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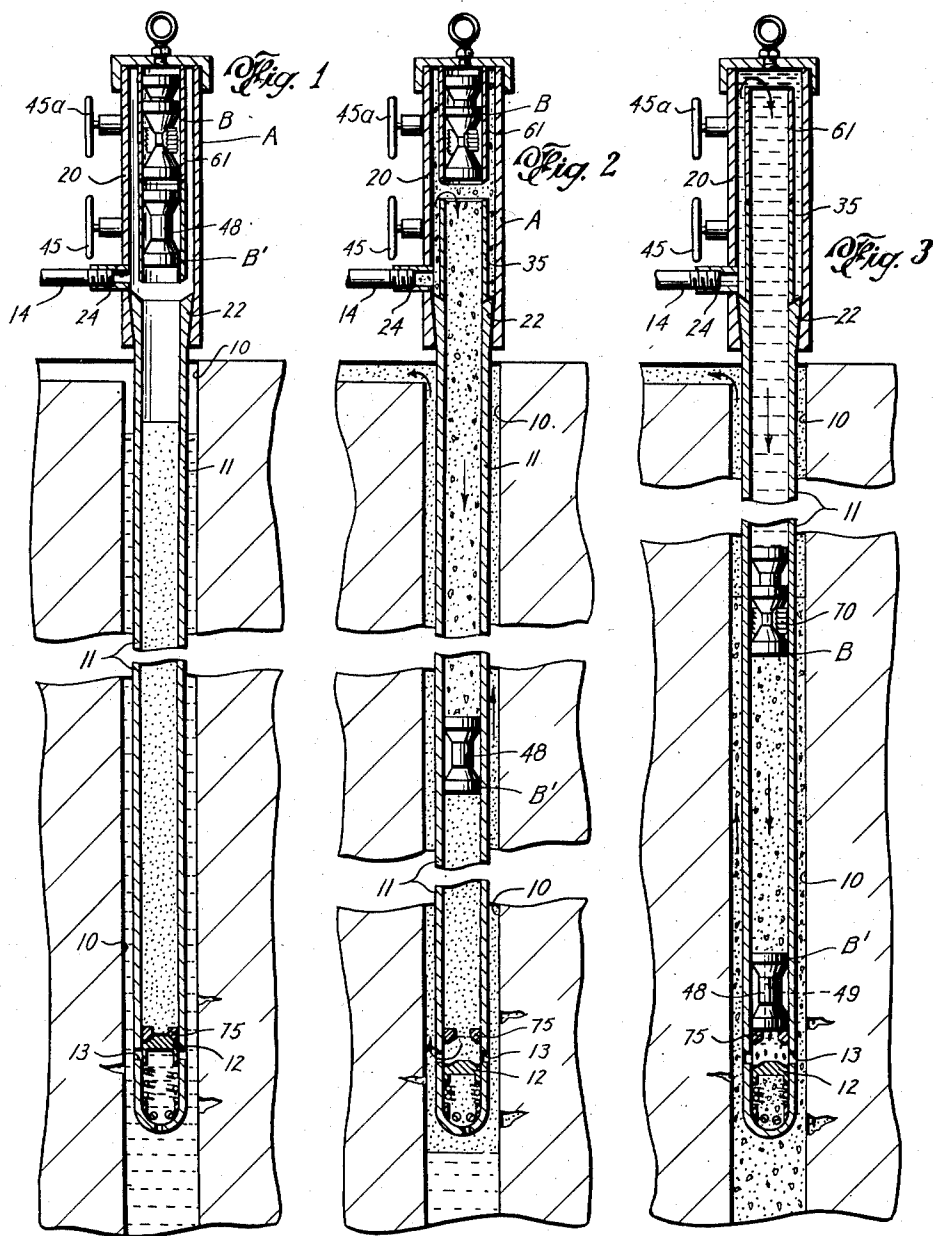
C. C. BROWN

