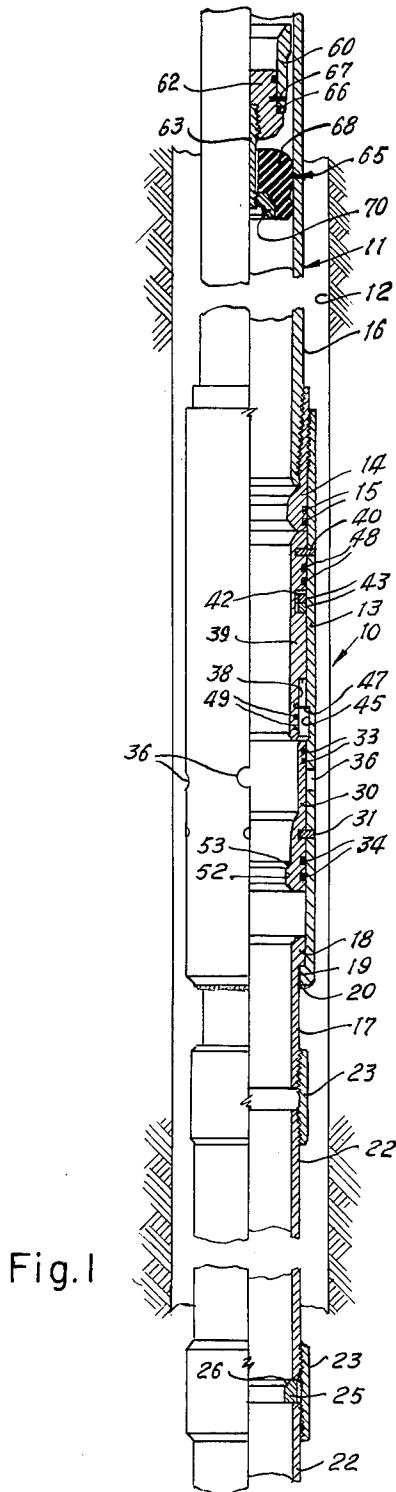
E. E. BAKER

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CEMENTING APPARATUS

Filed Oct. 20, 1960

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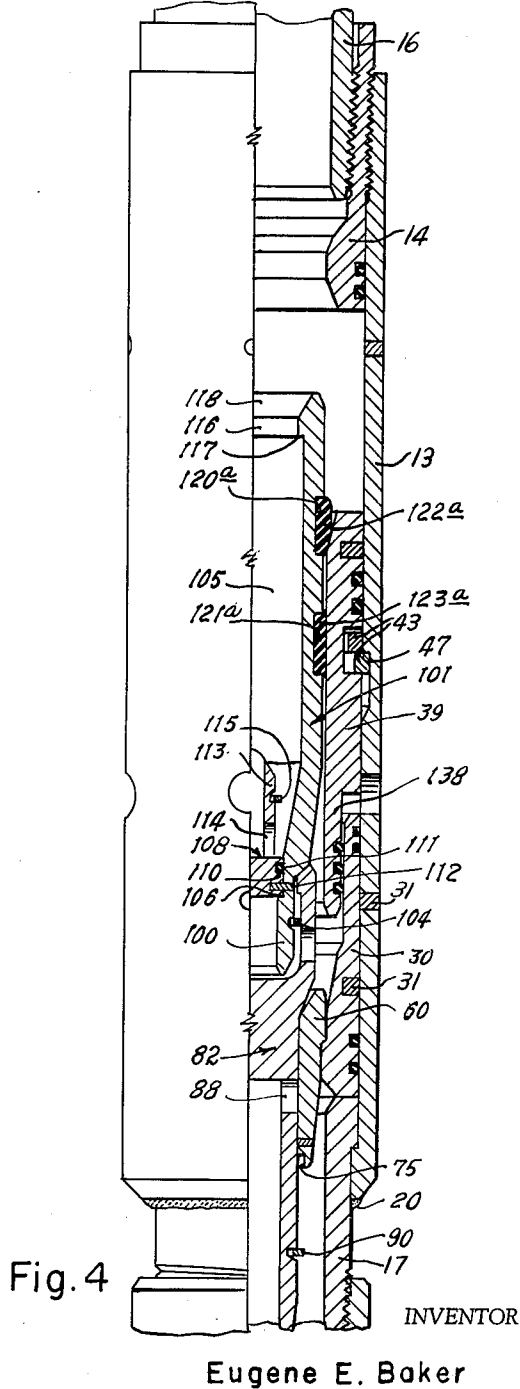
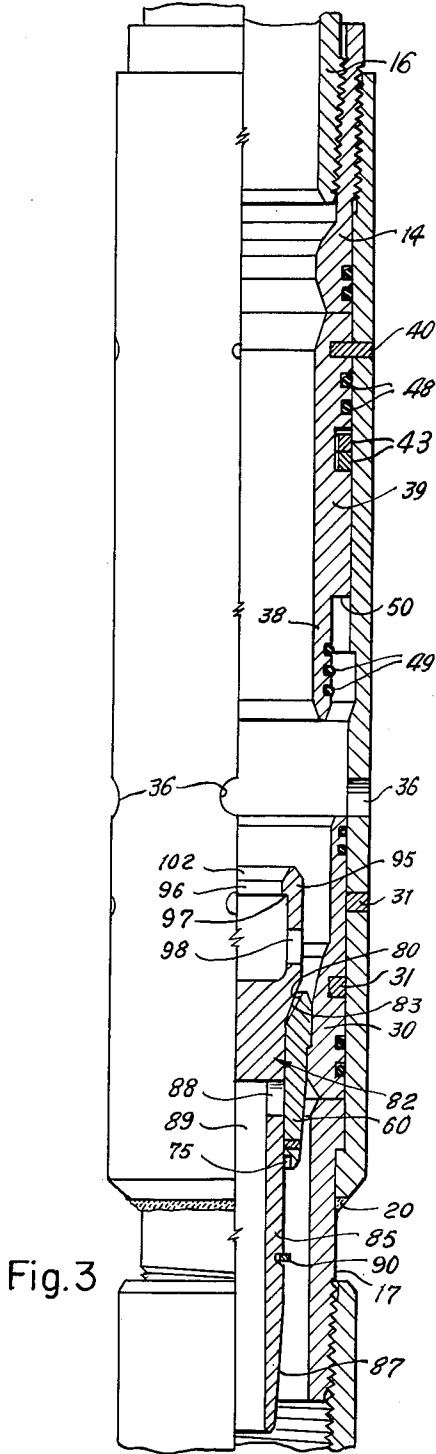
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CEMENTING APPARATUS

