Sept. 8, 1953 G. F. ABENDROTH ET AL 2,651,369

GRAVEL PACKING APPARATUS AND METHOD FOR ARRANGING SAME IN WELL CASINGS

Filed Feb. 25, 1952

4 Sheets-Sheet 1

FIG. 1.

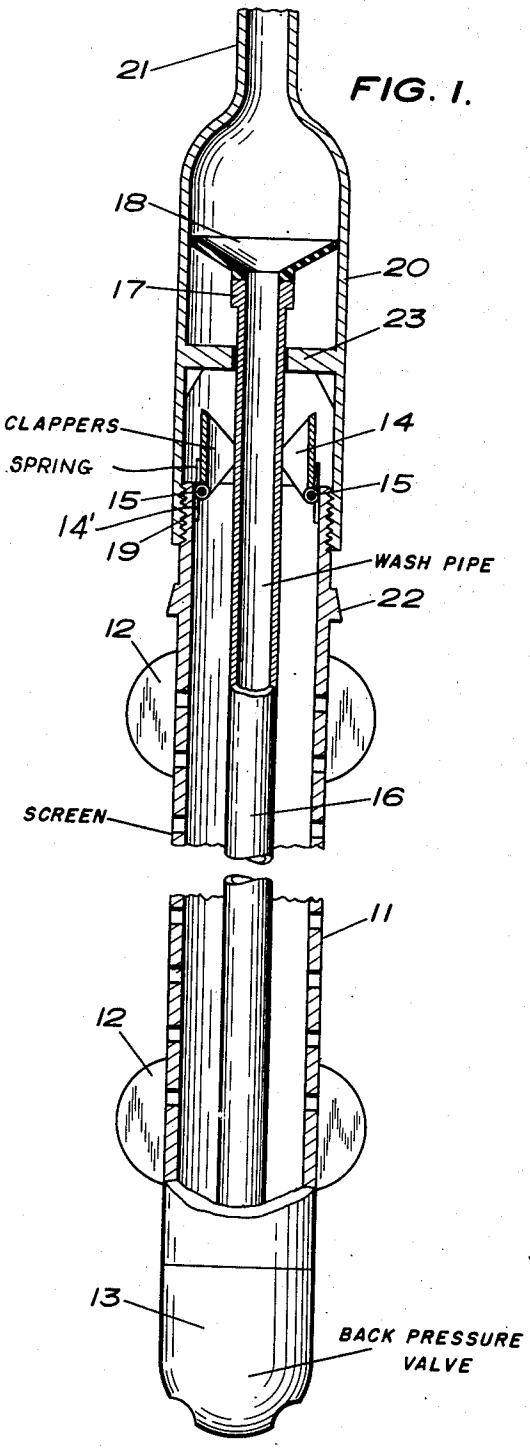
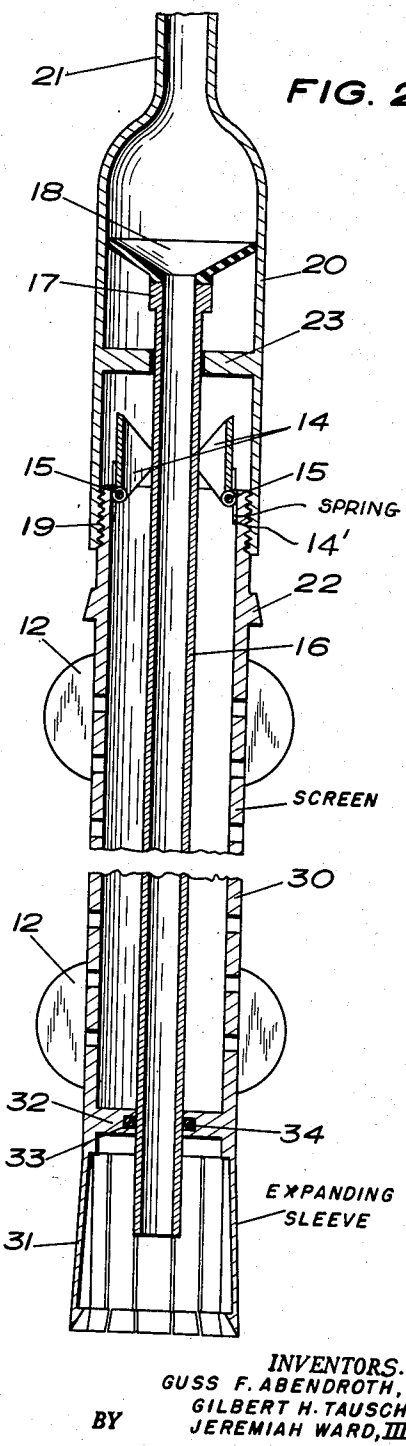


FIG. 2.