2,630,179

METHOD OF AND APPARATUS FOR CEMENTING WELLS

Filed June 24, 1949

4 Sheets-Sheet 1



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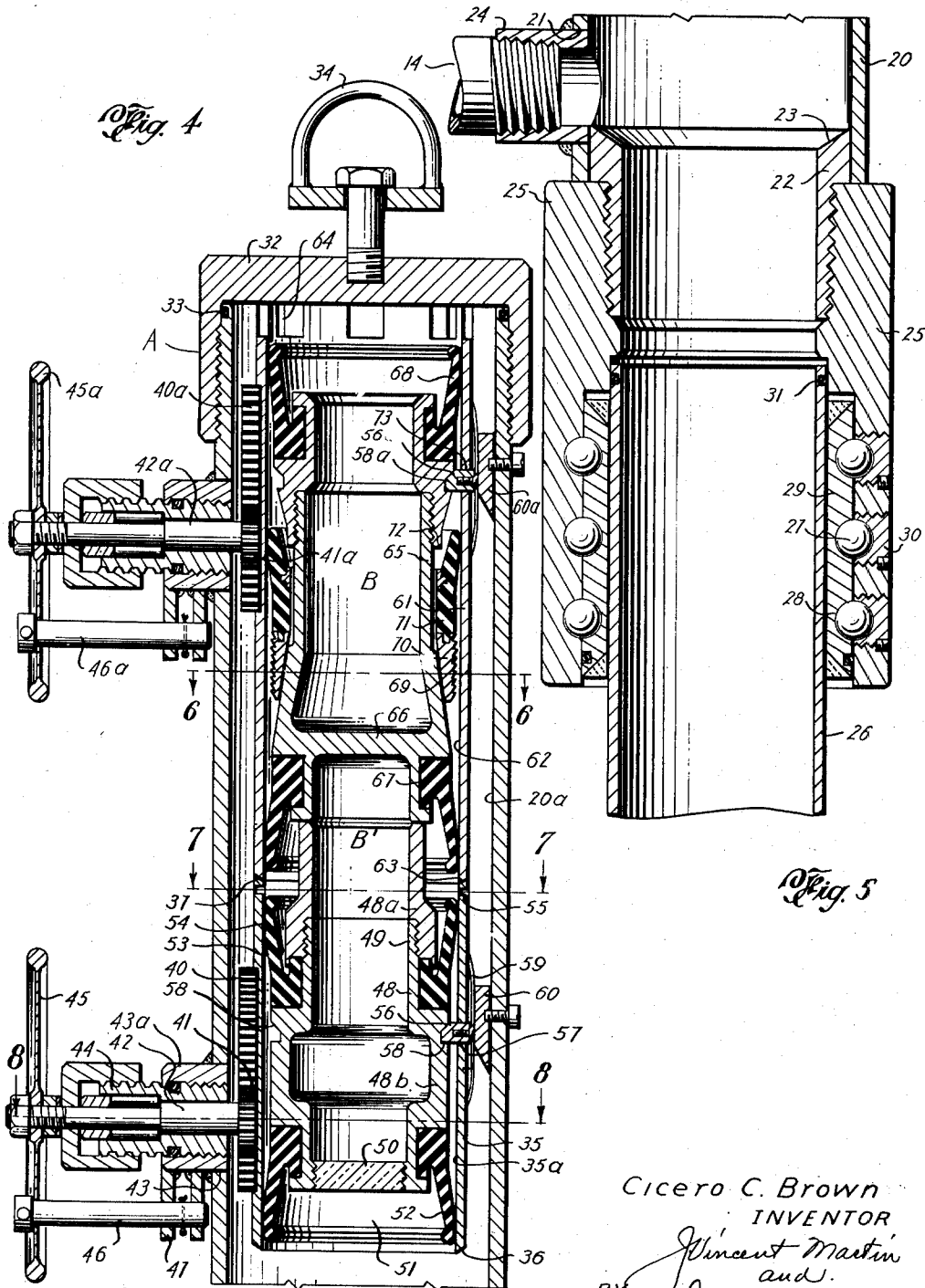
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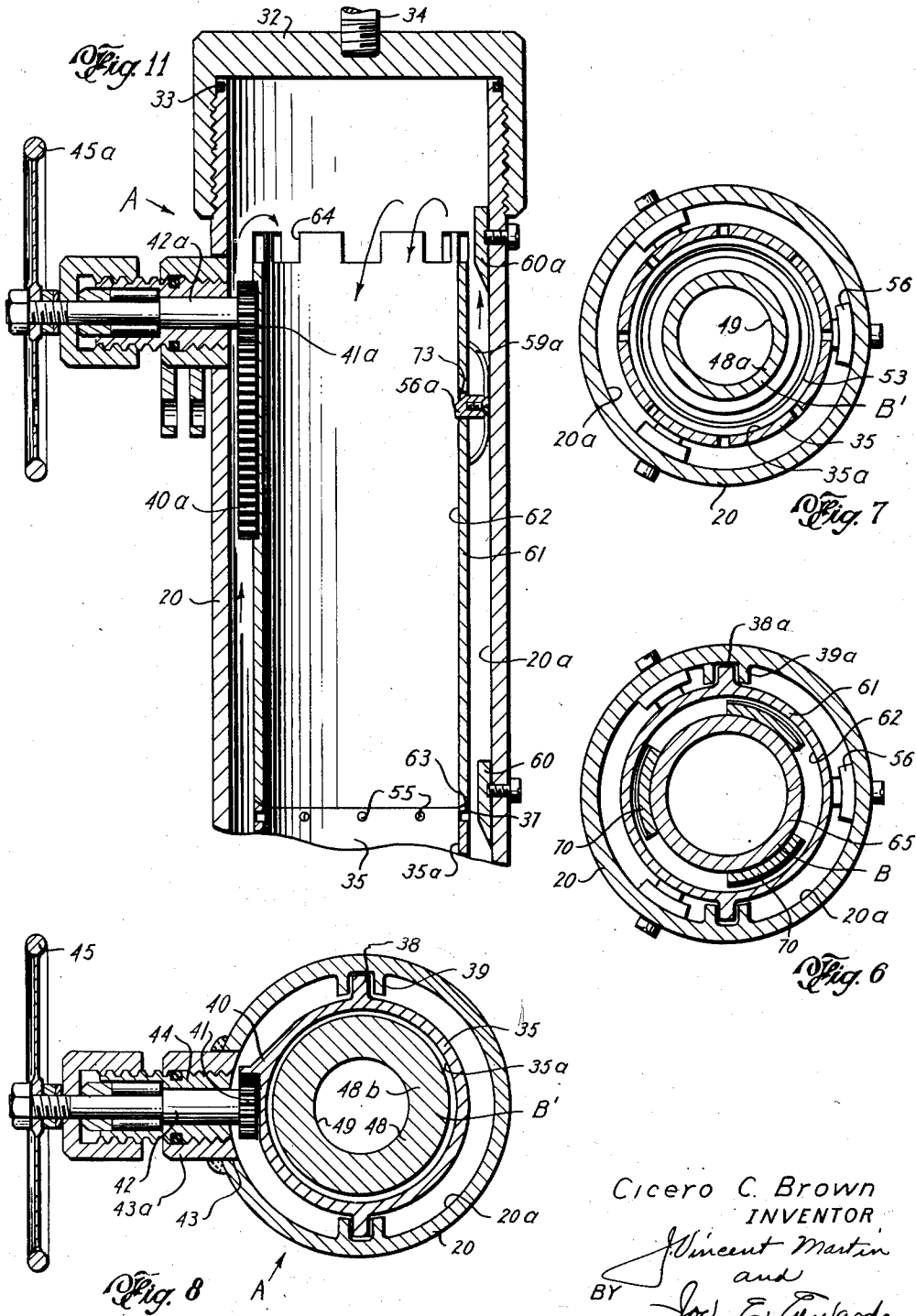
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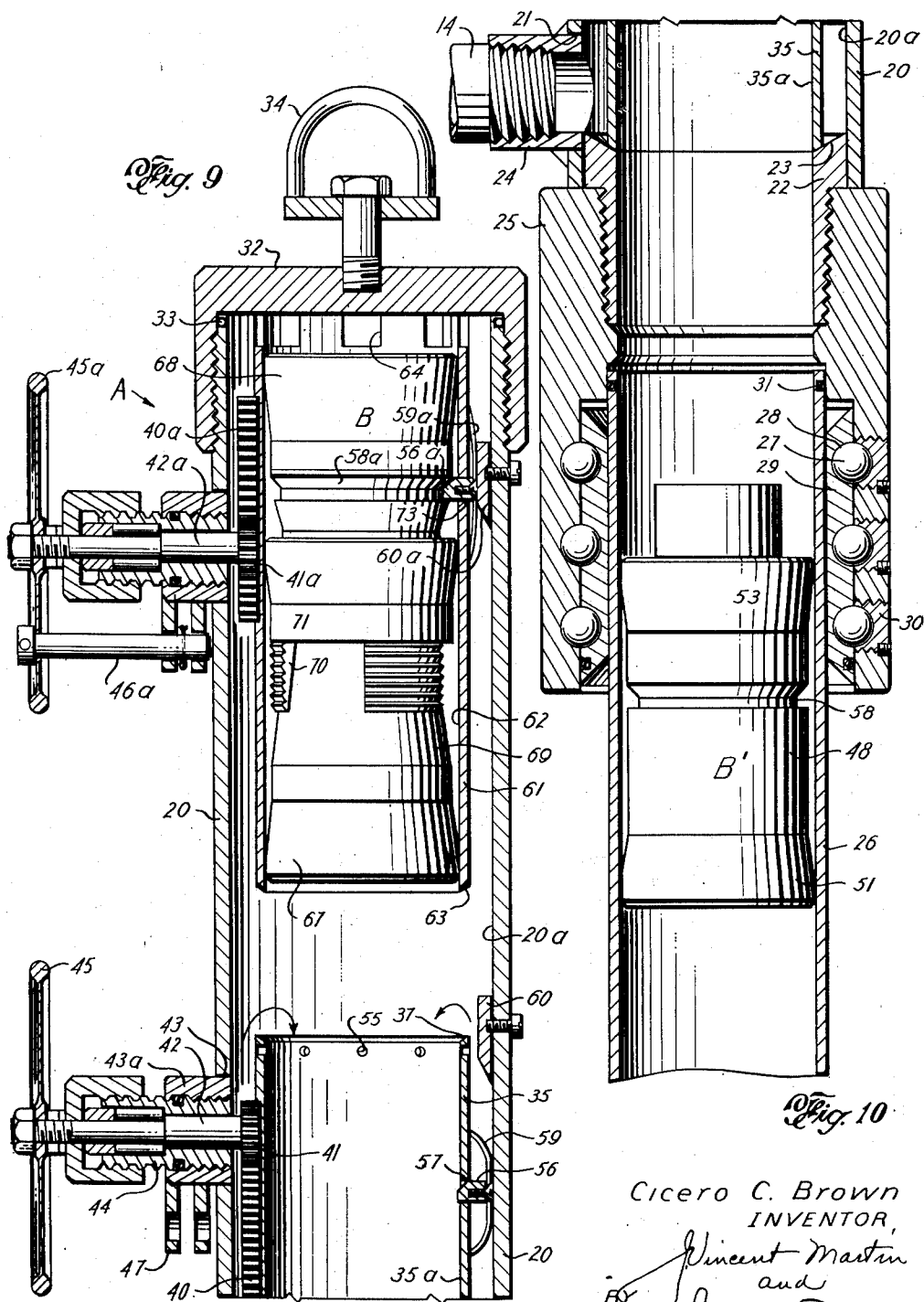
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METHOD OF AND APPARATUS FOR CEMENTING WELLS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR
CEMENTING WELLS