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3 Sheets-Sheet 2



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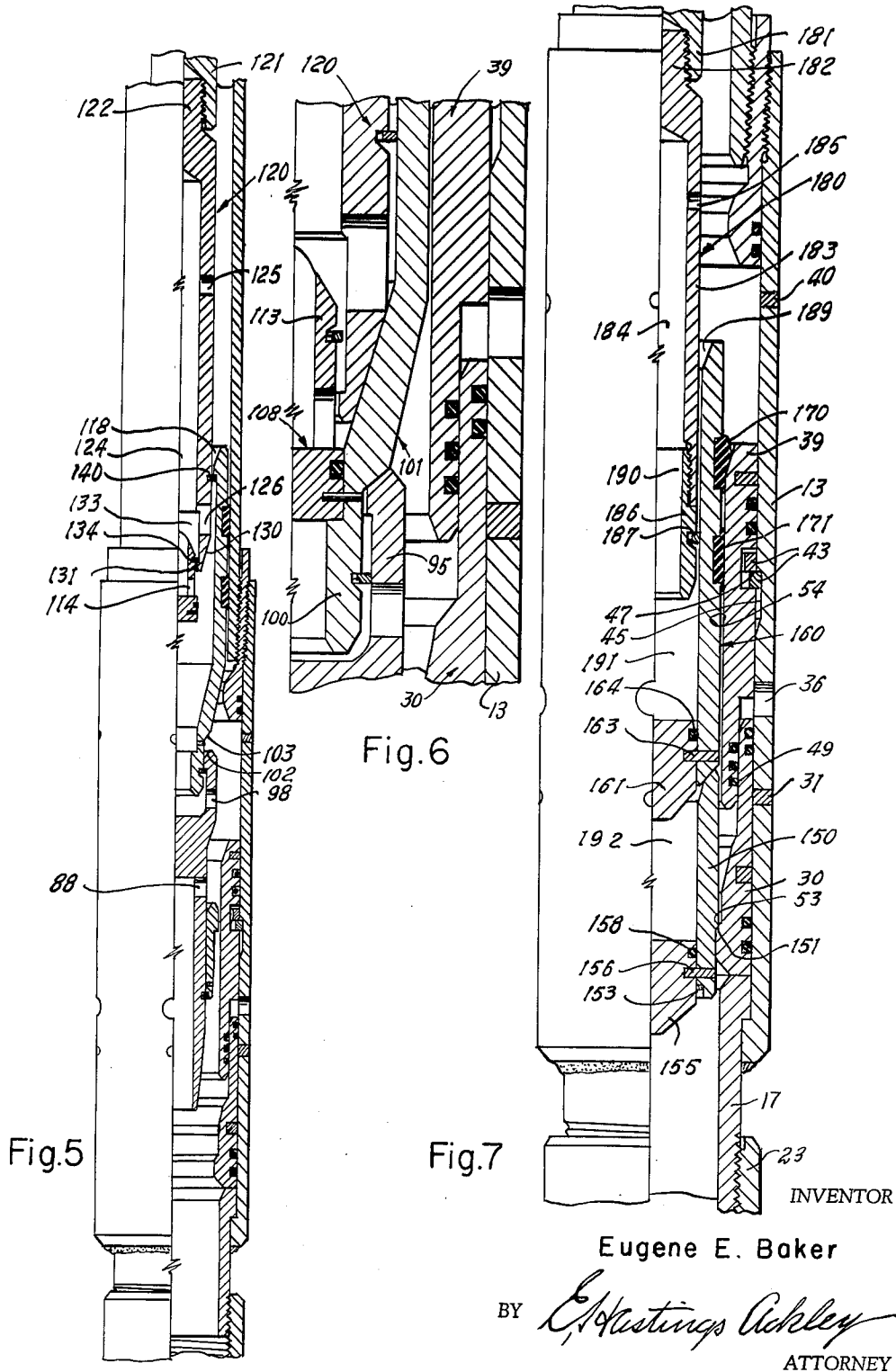
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CEMENTING APPARATUS

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3,223,160

CEMENTING APPARATUS

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22 Claims. (Cl. 166—27)

This invention relates to cementing apparatus employed in the cementing in a well of tubular flow conductors, such as tubing or casing.

In the multiple stage cementing of wells, a valve structure usually called "the multiple stage cementing unit" is made up with the flow conductor which is lowered into a well. The arrangement is such that, at the proper time, a lateral port in the unit can be opened so that cement slurry can flow outwardly therethrough and about the flow conductor and thereafter can be closed after the cement slurry has been discharged. Such an arrangement is disclosed in the patent to Pitts, 2,435,016, in which sleeve valves are provided for opening and for closing the ports through which the cement is discharged and in which the sleeve valves are actuated by the cementing plugs used in carrying on the multiple stage cementing operation. The bore of the flow conductor is opened after the cementing operation has been completed by drilling out the cementing plugs which have actuated the sleeve valves. The drilling out operation results in the destruction of the plugs and is costly and time consuming, especially in the case of tubing or casing of relatively small internal diameter.

Accordingly, it is an object of the invention to provide a multiple stage cementing unit for a flow conductor having sleeve valves for opening and closing the ports through which the cement slurry is discharged from the flow conductor to the exterior and in which the sleeve valves are positively actuated first to open the ports and then to close the ports by devices which are retrievable from the flow conductor upon the completion of the cementing operation to leave the bore of the flow conductor open.

Another object is to provide a multiple stage cementing unit for a flow conductor, wherein opening and closing sleeve valves are provided to open and close a lateral port of the well flow conductor to permit the discharge of cement slurry through the lateral ports and then to close the lateral ports upon the completion of the cementing operation wherein the sleeve valves provide a substantially unrestricted bore for the passage of fluids and well tools both before the initiation of the cementing operation and after its completion.

Still another object is to provide a multiple stage cementing unit for a flow conductor having opening and closing sleeve valves to open and close a lateral port of the well flow conductor to permit the discharge of cement slurry through the lateral ports and then to close the lateral ports upon the completion of the cementing operation wherein the sleeve valves provide a substantially unrestricted bore for the passage of fluids and well tools therethrough both before and after the cementing operation, and wherein the devices for moving the opening sleeve valve to open position and thereafter moving the closing sleeve valve to closed position have coengageable means for causing the devices to be removed as a unit from the flow conductor by any suitable retrieving means after the cementing operation is completed.

A further object is to provide a multiple stage cementing unit wherein the opening sleeve valve is provided with an upwardly facing annular shoulder of relatively very small width dimension which is engageable by an opening seat, detachably secured to the closing plug of a preceding stage of cement, to provide a seat for an open-

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ing bomb dropped into the well flow conductor to close the bore of the opening sleeve whereby an increase of pressure in the well flow conductor above the cementing unit will cause movement of the opening sleeve valve downwardly to open position and wherein the closing sleeve valve is movable to closed position by a closing plug having seal means engageable with the internal surfaces of the flow conductor and of the closing sleeve valve.

A still further object is to provide a cementing unit wherein the opening seat, the opening bomb and the closing plug have coengageable means whereby those devices are removable as a unit upon completion of the cementing operation.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a vertical partly sectional view of a well casing provided with the multiple stage cementing unit showing the sleeve valves in initial positions preceding a cementing operation and showing a top plug and opening seat in the casing above the sleeve valves;

FIGURE 2 is a vertical partly sectional view showing the opening seat in position in the opening sleeve valve of the multiple stage cementing unit;

FIGURE 3 is a view similar to FIGURE 2 showing an opening bomb seated on the opening seat of the opening sleeve valve and with the opening sleeve valve in open position;

FIGURE 4 is a view similar to FIGURE 3 showing a closing plug in position in the closing sleeve valve and in the opening bomb and the closing sleeve valve in lower closed position;

FIGURE 5 is a vertical, partly sectional view showing the assembly of the opening seat, opening bomb and closing plug as it appears during its removal by means of a retrieving tool;

FIGURE 6 is an enlarged fragmentary sectional view showing the manner in which the retrieving tool telescopes in the closing plug and about a plug valve thereof; and,

FIGURE 7 is a vertical, partly sectional view of a modified form of an opening seat, a closing plug and a retrieving tool for removing the assembly of the opening seat and closing plug upwardly from the flow conductor.

Referring now particularly to FIGURES 1 through 5 of the drawing, the multiple stage cementing unit 10 is shown connected in a well flow conductor 11, such as a casing, disposed in a well 12. The cementing unit includes a tubular elongate collar or valve housing 13 whose upper end is threaded on a tubular connector member 14 which in turn is threaded on the lower end of a plurality of upper flow conductor sections 16. The tubular connector member is provided with external annular recesses in which are disposed O-rings 15 or other suitable sealing means for sealing between the valve housing and the connector member.

The valve housing is provided with a tubular extension 17 having an external annular flange 18 at its upper end which engages the internal annular flange 19 at the lower end of the valve housing. The valve housing and its extension 17 are connected in any suitable manner, as by a weld 20. The housing extension 17 is connected to the upper end of a plurality of lower sections 22 of the flow conductor 11 by a coupling collar 23. The flow conductor may be provided below the cementing unit 10 with a seat ring 25 which is disposed in a coupling recess between the upper and lower ends of adjacent flow con-

ductor sections 22. The seat ring 25 projects inwardly into the bore of the flow conductor and provides an annular inwardly and downwardly beveled shoulder or seat 26 therein.

A lower opening sleeve valve 30 is slidably mounted in the valve housing 13 and is releasably held in an upper position in the valve housing, illustrated in FIGURE 1, by a shear pin 31. The lower sleeve valve has external annular grooves or recesses in which are disposed upper O-rings 33 and lower O-rings 34 which seal between the sleeve valve and the housing above and below a plurality of lateral ports 36 of the valve housing when the opening sleeve is in its upper position in the valve housing.