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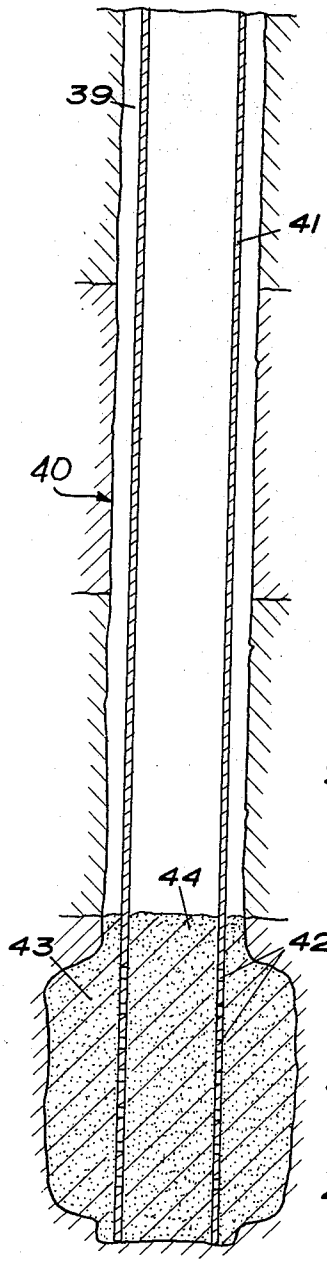
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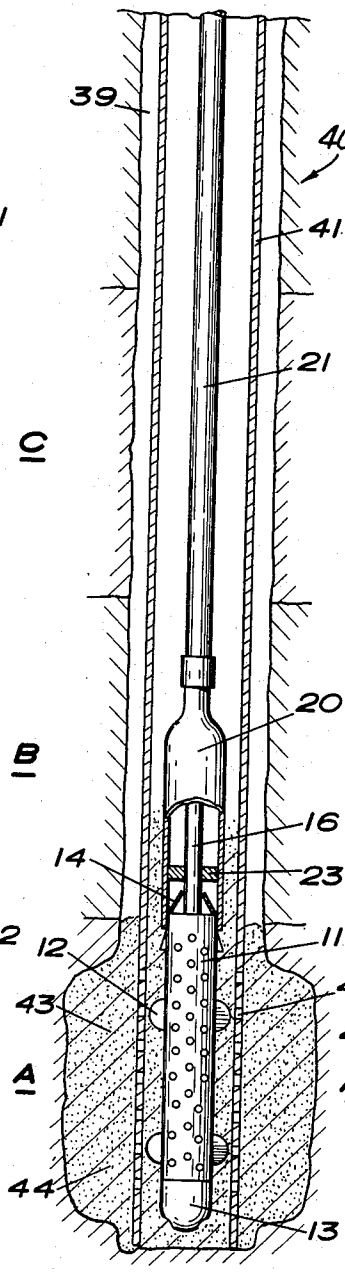
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FIG. 3.



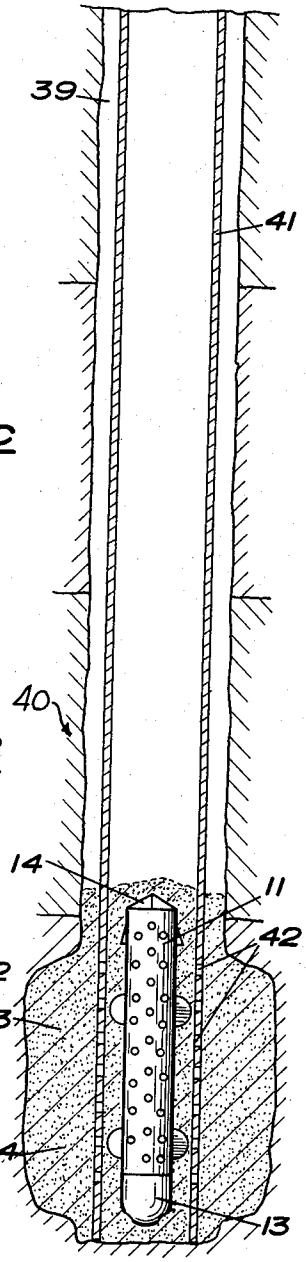
STEP 1.

FIG. 4.



STEP 2.

FIG. 5.



STEP 3.