Cicero C. Brown, Houston, Tex.

Application June 24, 1949, Serial No. 101,050

16 Claims. (Cl. 166—14)

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This invention relates to new and useful improvements in methods of and apparatus for cementing wells.

As is well known, the usual cementing operation is carried out by introducing the cement slurry into the upper portion of the well pipe or casing and pumping the same downwardly there-through with the cement being forced outwardly from the pipe or casing through a back-pressure cementing valve at the lower portion of the pipe or in the case of a "squeeze cementing" operation outwardly through perforations in the pipe, or casing wall. The well is filled with fluid or mud and the cement slurry is introduced as by pumping and under the pump pressure forces the fluid outwardly in advance of the cement. After the required amount of cement has been introduced a motivating or driving fluid follows said cement and is pumped behind the cement column to pump said cement downwardly to the point or elevation of its discharge from the well pipe.

In order to separate the cement column from the fluid in advance thereof as well as from the following or motivating fluid behind said column to prevent contamination of the cement column and to allow consolidation thereof, it is desirable to introduce separation plugs in advance of and behind said column. Because the well pipe must be closed during the introduction of the cement under pressure, the introduction of the separation plug elements has presented a problem because obviously, the pumping operation must be interrupted and the system opened to allow insertion of said plugs. Not only is the interruption of the pumping operation undesirable but also accurate determination of the exact time of insertion of the plugs is difficult, with the result that the plug elements may be erroneously placed with respect to the cement column.

In the co-pending application, Serial No. 75,451, filed February 9, 1949, an improved method of and apparatus for introducing the follow-up separation plug element into the well pipe without interrupting the pumping operation is disclosed but such application makes no provision for introducing the lead or advance plug into said pipe.

It is therefore one object of this invention to provide a method of and apparatus for introducing a plurality of separation plugs into a well pipe which method is an improvement on my co-pending application above referred to.

An important object of the invention is to provide an improved well cementing method

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wherein a plurality of separation plugs may be selectively introduced into a well pipe without halting the pumping operation or opening the system, whereby a continuous cementing operation may be carried out.