The upper end of the lower sleeve valve 30 may be received in the reduced end portion 38 of the upper or closing sleeve valve 39 when the upper sleeve valve is moved downwardly from its upper position in the valve housing illustrated in FIGURE 1 in which it is releasably held by the shear pin 40. The upper sleeve valve has an external annular ring recess 42 in which are disposed resilient split lock rings 43 which are receivable in an internal annular lock recess 45 of the valve housing to lock the closing sleeve valve against upward movement once it has been moved to its lower operative or closed position in the valve housing illustrated in FIGURE 4. A plurality of the lock rings 43 are provided to insure that at least one of the lock rings will be disposed to expand into the annular recess 45 to engage the downwardly facing shoulder 47 thereof to prevent upward movement of the closing sleeve valve even if the closing sleeve valve, for one reason or another, has not been moved to its lowermost possible position in the valve housing. The upper or closing sleeve is also provided with a pair of external annular recesses above the ring recess 42 in which are disposed O-rings 48 or other suitable sealing means for sealing between the upper sleeve valve and the valve housing. The lower reduced end portion 38 of the upper sleeve also has external annular recesses in which are disposed the O-rings 49 or other suitable sealing means for sealing between the upper and lower sleeves when the lower reduced portion of the upper sleeve valve is telescoped into the upper portion of the lower sleeve valve. Downward movement of the upper sleeve is limited by the engagement of an external annular shoulder 50 thereon with the upper end of the lower sleeve valve. Downward movement of the lower sleeve valve is limited by the engagement of its lower end with the upper end of the external flange 18 of the valve housing extension 17.

The lower sleeve valve has an internal annular flange 52 which provides a downwardly and outwardly extending stop shoulder 53 in its bore. The internal diameter of the flange 52 is slightly smaller than that of the sections of the flow conductor 11 above and below the multiple stage cementing unit for a purpose to be more fully explained hereinafter. The internal diameter of the upper sleeve valve, while greater than that of the internal flange of the lower sleeve, is slightly smaller than the internal diameter of the flow conductor sections to provide a sealing surface 54.

All internal upwardly facing shoulders of the connector member 14, the upper and lower sleeves and the housing extension 17 are beveled downwardly and inwardly to facilitate downward passage of well tools through the cementing unit, while all internal downwardly facing shoulders of the sleeve valves and of the connector member 14 are beveled upwardly and inwardly to facilitate upward passage of tools through the cementing unit.

A tubular opening seat 60 has its lower end telescoped over the reduced upper portion of a cap 62 threaded on a coupling rod 63 of a top plug 65. The cap is provided with an external annular upwardly facing shoulder 66 which limits downward movement of the opening seat 60 on the cap. The opening seat is releasably secured to the cap by a shear pin 67 which extends through a lateral

aperture in the opening seat into a lateral outwardly opening recess of the cap. The top plug 65 has a resilient packer or seal means 68 which is held on the connector rod by and between the cap and a nut 70 threaded on the lower end of the connector rod, and the plug is adapted to pass through the flow conductor behind a charge or stage of cement slurry and pass through the cementing unit 10 forcing the charge of cement slurry downwardly before it and thence through the open lower end of the flow conductor 11 until the top plug engages the upwardly facing shoulder or seat 26 of the stop ring 25.

The opening seat 60 has an external annular flange adjacent its upper end providing a downwardly facing shoulder 72 engageable with the upwardly facing shoulder 53 in the bore of the lower sleeve valve. The lower end of the opening seat has an internal annular recess 74 at its lower end which provides a downwardly facing stop shoulder 75, and the upper end of the opening seat is formed with a downwardly and inwardly extending annular shoulder or seat 80 for a purpose to be more fully set forth hereinafter.

It will be apparent that when the top plug 65 with the opening seat 60 connected thereto is pumped down through the well flow conductor behind a charge or stage of cement slurry which is to be discharged through the open lower end of the flow conductor, the resilient packing element 68 of the top plug deforms to pass through all upwardly facing obstructions, such as the upwardly facing shoulder 53 of the lower sleeve valve but that the engagement of the shoulder downwardly facing 72 of the opening seat 60 with the upwardly facing shoulder 53 of the lower sleeve valve limits downward movement of the opening seat through the lower sleeve valve. The shear pin 67 releasably connecting the opening seat to the cap 62 is sheared when a smaller downwardly shearing force is exerted thereon than the force necessary to shear the shear pin 31 which releasably holds the lower sleeve valve in its upper port 36 closing position in the valve housing. As a result, the assembly of the opening seat and the top plug 65 of the first stage of cement moves through the lower sleeve valve until the downwardly facing shoulder 72 of the opening seat engages the upwardly facing shoulder 53 of the lower sleeve valve, whereupon continued pumping of fluid into the upper end of the flow conductor will cause the shear pin 67 to shear to release the plug 65 from its connection with the opening seat for continued downward movement in the flow conductor until said plug engages the shoulder 26 of the seat ring 25. The lower sleeve valve, however, at this point continues to be held in its upper position by the shear pin 31.

The lower sleeve valve is subsequently movable to its lower open position by pressure applied downwardly through the flow conductor, after an opening bomb 82 has been dropped through the flow conductor into engagement with the seat 80 at the upper end of the opening seat to close the bore of the opening seat. The opening bomb 82 is enlarged adjacent its upper end to provide a downwardly and upwardly extending annular shoulder or seat 83 which is adapted to engage the upwardly facing internal seat 80 of the opening seat 60, the contact between the shoulders of the opening bomb and of the opening seat and of the lower sleeve valve providing a fluid tight seal so that the pressure of fluid pumped downwardly into the upper end of the flow conductor exerts a downward force on the lower sleeve valve. When this force increases to a predetermined value, the shear pin 31 is sheared and the lower sleeve is moved downwardly to its lower open position, its downward movement being stopped by the engagement of the lower end of the sleeve with the upper end of the valve housing extension. The lateral ports 36 of the valve housing are thus opened to permit flow between the bore of the flow conductor and the exterior thereof.

The opening bomb is provided with a guide extension 85 having at its lower end portion an inwardly and downwardly extending guide surface 87. The guide extension 85 is tubular and has in its upper portion a lateral port 88 which communicates the internal bore or passage 89 of the extension and the exterior thereof. The guide extension is also provided with an external annular recess or groove above the guide surface 87 in which is disposed a split resilient snap ring 90 which tends to project annularly outwardly of the outer surface of the guide extension of the opening bomb, whereby said ring engages the downwardly facing annular stop shoulder 75 at the lower end of the opening seat upon upward movement of the opening bomb with respect to the opening seat. The upper end of the opening bomb has an upper tubular extension 95, and an internal annular flange 96 at the upper end of said upper tubular extension provides a downwardly facing annular stop shoulder 97 thereon. The upper tubular extension of the opening bomb is also provided with a lateral port 98 to permit flow of fluid between the interior of the tubular extension and the exterior thereof.

The reduced lower end portion 100 of a closing plug 101 is receivable in the upper tubular extension of the opening bomb, and said lower end portion has an external annular recess in which a snap or latch ring 104 is mounted. The latch ring is cammed inwardly into the recess by its engagement with the downwardly and inwardly extending annular surface 102 above the shoulder 97 at the upper end of the upper tubular extension of the opening bomb when the lower end portion of the closing plug moves therepast, and is resiliently biased outwardly to a projecting position upon passing the internal flange 96 of the tubular extension. The latch ring will thus engage the downwardly facing annular shoulder 97 of the flange 96 of the tubular extension of the opening bomb to limit upward movement of the closing plug relative to the opening bomb. Downward movement of the reduced lower end portion of the closing plug into the upper extension of the opening bomb is limited by the engagement of an external downwardly facing shoulder 103 on the closing plug with the shoulder 102 at the upper end of such upper tubular extension.

The closing plug is substantially tubular in shape having a central bore or flow passage 105 reduced at its lower portion to provide an upwardly facing annular shoulder 106 therein which is engaged by and limits downward movement of a plug valve 108 in said bore and to provide a seal surface 110 which is engaged by an O-ring 111 or other suitable sealing means carried in an external annular recess on the plug valve. The plug valve is initially releasably secured in position in the closing plug to close off fluid flow through the bore 105 thereof, by a shear pin 112 extending through a suitable aperture in the closing plug into a laterally outwardly opening recess of the plug valve. The plug valve has a reduced tubular upward extension 113 which is spaced from the internal surfaces defining the bore of the closing plug when the plug valve is secured in place in the closing plug as illustrated in FIGURE 4. The extension 113 has a lateral port 114 communicating the lower end of its interior with its exterior and external annular recess in which is positioned a snap or latch ring 115 normally resiliently projecting outwardly of the recess.