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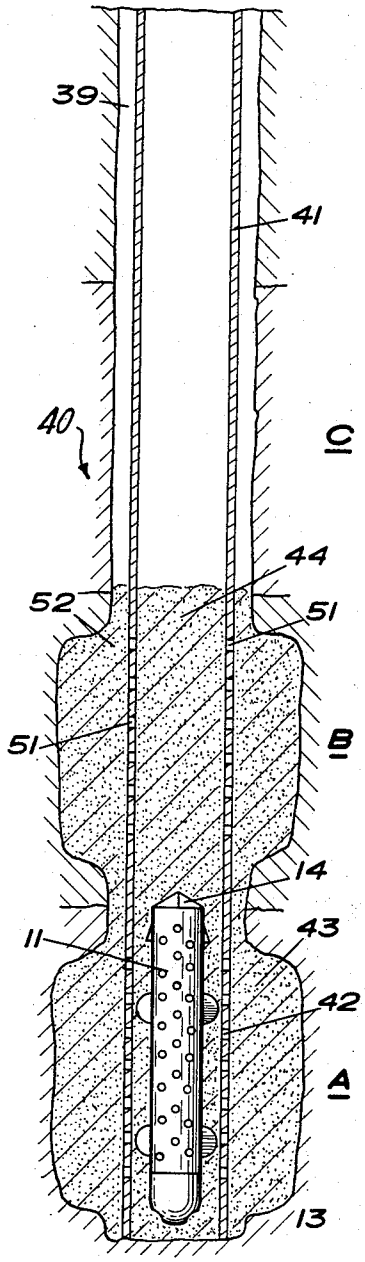
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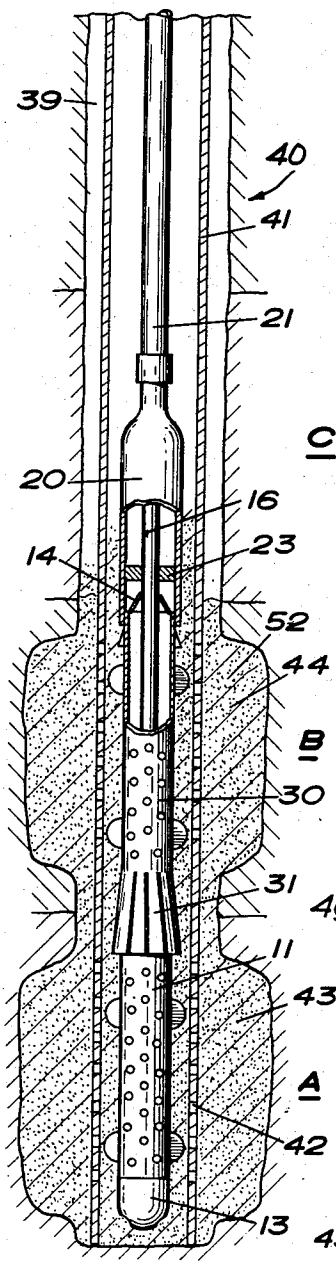
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FIG. 6.



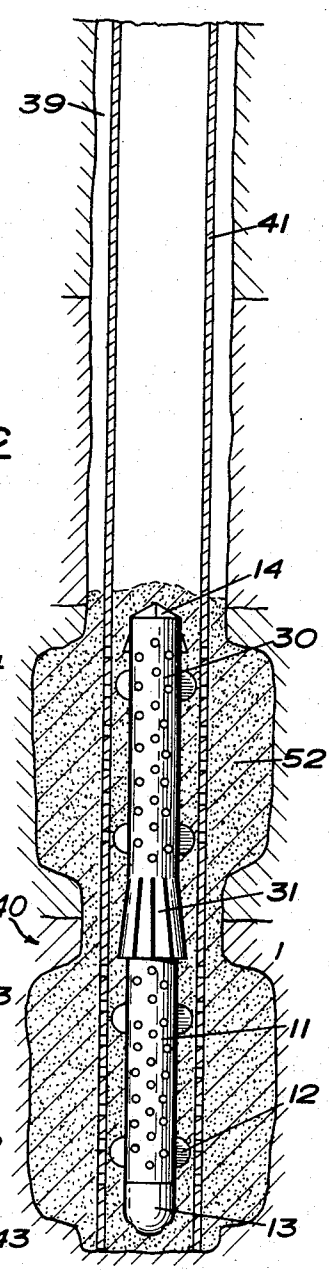
STEP 4.

FIG. 7



STEP 5.

FIG. 8



STEP 6.