Another object is to provide an improved continuous cementing method which comprises, starting the pumping operation, inserting a separation plug into the well pipe in advance of the cement slurry, without interrupting the pumping operation, continuing the pumping operation to pump the cement slurry under pressure downwardly through the well pipe, and then introducing a separation plug behind the cement without interrupting said pumping, whereby both plugs are properly placed and the cement is pumped into the well bore in a continuous operation.

A further object of the invention is to provide an improved apparatus for introducing a plurality of separation plugs in a well pipe in a desired relationship with respect to a cement column as the latter is being introduced into a well pipe under pressure, which apparatus includes means for supporting the plugs in position for introduction into the well pipe, together with manually actuated control means operable from exteriorly of the apparatus for selectively introducing the plugs into said pipe at the desired instant, whereby proper positioning of the plugs relative to the cement column may be accomplished without halting the pumping operation.

Still another object is to provide an apparatus, of the character described, wherein the plugs are initially latched in position within a chamber which communicates with the well pipe, but which is out of the direct line of inlet flow to the pipe, together with means for utilizing the line pressure for assuring a release of the plugs and introduction thereof into the well pipe at the predetermined desired times.

A particular object is to provide an improved apparatus, of the character described, wherein a manually operable valve means is associated with each separation plug and said valve means functions to control the application of line pressure to the separation plug whereby said line pressure may act against the plug to assure its introduction into the well pipe.

A still further object is to provide an apparatus, of the character described, wherein the valve means associated with adjacent separation plugs co-act with each other to control the flow from the inlet line to the well pipe, with such control selectively directing the line pressure against

each plug as the same is to be introduced, whereby a continuous uninterrupted cementing operation may be carried out.

Other and further objects of the invention will appear from the description of the invention.

In the accompanying drawings, which form a part of the instant specification, which are to be read in conjunction therewith and wherein like reference numerals are used to indicate like parts in the various views:

Figure 1 is a schematic view of a well bore and well pipe or casing and showing an apparatus constructed in accordance with the invention mounted on the upper portion of said pipe,

Figure 2 is a similar view illustrating the lower separation plug in position within the well pipe and illustrating the cement slurry being introduced,

Figure 3 is a similar view illustrating the upper plug introduced behind the cement and showing said cement being pumped through the lower plug which has reached a position in the lower portion of the well pipe,

Figure 4 is an enlarged transverse vertical sectional view of the upper portion of an apparatus constructed in accordance with the invention, and illustrating both plugs latched in position prior to introduction into the well pipe,

Figure 5 is a continuation of Figure 4,

Figure 6 is a horizontal cross-sectional view taken on the line 6—6 of Figure 4,

Figure 7 is a horizontal cross-sectional view taken on the line 7—7 of Figure 4,

Figure 8 is a horizontal cross-sectional view taken on the line 8—8 of Figure 4,

Figure 9 is a view similar to Figure 4 and illustrating the lower separation plug released from its latched position,

Figure 10 is a continuation of Figure 9, and

Figure 11 is a transverse sectional view of the upper portion of the apparatus showing the upper plug released therefrom.

In the drawings, the numeral 10 designates a well bore having a well pipe or casing 11 extending therethrough. The well pipe is arranged to be lowered within the bore 10 in any suitable manner and has an upwardly closing back pressure valve 12 coacting with fluid outlet openings 13 in the lower portion of the pipe. During running in or lowering of the well pipe or casing the pressure within the well bore exteriorly of the pipe and acting against the lower end of the valve 12 maintains the same in a position closing the openings 13 to prevent entry of fluid into the pipe. The valve is automatically moved downwardly to uncover and open the ports 13 whenever the pressure within the interior of the pipe string exceeds the pressure within the well bore. As is well known, the well bore is ordinarily filled with fluid or mud and the well pipe is lowered through such fluid; during the lowering operation the interior or bore of the well pipe is filled with fluid in any suitable manner whereby when the well pipe is landed in final position as shown in Figure 1, the casing is filled with fluid to a desired level.

After the pipe or casing string has been lowered into final position it is desirable to carry out the usual cementing operation and ordinarily cement is pumped downwardly through the pipe string and being under pressure functions to force the fluid within the pipe string outwardly through or past the valve which is opened by said pressure. The cement then flows outwardly into the well bore through the outlet ports 13

and rises to a predetermined height around the well pipe or casing to permanently bond the lower portion of the pipe within the well bore.

In order to separate the cement column from the fluid which is present within the well pipe it is desirable to introduce a plug into the pipe immediately in advance of the cement column. It is also desirable to introduce a second or follow-up plug immediately behind the cement column since a driving fluid for maintaining the pressure on said cement column is employed for finally pumping the cement completely outwardly into the well bore. The present invention is concerned with the introduction of a plurality of cement plugs with one of the plugs being introduced in advance of the cement column and the other being introduced immediately behind or on top of the cement column. As will hereinafter appear the plugs may be properly inserted within the well pipe or casing at the proper instant and without the necessity of halting or interrupting the pumping operation by which the cement is being introduced and without opening the well pipe or casing to atmosphere.

In carrying out the invention the improved apparatus A is adapted to releasably retain a pair of separation plugs B and B' and said apparatus is mounted on the upper end of the pipe string, being provided with a radial inlet conductor 14 which communicates with the interior of the apparatus and with the bore of the well pipe below the lowermost plug B'. The cement may be introduced through the conductor 14 and will flow downwardly into and through the well pipe or casing. The plugs B and B' are mounted in superposed relationship within the apparatus and are normally disposed out of the line of flow from the inlet 14 to the well pipe 11. When the pumping operation is started to begin the introduction of cement through the inlet 14 the lower plug B' is released so that it may enter the well pipe 11 in advance of the cement, as illustrated in Figure 2. When sufficient cement has been introduced behind the separation plug B' the second or upper plug B is released so that it may enter the pipe 11 behind or on top of the cement column. The release of both plugs into the well pipe (Figure 3) in proper position with respect to the cement column is accomplished without opening the well pipe or casing to atmosphere and without interrupting the pumping operation so that the pumps may be continuously operated from the start to the finish of the cementing operation.