The closing plug 101 also has an internal annular flange 116 at its upper end which provides a downwardly facing annular lower shoulder 117 and a downwardly and inwardly beveled upper shoulder 118 at the upper end of the plug. A pair of external annular recesses 120a and 121a in the upper portion of the plug have suitable sealing or packing means 122a and 123a, respectively, positioned therein, and said sealing means project outwardly of the closing plug to engage the internal surfaces of the flow conductor as the closing plug is moved downwardly therethrough and to engage the seal-

ing surface 54 of the upper sleeve valve to seal between the closing plug and the upper sleeve valve when the closing plug is disposed therein.

It will be noted that the snap or latch ring 90 of the opening bomb 82 is disposed below the lower end of the opening seat 60 and that the snap or latch ring 104 of the closing plug is disposed below the downwardly facing shoulder 97 of the upper tubular extension of the opening bomb when the opening bomb and the closing plug are in their lowermost positions relative to the opening seat and the opening bomb, respectively, whereby any upward force exerted on the closing plug will first cause upward movement of the closing plug relative to the opening bomb and will then cause upward movement of the opening bomb relative to the opening seat.

The assembly of the opening bomb and the closing plug is removable upwardly through the flow conductor by a retrieving tool 120 connected to a flexible line by the connecting sub 121 threaded on the upper reduced end 122 of the retrieving tool and the usual set of flexible line tools which may include jars or sinker bars (not shown). The lower portion of the retrieving tool is tubular in form and has a central longitudinal passage 124 which opens downwardly, an intermediate port 125 and a lower port 126. The ports provide communication between the passage 124 and the exterior of the running tool. The lower end portion of the running tool has an annular downwardly and inwardly extending guide surface 130 which, by camming engagement with the shoulder 118 at the upper end of the closing plug, guides the retrieving tool into the bore or passage 105 of the closing plug. The lower end of the retrieving tool also has an internal upwardly and inwardly extending cam shoulder 131 which serves to cam the snap or latch ring 115 on the tubular extension 114 of the plug valve 108 inwardly as the lower end of the retrieving tool telescopes over the tubular extension of the plug valve, so that such latch ring is guided into an internal annular recess 133 in the lower portion of the bore of the retrieving tool above an abrupt upwardly facing annular shoulder 134 at the lower end of said recess. The snap or latch ring 115 thus connects the tubular extension of the plug valve with the lower end of the retrieving tool. The retrieving tool also has an external annular recess in which is disposed a snap or latch ring 140, which is cammed inwardly into its recess by its engagement with the upper shoulder 118 of the closing plug during downward telescoping movement of the retrieving tool into the closing plug and expands after passing the flange 116 of the closing plug whereby said latch ring 140 will engage the shoulder 97 of the flange upon subsequent upward movement of the retrieving tool to lift the closing plug with said retrieving tool.

In use, the multiple stage cementing unit 10 is made up in the flow conductor 11 at the surface so that the unit constitutes a section of the flow conductor. The cementing unit 10 does not materially reduce the effective cross sectional bore or flow passage of the flow conductor since the sealing surface 54 of the upper valve sleeve and the flange 52 of the lower sleeve valve are only very slightly smaller in internal diameter than the internal diameter of the usual sections 16 and 22 of the flow conductor above and below the unit. The passage of tools and the flow of fluids through the multiple stage unit in either direction is therefore not substantially impeded or obstructed in any manner by the connection of the cementing unit to the flow conductor to form a section thereof.

The lower or opening sleeve valve 30 and the upper or closing sleeve valve 39 are now releasably held in their upper positions illustrated in FIGURE 1 by the shear pins 31 and 45, respectively, and the sealing means 33 and 34 seal between the lower sleeve valve and the valve housing above and below the lateral ports 36 and thus prevent any flow of fluids between the interior and exterior of the flow conductor.

In accordance with the usual practice, mud is then circulated down through the flow conductor and out the open lower end thereof and upwardly in the well about the flow conductor. The first stage of cement slurry is then pumped downwardly through the flow conductor and is followed by the top plug 65 to which the opening seat 60 is detachably secured. When the top plug 65 passes through the cementing unit and through the lower sleeve valve 30, the downwardly facing external shoulder 72 of the opening seat engages the upwardly facing shoulder 53 of the lower sleeve valve. Since the shear pin 67 has less shear strength than the shear pin 31, the pressure of the fluid being pumped downwardly behind the top plug 65 causes the shear pin 67 to shear, leaving the lower sleeve valve in its upper position and freeing the top plug for further movement downwardly through the flow conductor until it reaches the seat ring and there defines the upper limit of the first stage of cement slurry. The opening seat is then seated in the lower sleeve valve in the position illustrated in FIGURE 2.

The opening seat has a substantially smaller internal diameter than the lower sleeve so that the annular shoulder or seat 80 at its upper end projects a substantial distance into the bore of the flow conductor. The opening bomb 82 is then dropped into the well flow conductor, falling freely therethrough since the maximum external diameter thereof is considerably smaller than the internal diameter of the well flow conductor. When the lower tubular guide portion 85 of the opening bomb enters into the bore of the opening seat, the outwardly projecting latch ring 90 is cammed inwardly into the external recess of the guide portion by its engagement with the beveled shoulder 80 at the upper end of the opening seat, the bomb moving on downwardly until its downwardly facing seat or shoulder 83 engages the shoulder 80 to provide a fluid tight seal therewith closing the bore of said opening seat to downward flow of fluid therethrough.

Downwardly acting fluid pressure applied through the flow conductor, now acts upon the full cross sectional area of the lower sleeve valve, since its bore is now closed against the flow of fluid therethrough by the fluid-tight engagement of the opening bomb with the opening seat and of the opening seat with the lower sleeve valve, and such fluid pressure will shear the pin 31 holding the lower sleeve valve in its upper position. The fluid pressure will then move the assembly of the lower sleeve, the opening seat and the opening bomb to the lower position illustrated in FIGURE 3, wherein further downward movement of this assembly is limited by the engagement of the lower end of the lower sleeve valve with the upper end of the valve housing extension.

As the lower valve sleeve is now in its lower position, the ports 36 are open to provide a path of communication between the interior of the flow conductor above the lower sleeve valve and the exterior of the flow conductor, so that a second stage or charge of cement slurry may be introduced into the upper end of the flow conductor and pumped downwardly to be discharged through the lateral ports 36 to the exterior of the flow conductor. The assembly of the lower sleeve valve, the opening seat and the opening bomb closes the lower end of the valve housing so that the cement slurry cannot flow down through the lower end of the valve housing. The second stage of cement slurry is followed by the closing plug 101 whose flow passage or bore 105 is closed by the plug valve 108. The packing or sealing elements 122a and 123a of the closing plug contact the internal surfaces of the flow conductor as the plug is pumped downwardly through the flow conductor insuring that the cement slurry is moved ahead of the closing plug.

The closing plug moves downwardly in the flow conductor until its lower reduced end portion 100 telescopes into the upper tubular extension 95 of the opening bomb 82, the snap or latch ring 104 being cammed inwardly by the engagement thereof with the downwardly and in-

wardly extending shoulder 102 at the upper end of the upper tubular extension of the opening bomb until said ring passes below the internal flange 96. The latch ring resiliently returns to its outwardly projecting position after it passes beneath the lower shoulder 97 of the internal flange. As the closing plug moves downwardly into the multiple stage cementing unit 10, the sealing elements 122a and 123a move into sealing engagement with the sealing surface 54 of the upper sleeve valve to close off further fluid flow therethrough. The upper sleeve remains in its upper position in the valve housing, illustrated in FIGURES 1, 2 and 3, as the closing plug moves to the lowermost position in the valve housing wherein its further downward movement is arrested by the engagement of its external annular shoulder 103 with the upwardly facing internal shoulder 102 of the upper tubular extension of the opening bomb. As the lower reduced end of the closing plug enters into the upper tubular extension of the opening bomb, any fluid, such as cement slurry, which is in the tubular extension may escape through the ports 98 of the upper tubular extension of the bomb thereby facilitating movement of the closing plug into its lowermost position.