The lowermost or advance plug B' is adapted to permit the cement to pass therethrough, as will be explained, after said lower plug reaches its final position within the pipe. The upper plug B travels downwardly through the well pipe behind the cement as the operation continues and said plug functions to separate said cement from the driving fluid. When the cement has been discharged through the outlets 13 in the lower portion of the well pipe or casing the uppermost plug B finally abuts or engages the lower plug B' and said upper plug is constructed so that upward displacement or movement thereof within the pipe is impossible. In other words, the upper plug B is provided with means actuated by an excessive pressure therebelow which will firmly lock said plug against upper displacement in the well casing. In this manner the upper plug will form a closure which will prevent the cement from being forced back upwardly through the

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well pipe in the event that excessive pressure might develop in the well bore and act against the lower end of said plug through the outlets 13.

The apparatus A is clearly shown in Figures 4 and 5 and includes a cylindrical body or housing 20 having a radial inlet opening 21 in the lower portion of its wall and provided with an annular valve seat member 22 below said port. The seat member is formed with an annular valve seat or seating surface 23 at its upper portion. A coupling collar 24 is welded or otherwise secured within the inlet opening 21 and is adapted to receive the end of the inlet pipe or conductor 14 through which the cement and pressure fluid are introduced into the well pipe 11. The lower end of the valve seat member 22 is threaded into a mounting sleeve 25 which is rotatably secured to a pipe section 26 by means of ball bearings 27. The pipe section 26 has its lower end arranged to be coupled to the upper end of the pipe or casing string 11. The retaining balls 27 are confined within annular recesses 28, formed in an annular ring member 29 which is welded or otherwise secured to the section 26 by means of threaded plugs 30 threaded into the sleeve 25. Obviously, said ball bearings 27 rotatably couple the parts to each other. By removing the plugs 30 the balls may be removed to permit the body 20 to be disconnected from the pipe section 26. Suitable packing rings 31 pack off between the pipe section 26 and the mounting sleeve 25 as well as between the ring member 29 and said mounting sleeve. Since the pipe section 26 has its lower end coupled to the upper end of the pipe string or casing 11 the housing 20 is rotatably mounted on said pipe or casing whereby the casing may be rotated while the housing remains stationary.

The upper end of the housing 20 is closed by a flanged cap member 32 which is threaded onto said upper end and a suitable packing ring 33 seals off between the cap or closure and said housing. A clevis or ring 34 is secured to the center of the cap or closure 32 whereby a cable or line may be utilized to support the housing 20 as it is connected and disconnected from the well pipe or casing 11.

As has been noted, the separation plugs B and B' are adapted to be releasably mounted within the housing 20, and the lower plug B' is associated with a tubular valve element 35 which is located in the lower portion of the housing. This valve element has an axial bore 35a extending entirely therethrough and has a beveled seating surface 36 on its lower end with a similar beveled seating surface 37 at its upper end. The external diameter of the valve sleeve 35 is less than the diameter of the bore 20a of the housing 20 and said sleeve is maintained in axial alignment within the housing by means of longitudinal ribs or keys 38 formed on its external surface (Figure 8) and coacting with longitudinal grooves or keyways 39 provided on the inner surface of the bore 20a of the housing 20. The coacting keys and keyways not only align the valve sleeve 35 axially within the housing but also function to prevent a rotation of said sleeve with respect to the housing as well as to guide said sleeve in its axial movement within said housing.

The valve sleeve is formed with a longitudinally extending gear rack 40 on its external surface and said rack is adapted to be engaged by a rotatable pinion 41 which is mounted on the inner end of an operating shaft 42. The operating shaft extends outwardly through a radial opening

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43 in the housing and is rotatably mounted in a suitable bearing sleeve 44. The outer end of the rotatable shaft 42 is provided with a hand wheel 45 to facilitate manual rotation of said shaft and the pinion 41 secured thereto. Normally the hand wheel may be locked against operation by means of the locking pin 46 which extends through an opening in the web in the hand wheel and which has its inner end engaged within locking lugs 47 which extend radially from the mounting collar 43a surrounding the opening 43. It will be evident by observing Figure 4 that when the locking pin 46 is extending through the hand wheel and engaging the locking lugs a rotation of the hand wheel is prevented, with the result that the operating pinion 41 cannot be rotated. Removal of the locking pin 46 permits the hand wheel 45 and shaft 42 to be rotated, whereby the pinion 41 rotates and through its engagement with the gear rack 40 on the valve sleeve 45 imparts a longitudinal or axial movement to the valve sleeve within the bore of the housing 20a.

The valve sleeve is normally in the position shown in Figure 4 which may be termed its upper position and upon operation of the pinion 41 may be moved downwardly to the position shown in Figure 10. In its upper position the valve sleeve 35 has its lower end clear of the inlet 21 whereby the flow from the inlet may pass directly into the well pipe 11. In its lowered position the valve surface 36 at the lower end of the valve sleeve 35 will engage the annular valve seat 23 within the lower portion of the housing 20 below the inlet 21 (Figure 10) and in such position direct flow from the inlet 21 to the well pipe is prevented. In such case the flow from the inlet will be upwardly around the valve sleeve 35 and into the upper end of said valve sleeve as indicated by the arrows in Figure 9, after which flow will be downwardly through the valve sleeve and into the well pipe 11.

The lower plug B' is adapted to be normally retained within the valve sleeve 35 and said plug includes a tubular mandrel 48 which may be made of an upper section 48a and a lower section 48b connected together by threads. An axial bore 49 extends entirely through the mandrel 48 and is normally closed at its lower end by means of a frangible disc 50 which may be threaded into the lower portion of said bore. An outwardly flared elastic packing element 51 is mounted on the lower end of the mandrel and has its flared lip portion 52 directed downwardly. A similar flared packing element 53 having its lip portion 54 directed upwardly is mounted on the upper portion of the mandrel and when the plug B' is within the valve sleeve 35 the upper packing element 53 is below the upper end of said valve sleeve. Pressure equalizing ports 55 extend through the valve sleeve 35 adjacent its upper end so that when the plug B' is in position within the valve sleeve 35 pressures across the plug may be equalized.

The plug B' is normally latched within the sleeve valve 35 by means of latching dogs 56. Each dog extends through a radial opening 57 in the valve sleeve 35 and has its inner end normally engaged with a recess 58 formed in the exterior surface of the mandrel 48. Each dog has its outer end attached to a bowed spring member 59 and when the valve sleeve 35 is in a raised position as shown in Figure 4 the spring 59 is disposed opposite a projection 60 which is secured to the wall 20a of the housing. It will be apparent that with each latching dog opposite

its complementary projection 60 said latching dog cannot be retracted from the recess 58 in the mandrel and thus so long as the valve sleeve 35 is in a raised position the plug B' is locked within the valve sleeve.

When the operating pinion 41 is rotated to impart a downward longitudinal movement to the valve sleeve the latching dogs 56 are moved below the projections 60 and the tension of the bowed springs 59 moves said springs to the position shown in the lower portion of Figure 9 whereby the latching dogs 56 are retracted from their respective recesses 58. This results in a release of the plug B' allowing it to fall downwardly into the well pipe 11. It will be evident that as the valve sleeve 35 moves downwardly into engagement with the seat 23 (Figure 10) the flow of pressure fluid entering through the inlet 21 will be directed upwardly around the valve sleeve 35 and into the upper end thereof behind or on top of the plug B'. Thus the full force of the pressure fluid which at this point will be cement is directed against the plug B' to assure that it will move downwardly out of the valve sleeve 35 and into the well pipe 11.

The upper plug B is normally mounted within an upper valve sleeve 61 which has an axial bore 62 extending entirely therethrough. The lower end of the upper valve sleeve is formed with an annular seating surface 63 which is adapted to be engaged by the seating surface 37 at the upper end of the lower valve sleeve 35. Pressure equalizing openings 64 are formed in the extreme upper end of the upper valve sleeve 61 and in its upper position said upper valve sleeve may engage the under side of the cap or closure 32.

The upper valve sleeve 61 is mounted in a manner similar to the manner of mounting of the lower valve sleeve being non-rotatably confined and guided in its longitudinal movement within the bore of the housing by coacting keys and keyways 38a and 39a. The upper valve sleeve has a longitudinally extending gear rack 49a which is in constant mesh with an operating pinion 41a. The operating pinion is carried by an operating shaft 42a mounted in a manner similar to the shaft 42 of the lower valve sleeve and a hand wheel 45a located exteriorly of the housing permits manual rotation of the pinion 41a. A locking pin 46a prevents accidental operation of the hand wheel.

It will be evident that the upper valve sleeve 61 may be moved longitudinally within the bore of the housing 20 by means of the pinion 41a and gear rack 49a. In its upper position the valve sleeve 61 is as shown in Figure 4 and with the lower valve sleeve 35 in its raised position has its lower end engaging the upper end of said lower sleeve. When the lower sleeve has been moved downwardly as illustrated in Figure 9 the upper valve sleeve 61 may be subsequently moved to its lower position as shown in Figure 11 and in this position the lower end of said upper sleeve again re-engages the lower valve sleeve 35. The sleeves 61 and 35 are of substantially the same diameter so that when said sleeves are in engagement with each other they form a continuous conductor.

The upper plug B is arranged to be releasably mounted in the upper valve sleeve 61 and includes a tubular mandrel 65 which has the lower portion of its bore closed by a transverse partition or plate 66. A downwardly directed flared packing element 67 is mounted on the lower portion of the mandrel while an upwardly directed flared

packing element 68 is mounted on the upper end of said mandrel. Intermediate its ends the mandrel is formed with a conical slip-expanding surface 69 upon which a plurality of segmental gripping slips 70 are slidably mounted. The upper ends of the slip members are attached to an annular packing sleeve 71 which is flared in an upward direction whereby pressure from above may be sealed by said sleeve. Upward movement of the slips relative to the mandrel is limited by an external shoulder 72 formed on the mandrel.

The upper plug B is adapted to be latched within the upper valve sleeve 61 by a plurality of latching dogs 56a which are identical in construction to the latching dogs 56 which lock the lower plug B' within the lower valve sleeve 35. Each latching dog 56a extends through a radial opening 73 in the wall of the valve sleeve 61 and has its inner end engaging a recess 58a in the mandrel 65. The outer end of each dog is attached to a bowed spring 59a which is disposed opposite a projection 60a on the wall of the bore of the housing when the valve sleeve 61 is in its raised position. It will be apparent that when the valve sleeve 61 is moved downwardly to locate the springs 58a of the locking dogs 56a below their respective projections 60a, said springs will function to retract the latching dogs 56a from their respective recesses 58a in the mandrel 65 of the plug B. When this occurs the plug B is released and may fall downwardly from the upper valve sleeve 61, through the lower valve sleeve 35 and into the well pipe or casing 11.

In the operation of the apparatus the parts are in the position shown in Figures 4 and 5, in which position the valve sleeves 61 and 35 are in their raised positions engaged with each other and the plugs B and B' are latched in their respective sleeves. At this time any pressure entering the lower portion of the housing through the inlet 21 may pass upwardly around the sleeves 35 and 61 and may equalize around both of the plugs B and B'. Pressure may enter the space between the plugs through the ports 55 in the upper end of the lower valve sleeve 35 and may enter the upper end of the upper sleeve 61 through the opening 64.