Downwardly acting fluid pressure then applied through the flow conductor acts across the cross sectional area of the upper sleeve valve to shear the shear pin 40 and move the upper sleeve valve downwardly between the closing plug and the valve housing to its lower closed position illustrated in FIGURE 4. The reduced lower end portion 38 of the upper sleeve telescopes into the upper end portion of the lower sleeve and the O-rings or sealing elements 49 seal between the two sleeve valves below the lateral ports 36. Since the O-rings 33 and 34 of the lower sleeve valve now seal between the valve housing and the lower sleeve valve below the ports 36, and since the O-rings 48 of the upper sleeve valve seal between the valve bearing and the upper sleeve valve above the ports 36, the lateral ports are now sealed off or placed out of communication with the internal flow passage or bore of the flow conductor. As the upper sleeve valve moves downwardly to its closed position, one or more of the lock rings 43 move outwardly into the lock recess 45 of the valve housing for engagement with the downwardly facing shoulder 47 of the valve housing to lock the upper sleeve valve and the lower sleeve valve in their lower port closing positions. Upward movement of the lower sleeve valve is limited by the engagement of its upper end with the downwardly facing shoulder 50 of the upper sleeve valve.

When the cementing operation is thus completed and the lateral ports 36 are closed, the assembly of the activating devices for moving the sleeve valves individually in the valve housing may be retrieved upwardly through the flow conductor to open the flow passage of the flow conductor through the cementing device and leave the same unobstructed. A retrieving tool 120 is lowered by means of the flexible line mechanism until its lower end telescopes into the upper end of the closing plug. The beveled shoulder 118 at the upper end of the closing plug cams the external latch ring 140 inwardly in the external recess in which the same is mounted on the retrieving tool thereof to permit entry of the latch ring and the lower end of the retrieving tool downwardly into the bore 105 of the closing plug, such downward movement continuing until the external latch ring moves below the internal flange 116 of the closing plug. The tubular lower end of the retrieving tool also telescopes over the tubular extension 114 of the plug valve 108, the shoulder 131 at the lower end of the bore of the retrieving tool camming the latch ring 115 on the plug valve inwardly to permit the upwardly facing internal shoulder 134 in the lower end of the bore of the retrieving tool to move downwardly below the latch ring.

An upward force or jars imparted to the retrieving tool by means of the usual set of flexible line tools will now

first cause the shear pins 112 securing the plug valve to the closing plug to shear and free the plug valve for upward movement in the closing plug due to the engagement of the upwardly facing shoulder 134 of the retrieving tool with the latch ring 115 of the plug valve. Movement of the valve plug upwardly through a short distance moves its O-ring or seal means 111 out of engagement with the seal surface 110 in the bore of the closing plug so that fluid may flow downwardly past the plug valve to facilitate upward movement of the latter in the closing plug. The lateral ports 114 and 126 of the plug valve and of the retrieving tool then permit flow of fluids from the bore or flow passage of the flow conductor above the upper sleeve valve through the lateral port 125 of the retrieving tool and its bore 124 to the bore of the closing plug.

As the retrieving tool moves upwardly to the position illustrated in FIGURE 5, the external latch ring 140 thereon engages the downwardly facing shoulder 117 at the upper end of the closing plug, whereupon further upward movement of the retrieving tool lifts said closing plug and moves the reduced lower end portion 100 of the same upwardly in the upper tubular extension 95 of the opening bomb until the latch ring 101 on the exterior of the closing plug engages the downwardly facing shoulder 97 in the bore of such upper tubular extension. Further upward movement of the retrieving tool now also moves the opening bomb upwardly relative to the opening seat 60 until the external latch ring 90 of the lower guide portion or extension 85 of the opening bomb engages the downwardly facing internal shoulder 75 at the lower end of the opening seat. At this time the lateral port 88 of the guide extension is disposed above the upper end of the opening seat, and, as a result, fluids may pass readily through the assembly of the retrieving tool, the plug valve, the closing plug, the opening bomb and the opening seat to facilitate passage of this assembly through the flow conductor. Fluids may flow through the port 125, the bore 124 and the lateral port 126 of the retrieving tool, the lateral port 114 of the tubular extension of the valve plug, the tubular flow passage 105 of the closing plug, the lateral port 98 of the upper tubular extension 95 of the opening bomb, and externally thereof to the lateral port 88 of the guide, then inwardly thereof and downwardly through the bore 89 of such guide extension. Thus a flow course is provided past the sealing elements 122 and 123 of the closing plug to minimize any swabbing action due to the engagement of these sealing elements with the internal surfaces of the flow conductor during upward movement of the closing plug therethrough. Fluid flow through the lateral port 88 and the bore 89 of the guide extension past the opening seat also facilitates removal of assembly since the clearance between the opening seat and the internal surfaces of the sections of the flow conductor is relatively small.

The assembly of the devices for moving the valve sleeves sequentially to their lower positions may thus be removed by a single trip of the retrieving tool into the flow conductor. When these devices are removed, the multiple stage cementing unit has an open unobstructed bore for the passage of fluids and well tools therethrough.

It is now be seen that a new and improved multiple stage cementing unit has been illustrated and described wherein the internal diameter of the sleeve valves is only slightly smaller than the internal diameter of the flow conductor above and below the unit so that the usual well tools may freely pass in both directions through the multiple stage cementing unit as required during operation of the well.

It will further be seen that the devices used to sequentially move the sleeve valves of the cementing unit to their lower positions during a cementing operation are retrievable with a single trip of a retrieving tool, thus obviating any drilling out operations.

It will also be seen that the number of pump down

operations necessary to operate the sleeve valves is reduced to a minimum by the detachable connection of the opening seat to the upper plug of a prior cementing stage, the opening seat providing an inwardly extending or projecting shoulder in the flow passage of the flow conductor to engage and provide a stop for an opening bomb of relatively small outer diameter which may be then dropped into the well flow conductor without any pump down operation.

It will likewise be seen that the retrieving tool and the various sleeve valve operating devices introduced into the flow passage conductor are provided with flow passages and ports which permit the movement of fluid past these devices as they are moved upwardly as an assembly through the flow conductor upon the completion of the cementing operation.

It believed readily apparent that while the flow conductor has been illustrated in FIGURE 1 as a well casing positioned in a well, the multiple stage cementing unit 10 may also be connected in a tubing string to permit cementing of the tubing in other tubular members such as a well casing.

In FIGURE 7 is illustrated a modified form of the devices for sequentially operating the valve sleeves in the valve housing 13. The tubular opening seat 150 has an external downwardly facing shoulder 151 which is engageable with the upwardly facing shoulder 53 of the lower valve sleeve to provide a fluid-tight seal therebetween. The lower end of the opening seat has an internal annular recess which provides a downwardly facing annular latch shoulder 153. A closure plug 155 is releasably secured in the opening seat by a shear pin 156 which extends through a lateral aperture in the opening seat into a suitable lateral external opening in the plug. The plug is provided above the shear pin with an external annular recess in which is disposed an O-ring or other suitable sealing means 158 for sealing between the plug and the opening seat.

The closing plug 160 is also tubular in form and has its lower end closed by a closure plug 161 releasably secured thereto by a shear pin 163 extending inwardly through a lateral aperture in the closing plug into a suitable external lateral opening in the closure plug. The closure plug 161 is provided with an external annular recess in which is disposed an O-ring 164 or other suitable sealing means for sealing between the closure plug and the closing plug. The closing plug has external sealing or packing means 170 and 171 mounted in a pair of longitudinally spaced external annular recesses on said plug. Downward movement of the closing plug in the valve housing is limited by the engagement of its lower end with the upper end of the opening seat.

When it is desired to operate the multiple stage cementing unit, the opening seat 150 with the closure plug 155 secured therein is forced downwardly through the flow conductor 11 by means of a flexible line mechanism including weights or jars suspended on a flexible line until the lower end portion of the opening seat moves into the lower valve sleeve releasably held in its upper position by the shear pin 31, until the downwardly facing shoulder 151 of the opening seat engages the upwardly facing shoulder 53 of the lower sleeve. Since the flow conductor is filled with liquid and the clearance between the outer surface of the opening seat and the internal surfaces of the flow conductor is small, it is desirable to force the opening seat 150 down by the use of such flexible line mechanism. When the shoulder of the opening seat is engaged with the shoulder 53 of the lower sleeve valve, their engagement forms a fluid-tight seal which prevents flow of fluid downwardly past the opening seat. Jars are then imparted to the upper end of the opening seat to cause the shear pin 31 to be sheared and the opening or lower sleeve valve to be moved to its lower open position illustrated in FIGURE 7.