When the cementing operation is begun, the cement under pressure is pumped in through the inlet line 14 and following starting of the pumps and just before the cement begins to enter the inlet 21, the lower valve sleeve 35 is moved downwardly by manipulating the hand wheel 45 and rotating the operating pinion 41. Through the pinion 41 and gear rack 40 the lower valve sleeve 35 is moved downwardly so that its lower end engages the valve seat 23 and this shuts off a direct flow from the inlet 21 to the well pipe 11. The pumped cement entering the line 21 must then flow upwardly around the lower valve sleeve 35 and may enter the upper end of said sleeve as indicated in Figure 9 because the lowering of said sleeve has separated the same from the upper sleeve. As the valve sleeve 35 was initially moved downwardly the latching dogs 56 were disengaged from the locking recesses 58 in the plug B' and said plug was released from its latched position within the valve sleeve 35. The plug will fall downwardly by gravity into the well pipe and its release from the sleeve 35 will be positively assured because the cement under pressure is acting above said plug. The upwardly flared packing element 63 on the upper portion of the plug B' will seal with the wall of the pipe 11 and thus the cement under pres-

sure will force the plug downwardly through the pipe. Because the plug B' has its bore closed by the frangible closure or disc 50 said plug will positively separate the cement column from any fluid which may be present within the well pipe, and it is evident that as the cement column moves downwardly the fluid within the pipe is forced outwardly through the outlets 13 in the lower portion thereof.

Introduction of cement continues in this manner until the desired volume or quantity of cement has been introduced and at this point it is desirable to release the upper separation plug B on top of or behind the cement column. In order to accomplish release of the upper plug B without halting the pumping operation it is only necessary to rotate the operating pinion 41a through the hand wheel 45a. This moves the upper valve sleeve 61 downwardly within the housing until its lower end 63 again re-engages the upper end of the lower valve sleeve 35. This downward movement of the upper sleeve 61 results in a release of the latching dogs 56a whereby the upper plug B is released from the valve sleeve 61 and may fall downwardly therefrom. At the same time the downward movement of the upper sleeve to the position shown in Figure 11 causes the pressure fluid which is utilized to drive the cement column downwardly within the well pipe to flow upwardly around the upper sleeve 61 to its upper end as indicated by the flow arrows in Figure 11. Thus, this pressure fluid is applied against the plug B and urges said plug and the cement column in advance thereof downwardly through the well pipe 11.

After both plugs have been introduced with the cement column therebetween the plugs and column moves downwardly through the well pipe as a unit until the lower plug B' engages an annular seat or projection 75 within the lower portion of the pipe. The continued application of driving fluid pressure then results in a fracturing or breaking of the frangible closure disc 50 in the lower plug whereby the cement may then pass through the lower plug. It is noted that the provision of the frangible disc 50 permits the cement column to consolidate before it is finally pumped out of the well pipe. Upon passing through the lower plug B' the cement is then discharged through the outlet ports 13 in the lower portion of the well pipe and the upper or follower plug B follows the cement until said plug strikes the lower plug.

It is noted that the upper or follower plug B is provided with the segmental slips 70 which will function to prevent an upward movement of this plug with respect to the pipe. Thus, in the event that the pressure below the cement column becomes excessive to the point of overcoming the pressure of the driving fluid there would be a tendency for the cement column and upper plug to be moved upwardly within the well pipe. Any excessive pressure against the plug B will act on the lower packing element 67 and will move the mandrel 65 of said plug upwardly with respect to the slips 70, said slips being held momentarily stationary by the frictional engagement of the packing sleeve 71 with the wall of the pipe. A relative upward movement of the mandrel 65 with respect to the slips 70 will result in a coaction between the conical surface 69 of the mandrel and the slips whereby the slips will be engaged with the wall of the well pipe to prevent further upward movement. Thus the upper plug is provided with the slip

members which will prevent reverse or upward flow of the cement through the well pipe in case excessive pressures within the well bore are encountered.

After the cementing operation is complete the plugs B and B' are located within the lower portion of the well bore as illustrated in Figure 3 and it is preferable that these plugs be constructed of a material which is readily drillable, whereby both plugs may be subsequently drilled out after the cement has properly set and it is desired to reopen the bore of the well pipe.

From the foregoing it will be seen that the apparatus provides an accurate means for introducing a plurality of separation plugs into a well pipe during the cementing operation without interrupting such operation and without having to open the well pipe to atmosphere. Because each of the plugs are quickly and easily released by a mere manipulation of the hand wheels, it is possible to introduce the plugs at the exact desired instant and this assures proper placement of the plugs with respect to the cement column. The provision of the valve sleeves 35 and 61 allows the pressure of the cement or of the driving fluid to be utilized to assure that each plug will be properly released and introduced into the well pipe. As explained, the arrangement of the upper and lower valve sleeves 35 and 61 is such that the flow of the pressure fluid is controlled to accomplish the results. Normally and before either of the plugs are introduced, both plugs and their associated parts are completely out of the line of flow so that a direct flow from the inlet 21 into the well pipe 12 may occur. It is only when the pressure of the fluid entering the inlet 21 is desired for assuring release of the plugs that the valve members are actuated to shut off direct flow between the inlet 21 and the pipe 12.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described the invention, I claim:

1. An apparatus for inserting separation plugs in advance of and behind cement in a well pipe, including, a well pipe having a single inlet in its upper portion whereby fluid may be pumped under pressure into said pipe, a chamber connected with the upper end of the pipe above the inlet and communicating with the bore of the pipe, a pair of separation plug elements disposed within the chamber out of the direct line of flow of the fluid flowing from the inlet into the pipe, a latching means for releasably holding each of said plug elements in said chamber above said inlet, and means releasing said latching means for selectively releasing said plug elements and simultaneously therewith for by-passing fluid from the inlet upwardly into the chamber behind one or the other of said elements to introduce said plug elements into the pipe in ad-

vance of and behind cement being introduced through the inlet without halting the pumping operation.

2. An apparatus for inserting separation plugs in advance of and behind cement in a well pipe, including, a well pipe having a single inlet in its upper portion whereby fluid may be pumped under pressure into said pipe, a chamber connected with the upper end of the pipe above the inlet and communicating with the bore of the pipe, a pair of separation plug elements disposed within the chamber out of the direct line of flow of the fluid flowing from the inlet into the pipe, a latching means for releasably holding each of said plug elements in said chamber above said inlet, means for by-passing cement upwardly around one of the plug elements and simultaneously releasing said latching means to insert said one of the plug elements into the well pipe by means of the cement pumping operation, and means by-passing a driving fluid introduced through the inlet around the second separation plug for inserting the second plug element into the pipe behind the cement and in advance of the driving pressure fluid without halting the pumping operation.

3. An apparatus as set forth in claim 1 wherein the pressure of the pumped fluid is utilized to effect introduction of the plug elements into the well pipe.

4. An apparatus for inserting a pair of separation plugs in a well pipe including, a well pipe adapted to extend into a well bore, a tubular body having an inlet at its lower end, said body being connected to the upper portion of said pipe and having the lower portion of its bore in communication with the well pipe inlet and also in communication with the bore of the inlet, movable valve means mounted in the body and arranged to be actuated to shut off a direct flow from the inlet to the well pipe whereby flow is from the inlet into the bore of the body and then around and through the valve means to the bore of said pipe, a separation plug releasably mounted within the valve means, means for releasing said plug and introducing it into the well pipe when the valve means is actuated to shut off direct flow from the inlet to the pipe, means for introducing cement through the inlet and valve means into the pipe behind the separation plug, a second separation plug releasably mounted in the upper portion of the housing above the valve means, and means for inserting said second plug behind the cement column which has been previously introduced into the well pipe.

5. An apparatus as set forth in claim 4, together with means for utilizing the pressure of the pumped fluid to effect release and insertion into the pipe of both plug elements.

6. An apparatus as set forth in claim 4, together with a tubular valve element associated with the second plug element and movable into a position engaging the first valve means whereby the pumped pressure is directed against the second plug element to release said second plug.

7. An apparatus as set forth in claim 4 wherein the movable valve means is actuated by a manual means located exteriorly of the housing.

8. An apparatus for inserting separation plugs in a well pipe comprising a closed system and including, a well pipe having an inlet line in its upper portion whereby cement and other fluid may be pumped into said casing, a pair of cement plugs releasably disposed within the system above said inlet and out of the line of flow from the in-

let to the pipe, and means for selectively releasing said plugs and for simultaneously by-passing fluid from the inlet around the plugs for introducing said plugs into the well pipe ahead of and behind the cement without interrupting the pumping operation.

9. An apparatus for inserting separation plugs in advance of and behind cement in a well pipe including, a well pipe having an inlet line in its upper portion whereby cement and other fluid may be pumped into said pipe, a pair of separation plugs normally disposed out of the direct line of flow from the inlet to the pipe, tubular valve means surrounding each separation plug, and means for selectively operating the valve means associated with each plug for shutting off the direct flow from the inlet to the pipe and for directing pressure against its respective plug in a direction to urge the plug into the pipe, whereby said plugs are introduced into the well pipe by means of said pressure.

10. An apparatus as set forth in claim 9, wherein the operating means for the valve means is operable from the exterior of the well pipe.

11. The method of introducing separation plugs within a well bore during a cementing operation, which includes mounting a closed separation plug within a chamber which communicates with the upper portion of the well pipe, releasing the plug from its mounting within the chamber, delivering cement into the upper portion of the well pipe and by-passing the plug within the chamber to direct said cement against the upper end of the plug simultaneously with said releasing of the plug, whereby the plug is introduced into the pipe ahead of the cement column, mounting a second separation plug in the chamber above the first plug, releasing the second plug to insert it into the pipe immediately behind the cement column without interrupting the pumping operation whereby the plugs and cement confined therebetween are pumped downwardly through said pipe, opening by means of pump pressure the first named separation plug when said plug reaches a point within the lower portion of the pipe, whereby the cement may pass through said plug, and then discharging said cement from the well pipe into the well bore.

12. The method of introducing separation plugs into a well pipe within a bore hold during a cementing operation wherein the well pipe has only a single conductor inlet near its upper portion, said method including, releasably mounting a pair of separation plugs in superposed relation to the extreme upper end of said well pipe above the inlet, applying pressure through a pumping operation to a cement slurry to direct the slurry into the upper portion of said well pipe, releasing the lower separation plug and simultaneously therewith shutting off direct communication between the inlet and well pipe, by-passing the cement slurry upwardly around the lowermost separation plug and directing said slurry against the plug to effect insertion of the plug into the well pipe, continuing the introduction of cement into the well pipe until a desired volume has entered the pipe, then introducing a driving fluid behind the cement through the single conductor inlet, releasing the second separation plug and simultaneously therewith by-passing the driving fluid which enters through the inlet upwardly around the second separation plug to apply said driving fluid to said second plug and thereby effect insertion of the second plug into the well pipe behind the cement

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column, the release of said plugs and the bypassing of cement and fluid past the same being carried out without halting the pumping operation.

13. The method as set forth in claim 11, together with the additional step of opening the lower separation plug by the application of a predetermined pressure thereto after the plugs and cement are in a desired position within the well pipe.

14. An apparatus for inserting separation plugs into a well pipe, including a well pipe adapted to extend into a well bore, a chamber at the upper end of said well pipe having an inlet therein, an upper and a lower separation plug disposed within said chamber, latching means for releasably holding said plugs in said chamber above said inlet whereby fluid may be directed from said inlet below said plugs in its flow to said well pipe, a valve sleeve surrounding each of said plugs and disposed within said chamber, and control means operated from the exterior of said chamber for axially moving each sleeve and its respective plug to direct the fluid from the inlet into said chamber above each plug and to also release said latching means whereby the fluid may force the plugs downwardly into the well pipe.

15. The apparatus as set forth in claim 14, in-

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cluding a valve seat in the upper portion of said well pipe which is disposed below said inlet and is spaced from the lower edge of the lower valve sleeve when said latching means is holding same, and said lower valve sleeve seating on the valve seat upon actuation by said control means, whereby the fluid flow from the inlet directly to the well pipe is closed off so that the fluid flow is directed into said chamber and above the plug in the lower valve sleeve.

16. The apparatus as set forth in claim 14, wherein the upper separation plug has a gripping means associated therewith to prevent upward displacement of said upper separation plug after it has been released from its latched position.

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