The flexible line and the tools attached thereto are

then removed from the well and the stage or charge of cement slurry is pumped downwardly in the flow conductor and out through the lateral ports 36 of the valve housing. The closing plug 160 of course follows such stage or charge of cement and is pumped downwardly therewith in the same manner as was the closing plug of the form first described, and the sealing elements 170 and 171 of the closing plug engage the internal surfaces of the flow conductor during such downwardly movement through the flow conductor to move the charge or stage of cement downwardly therethrough.

At this time the upper valve sleeve is of course still in its upper position, being releasably held therein by the shear pin 40. As the closing plug moves downwardly through the upper valve sleeve, its downward movement is stopped by the engagement of its lower end with the upper end of the opening seat. The sealing elements 170 and 171 on the closing plug engage the sealing surface 54 in the bore of the upper sleeve valve and seal therebetween. Fluid pressure is then introduced into the flow conductor to act downwardly on the cross sectional area of the upper end of the upper sleeve valve and will move the valve downwardly, shearing the pin 40 to permit such downward movement of the upper sleeve valve.

One or more of the lock rings 43 of the upper sleeve valve enter into the lock recess 45 of the valve housing to engage the downwardly facing annular lock shoulder 47 therein to lock the upper sleeve valve in its lower position against upward movement in the valve housing. The seal means or O-rings 49 on the lower reduced end portion 38 of the upper sleeve valve then engage the lower sleeve valve to seal off the ports 36 from the interior of the flow conductor, and to prevent flow of fluids in either direction through said ports.

The actuating devices comprising the opening seat 150 and the closing plug 160 may then be removed from the flow conductor by means of a retrieving tool 180 which is connected to a flexible line through the connector sub 181 and the usual set of flexible line tools which may include weights or jars. The retrieving tool 180 includes an upper member having a threaded pin 182 at its upper end which is threaded into the conductor sub 181, and has a longitudinal downwardly opening bore 184 and a lateral port 185 communicating therewith. A tubular sub 186 is threaded into the lower end of the tubular member 183 and has an external annular recess in which is disposed a snap or latch ring 187 which projects resiliently outwardly of the outer surface of the sub.

When the retrieving tool is lowered through the flow conductor, it telescopes into the open upper end of the closing plug 160, the inwardly and downwardly extending cam shoulder 189 at the upper end of the closing plug camming the latch ring 187 inwardly to permit such downward movement of the retrieving tool into and through the closing plug. When the lower end of the sub 186 engages the closure plug 161, downward jars are imparted to the closure plug through the retrieving tool by means of the flexible line tool to shear the pin 163 and move the closure plug 161 downwardly through the bore of the opening seat 150 therebelow. When downward movement of the closure plug 161 is stopped by the engagement of its lower end with the upper end of the closure plug 155 of the opening seat, further downward jars are imparted to the closure plug 155 through the retrieving tool to shear the pin 156 and move both closure plugs downwardly out of the cementing unit to fall to the bottom of the flow conductor. The retrieving tool is moved further downwardly until the latch ring 187 moves below the downwardly facing latch shoulder 153 of the lower end of the opening seat. The engagement of the latch ring 187 with this latch seat upon subsequent upward movement of the retrieving tool now causes both the opening seat and the closing plug to move upwardly as a unit with the retrieving tool for removal from the flow conductor.

Since the closure plugs do not now close the ends or the tubular opening seat and the tubular closing plug, fluid may flow through the lateral port 185 of the tubular member 183 of the retrieving tool, the bore 184 of the tubular member of the retrieving tool, the bore or passage 190 of the lower sub of the retrieving tool and through the bores or passages 191 and 192 of the closing plug and the opening seat, respectively, to facilitate upward movement of the assembly of the retrieving tool and the actuating devices through the flow conductor and to minimize any swabbing action in the flow conductor due to the engagement of the sealing elements 170 and 171 with the internal surfaces of such flow conductor.

It will now be seen that in both forms of the actuating devices for the multiple stage cementing unit having upper and lower sleeve valves, the actuating devices may be removed as a unit from the cementing unit upon the completion of the cementing operation with a single trip of the retrieving tool.

It will also be seen that both forms of the actuating devices for the sleeve valves of a cementing unit are so designed that the internal diameter of the sleeve valves is only slightly smaller than the internal diameter of the flow conductor above and below the unit whereby the usual well tools may freely pass in both directions through the cementing unit as required during operation of the well, and so that the flow of fluids through the flow conductor is not unduly hindered by the inclusion of the multiple stage cementing unit in the flow conductor as a section thereof.

The foregoing description of the invention is explanatory only, and changes in the details of the constructions illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In combination: a cementing device including a housing having a longitudinal flow passage and a lateral port formed therein communicating with said flow passage; first and second valve means for opening and closing said lateral port and each having a bore communicating with said flow passage of said housing, said first valve means initially closing said lateral port; first actuating means insertable in one direction into said housing and engageable with said first valve means to close the bore of said first valve means whereby fluid pressure introduced into said flow passage of said housing is effective to move said first valve means to open said lateral port of said housing; second actuating means insertable in said one direction in said housing to engage and be supported by said first actuating means and slidably engageable with said second valve means to close said bore of said second valve means whereby fluid pressure introduced into said flow passage of said housing is effective to move said second valve means to close said lateral port of said housing; means on said first actuating means and said second actuating means coengageable upon movement of said second actuating means in a direction opposite said one direction for limiting longitudinal movement of said second actuating means relative to said first actuating means; and means on said second actuating means engageable by a removing means whereby both said actuating means may be removed simultaneously from said housing.

2. A method of cementing a well having a flow conductor therein, said flow conductor having a longitudinal flow passage and a lateral flow port for providing communication between the flow passage and the exterior of the flow conductor, said flow conductor having a lower sleeve valve initially closing said lateral port and an upper sleeve valve spaced thereabove and movable downwardly to subsequently close said lateral port, said method including: injecting a first cement slurry downwardly through said flow conductor; defining the upper limit of

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said first cement slurry; closing the flow conductor at a point spaced below said lateral port by first closure means introduced into the flow conductor following said first cement slurry; moving said lower sleeve valve downwardly to open said lateral port to provide a flow course from the flow passage of said flow conductor to the exterior thereof at a point spaced above said first cement slurry; injecting a second cement slurry into said conductor and forcing the same downwardly therein and outwardly therefrom through said lateral port into the well exteriorly of said conductor; closing the flow conductor in said upper sleeve valve at a point spaced above said lateral port by second closure means introduced into the flow conductor following said second cement slurry; moving said upper sleeve valve downwardly to close said lateral port; and lifting both said closure means simultaneously from the conductor to the surface of the well to open the flow passage of said conductor below said lateral port for flow therethrough past said closed lateral port and said point spaced above said first cement slurry.

3. A cementing device including: a housing having a longitudinal flow passage therethrough adapted to be connected in a well conductor to form a part thereof and having means therein providing a lateral port from the interior to the exterior of said housing at a point intermediate the ends thereof; first valve means in said cementing device housing having a flow passage communicating with the interior of said conductor and initially closing said lateral port; first actuating means insertable in said conductor engageable with said first valve means for closing said flow passage of said first valve means whereby the fluid pressure introduced into the interior of said conductor is effective to move said first valve means in one direction in said cementing device housing to open said lateral port; second valve means in said cementing device housing having a flow passage communicating with the interior of said conductor and being movable therein to a position closing said lateral port; second actuating means insertable through said conductor into said cementing device housing to be supported by said first actuating means and having seal means thereon engageable with said second valve means to close said flow passage of said second valve means whereby fluid pressure introduced into the interior of said conductor is effective to move said second valve means to a position closing said lateral port; and means on said first and second actuating means coengageable upon movement of said actuating means in a direction opposite to said one direction to remove said first and second actuating means from said cementing device simultaneously as a unit.

4. A method of cementing a well having a flow conductor therein, the flow conductor having a flow passage and an initially closed lateral port for providing communication between the flow passage and the exterior of the flow conductor, including: injecting a first cement slurry downwardly through said flow conductor; defining the upper limit of said first cement slurry; closing the flow passage of the flow conductor at a point spaced below said lateral port by first closure means introduced into the flow conductor and following said first cement slurry in said well conductor and opening said lateral port to provide a flow course from the flow passage of said flow conductor to the exterior thereof at a point spaced above the first cement slurry; injecting a second cement slurry into said conductor and forcing the same downwardly therein and outwardly therefrom through said lateral port into the well; closing the flow passage of the flow conductor at a point spaced above said lateral port by second closure means introduced into the flow conductor and following said second slurry; closing said lateral port; lifting both said closure means simultaneously in an unfragmented condition from within the flow conductor to the surface of the well to open the flow passage of said conductor for flow therethrough past

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said lateral port and said point spaced above the first cement slurry.

5. An actuating apparatus for use with a cementing unit having a housing connectable in a flow conductor and having a lateral port affording communication between the interior and the exterior of the housing, a lower sleeve valve having an upwardly facing shoulder initially releasably secured in an upper position in the housing and closing the lateral port and an upper sleeve valve initially releasably held in an upper position and movable downwardly in the housing to close said port after said port has been opened by downward movement of the lower sleeve valve from its upper position in the housing including: an opening seat movable downwardly through the flow conductor to engage the upwardly facing shoulder of the lower sleeve valve, said opening seat having an upwardly facing shoulder having a smaller internal diameter than the diameter of the upwardly facing shoulder of the lower sleeve valve means for inserting said opening seat in said lower sleeve on said shoulder in said lower sleeve; an opening bomb for closing the bore of said lower sleeve valve movable downwardly through the casing and having means engageable with the shoulder of said opening seat to limit movement of said opening bomb relative to said opening seat to close the bore of said lower sleeve valve whereby fluid pressure is effective to move said lower sleeve valve downwardly to open said port of said housing; and a closing plug movable downwardly into the housing and said upper sleeve valve to engage the opening bomb to be supported thereby, said closing plug having means slidably sealingly engaging the bore wall of said upper sleeve valve to close the bore of said upper sleeve valve whereby downwardly acting fluid pressure acting on the upper sleeve valve is effective to move said upper sleeve valve slidably downwardly in said housing between said closure plug and said housing to close said port of said housing.

6. An actuating apparatus for use with a cementing unit having a housing connectable in a flow conductor and having a lateral port affording communication between the interior and the exterior of the housing, a lower sleeve valve having an upwardly facing shoulder initially releasably secured in an upper position in the housing and closing the port and an upper sleeve valve initially releasably held in an upper position and movable downwardly in the housing to close said port after said port has been opened by downward movement of the lower sleeve valve from its upper position in the housing including: an opening seat movable downwardly through the flow conductor to engage the upwardly facing shoulder of the lower sleeve valve, said opening seat having an upwardly facing shoulder of smaller internal diameter than the internal diameter of the upwardly facing shoulder of the lower sleeve valve; an opening bomb movable downwardly through the casing and having means engageable with the shoulder of said opening seat to limit movement of said opening bomb relative to said opening seat and to close the bore of said lower sleeve valve whereby fluid pressure is effective to move said lower sleeve valve downwardly to open said port of said housing; and a closing plug movable downwardly into the housing to engage and be supported by said opening bomb and having sealing means thereon engageable with the bore wall of said upper sleeve valve to close the bore of said upper sleeve valve whereby downwardly acting fluid pressure acting on the upper sleeve valve is effective to move said upper sleeve valve downwardly in said housing to close said port of said housing, said opening seat and said bomb having coengageable means and said bomb and said closing plug having coengageable means limiting upward longitudinal movement thereof relative to one another whereby said actuating apparatus may be removed upwardly as a unit from the flow conductor.

7. An actuating apparatus for sequentially moving lower and upper sleeve valves in the housing of a cement-

ing unit for opening and closing a lateral port of the housing including: first means movable through said housing to engage said lower sleeve valve to close to bore thereof whereby fluid pressure introduced into the housing is effective to move it downwardly in the housing to open said port; second means movable through said housing and into said upper sleeve valve to be supported by said first means and having seal means thereon engaging the bore wall of said upper sleeve valve to close said upper sleeve valve whereby downwardly acting fluid pressure acting on the upper sleeve valve is effective to move said upper sleeve valve downwardly in said housing to close said port; said first and second means having means coengageable upon upward movement of one of said means relative to the other whereby said first and second means may be lifted together to be removed from said housing as a unit.

8. An actuating apparatus for sequentially moving lower and upper sleeve valves in the housing of a cementing unit for opening and closing a lateral port of the housing including: first means movable through said housing to engage said lower sleeve valve to close said lower sleeve valve whereby downwardly acting fluid pressure acting on the upper sleeve valve is effective to move it downwardly in the housing to open said port; second means movable through said housing and into said upper sleeve valve to be supported by said first means and having seal means thereon engaging the bore wall of said upper sleeve valve to close said upper sleeve valve whereby downwardly acting fluid pressure acting on the upper sleeve valve is effective to move said upper sleeve valve downwardly in said housing to close said port; said first and second means having means coengageable upon upward movement of said first means relative to said second means whereby said first and second means may be lifted together to be removed from said housing as a unit, said first and second means being tubular and having plugs releasably secured thereto to close the bores of said first and second means; and a retrieving tool movable into said housing and through said first and second means for ejecting said plugs downwardly from said first and second means to permit passage of said retrieving tool therethrough, said retrieving tool having extendable means engageable with said first means upon upward movement of the retrieving tool relative thereto after said retrieving tool has ejected the plugs out of said first and second means whereby said retrieving tool and said first and second means are movable upwardly out of the housing as a unit.

9. An actuating apparatus for sequentially moving a lower sleeve valve and an upper sleeve valve in a housing of a cementing unit for opening and then closing a lateral port of said housing, said sleeve valves having longitudinally aligned passages including: a first actuating device movable through said housing and through the longitudinally aligned passages of said sleeve valves, said first actuating device having means engageable with upwardly facing seat means of the lower sleeve valve, said first actuating device having a flow passage communicating with said flow passages of said sleeve valves when in position in said lower sleeve valve; a second actuating device movable downwardly through said housing and through said passages of said sleeve valves and said first actuating device, said second actuating device and said first actuating device having coengageable means for limiting downward movement of said second actuating device relative to said first actuating device and for closing said flow passage of said first actuating device whereby fluid pressure acting downwardly through said flow passages of said sleeve valves is effective to move said lower sleeve valve in said housing to open said port of said housing; and a third actuating device movable downwardly through said housing into said flow passage of said upper sleeve valve and engageable with said second actuating device to be supported thereby and having seal means thereon engaging the bore wall of said upper sleeve valve to close said

flow passage of said upper sleeve valve whereby fluid pressure acting downwardly in said housing is rendered effective to move said upper sleeve valve downwardly in said housing to close said port of said housing.

10. An actuating apparatus for sequentially moving a lower sleeve valve and an upper sleeve valve in a housing of a cementing unit for opening and then closing a lateral port of said housing, said sleeve valves having longitudinally aligned passages including: a first actuating device movable through said housing and through the longitudinally aligned passages of said sleeve valves, said first actuating device having means engageable with upwardly facing seat means of the lower sleeve valve, said first actuating device having a flow passage communicating with said flow passages of said sleeve valves when in position in said lower sleeve valve; a second actuating device movable downwardly through said housing and through said passages of said sleeve valves and said first actuating device, said second actuating device and said first actuating device having coengageable means for limiting downward movement of said second actuating device relative to said first actuating device and for closing said flow passage of said first actuating device whereby fluid pressure acting downwardly through said flow passages of said sleeve valves is effective to move said lower sleeve valve in said housing to open said port of said housing; and a third actuating device movable downwardly through said housing into said flow passage of said upper sleeve valve and engageable with said second actuating device to be supported thereby and having seal means thereon engaging the bore wall of said upper sleeve valve to close said flow passage of said upper sleeve valve whereby fluid pressure acting downwardly in said housing is rendered effective to move said upper sleeve valve downwardly in said housing to close said port of said housing, said second and third actuating devices having coengageable means limiting downward movement of said third actuating device in said housing.

11. An actuating apparatus for sequentially moving a lower sleeve valve and an upper sleeve valve in a housing of a cementing unit for opening and then closing a lateral port of said housing, said sleeve valves having longitudinally aligned passages including: a first actuating device movable through said housing and through the longitudinally aligned passages of said sleeve valves, said first actuating device having means engageable with upwardly facing seat means of the lower sleeve valve, said first actuating device having a flow passage communicating with said flow passages of said sleeve valves when in position in said lower sleeve valve; a second actuating device movable downwardly through said housing and through said passages of said sleeve valves and said first actuating device, said second actuating device and said first actuating device having coengageable means for limiting downward movement of said second actuating device relative to said first actuating device and for closing said flow passage of said first actuating device whereby fluid pressure acting downwardly through said flow passages of said sleeve valves is effective to move said lower sleeve valve in said housing to open said port of said housing; and a third actuating device movable downwardly through said housing into said flow passage of said upper sleeve valve, said second actuating device and said third actuating device having coengageable means limiting downward movement of said third actuating device in said housing and supporting the same therein, said third actuating device having seal means thereon engageable with the bore wall of said upper sleeve valve to close said flow passage of said upper sleeve valve whereby fluid pressure acting downwardly in said housing is rendered effective to move said second sleeve valve downwardly in said housing to close said port of said housing, said actuating devices having means coengageable with one another upon upward movement of said third device relative to said second device

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and of said second device relative to said first device whereby upward movement imparted to said third device causes removal of said actuating devices as a unit from the housing.

12. An actuating apparatus for sequentially moving a lower sleeve valve and an upper sleeve valve in a housing of a cementing unit for opening and then closing a lateral port of said housing, said sleeve valve having longitudinally aligned passages including: a first actuating device movable through said housing and through the longitudinally aligned passages of said sleeve valves, said first actuating device having means engageable with upwardly facing seat means of the lower sleeve valve, said first actuating device having a flow passage communicating with said flow passages of said sleeve valves when in position in said lower sleeve valve; a second actuating device movable downwardly through said housing and through said passages of said sleeve valves and said first actuating device said second actuating device and said first actuating device having coengageable means for limiting downward movement of said second actuating device downwardly relative to said first actuating device and for closing said flow passage of said first actuating device whereby fluid pressure acting downwardly through said flow passages of said sleeve valves is effective to move said lower sleeve valve in said housing to open said port of said housing; and a third actuating device movable downwardly through said housing into said flow passage of said upper sleeve valve, said second actuating device and said third actuating device having coengageable means limiting downward movement of said third actuating device in said housing and supporting the same, said third actuating device having seal means thereon engageable with the bore wall of said upper sleeve valve to close said flow passage of said upper sleeve valve whereby fluid pressure acting downwardly in said housing is rendered effective to move said second sleeve valve downwardly in said housing to close said port of said housing, said third device having means engageable by a retrieving tool movable into said housing whereby upward movement may be imparted to said third device by said retrieving tool, said actuating devices having means coengageable with one another upon upward movement of said third device relative to said second device and of said second device relative to said first device whereby upward movement imparted to said third device causes removal of said actuating devices as a unit from the housing, said actuating devices having passage means placed in communication with one another upon said upward movement of said third actuating device relative to said second actuating device and of said second actuating device relative to said first actuating device for permitting flow of fluid through said actuating devices and past said sealing means of said third actuating device during upward movement of said actuating devices as a unit through said housing.

13. A cementing device including: a housing having a longitudinal flow passage therethrough and a lateral port; first and second valve means each having a bore communicating with said flow passage of said housing and movable longitudinally in said housing for opening and closing said lateral port, said first valve means initially closing said lateral port; first actuating means insertable into said housing and sealingly engageable with said first valve means to close said bore of said first valve means, whereby fluid pressure introduced into said flow passage of said housing is effective to move said first valve means to open said port; second actuating means insertable in said housing into engagement with said first actuating means to be supported by said first actuating means and slidably sealingly engageable with said second valve means to close said bore of said second valve means whereby fluid pressure introduced into said flow passage of said housing acts on the upper end of said second valve means to move said second valve means to close said lateral port.

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14. A cementing device including: an elongate tubular member adapted to be connected in and form a part of a flow conduit string to be disposed in a well bore, said member having a longitudinal passage therethrough and having a side port communicating between said longitudinal passage and the exterior thereof; a first sleeve valve member in said tubular member and slidable longitudinally therein; seal means on said tubular member on longitudinally opposite sides of said lateral port for sealing between said first sleeve valve member and said tubular member when said sleeve valve member is in a first position in said tubular member to close the side port; said first sleeve valve member being movable longitudinally in said tubular member from a port closing position into a second position out of engagement with one of said sealing means for opening said side port; a second sleeve valve member in said tubular member and slidable longitudinally therein; first seal means on said second sleeve valve member sealing between said second sleeve valve member and said first sleeve valve member when said members are in telescoped position; second seal means on said second sleeve valve member sealing between said second sleeve valve member and said tubular member, said second sleeve valve member when in said second position closing off flow through said side port in said tubular member; releasable means initially retaining said first sleeve valve member in said first port closing position and releasable to permit said first sleeve valve member to move to said second port opening position; releasable means initially retaining said second sleeve valve member in a first position spaced from said side port of said tubular member and releasable to permit said second sleeve valve member to move longitudinally of said tubular member to a second position across said side port and in telescoping sealing relationship to said first sleeve valve member, said second sleeve valve member when moved to said second position closing said side port to flow therethrough; first operating means lowerable through said well flow conduit string and having means engageable with said first sleeve valve member to be supported by said first sleeve valve member to close the bore therethrough whereby fluid pressure introduced into the flow passage of the tubular member thereabove is effective to move said first sleeve valve member to open said side port; and second operating means insertable through said well flow conduit string and having means engageable with said first operating means whereby said second operating means is supported by said first operating means, said second operating means having seal means on its exterior slidably engageable with the bore wall of said second sleeve valve member for sealing therebetween whereby fluid pressure in said conduit string above said second sleeve valve member acts on the upper end of said second sleeve valve member to move said second sleeve valve member slidably longitudinally downwardly between said second operating means and said tubular member from said first position to said second position reclosing said side port.

15. In combination with the cementing device of claim 14, means on said second sleeve valve member and said tubular member coengageable upon movement of said second sleeve valve member to said second position to hold said second sleeve valve member in said second side port closing position.

16. In combination with the device of claim 14, retrieving means lowerable through said conduit string and engageable with one of said first and second operating means for retrieving both said first and second operating means from within the bore of said cementing device.

17. A cementing device of the character set forth in claim 14 wherein: said first sleeve valve member has means providing an upwardly facing stop shoulder in its bore, said shoulder providing means engageable by said first operating means for locating said first and second operating means in said device with respect to said first

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sleeve valve member and said second sleeve valve member.

18. In combination with the cementing device of claim 17, opening seat means lowerable through said conduit string into engagement with said upwardly facing stop shoulder in said first sleeve valve member to provide an inwardly projecting upwardly facing stop shoulder for engagement by closure means adapted to be subsequently introduced into said conduit string for operating said sleeves.

19. A cementing device of the character set forth in claim 17, wherein said first operating means lowerable through said conduit string includes opening seat means engageable with said upwardly facing shoulder of said first sleeve valve member for supporting the same therein and closure means engageable with the opening seat means for closing the passage through said first sleeve valve member, whereby fluid pressure within said conduit string above said cementing device may be used to move said first sleeve valve member from said first position to said second position to open the lateral port of said tubular member.

20. A cementing device of the character set forth in claim 17 wherein: the bores of said first and said second sleeve valve members are substantially equal to and slightly less in diameter than the bore of the flow conduit string in which the device is adapted for use; and wherein the means providing the upwardly facing shoulder in said bore of said first sleeve valve projects slightly into the bore of said sleeve, said shoulder being of a dimension which does not restrict passage of the usual well tools through said sleeve.

21. A cementing device of the character set forth in claim 20, wherein said second operating means lowerable through said conduit string and said first operating means have coengageable shoulder means thereon whereby said second operating means is supported by said first operating means.

22. A cementing device including: a housing having a longitudinal flow passage therethrough and a lateral port; first and second valve means each having a bore communicating with said flow passage of said housing and movable longitudinally in said housing for opening and closing said lateral port, said first valve means initially

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closing said lateral port and said second valve means being spaced from said lateral port; first actuating means insertable into said housing and sealingly engageable with said first valve means to close said bore of said first valve means, whereby fluid pressure introduced into said flow passage of said housing is effective to move said first valve means to open said port; coengageable shoulder means on said first actuating means and said first valve means whereby said first actuating means is supported by said first valve means in bore closing position; second actuating means insertable in said housing and having means engageable with said first actuating means whereby said second actuating means is supported by said first actuating means, said second actuating means having external sealing means thereon slidably sealingly engageable with said second valve means to close said bore of said second valve means whereby fluid pressure introduced into said flow passage of said housing acts on the upper end of said second valve means to move said second valve means to close said lateral port; and means on said first and second actuating means coengageable upon upward movement of said second actuating means relative to said first actuating means whereby said first and second actuating means may be removed from said housing as a unit.

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