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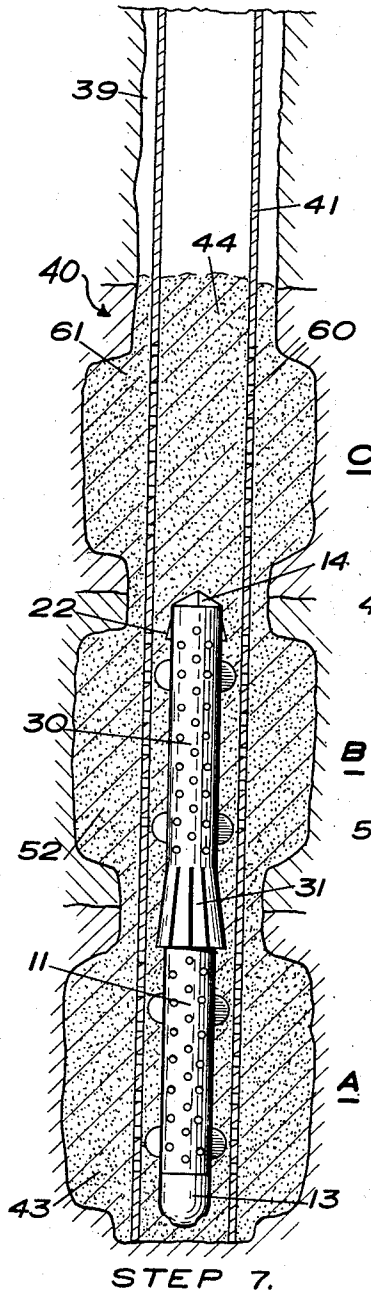
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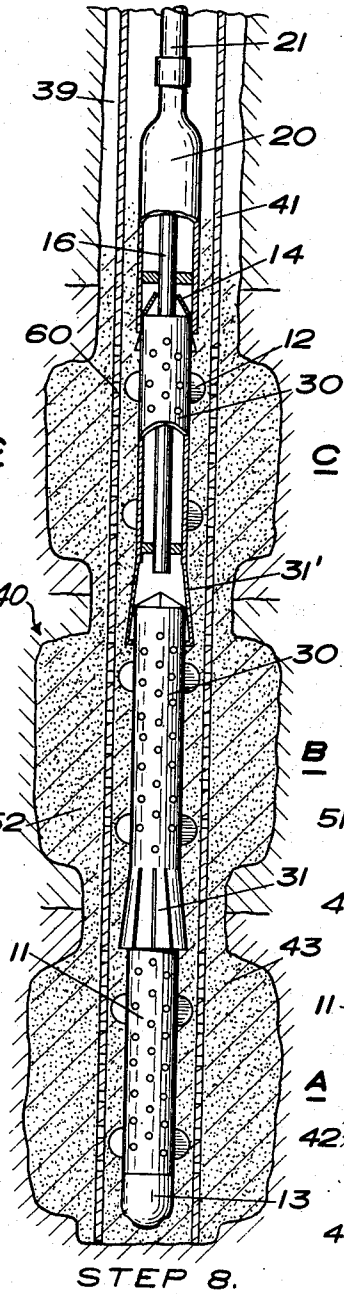
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FIG. 9.



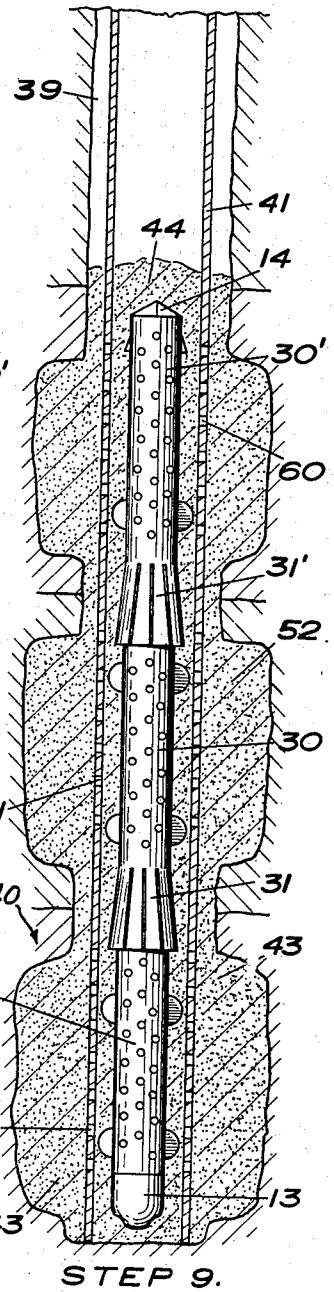
STEP 7.

FIG. 10.



STEP 8.

FIG. 11.



STEP 9.

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Patented Sept. 8, 1953

2,651,369

UNITED STATES PATENT OFFICE

2,651,369

GRAVEL PACKING APPARATUS AND METHOD FOR ARRANGING SAME IN WELL CASINGS

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Application February 25, 1952, Serial No. 273,278

6 Claims. (Cl. 166—1)

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The present invention is directed to a screen assembly for use in gravel packing operations in a cased well bore traversing a long producing assembly. More particularly, the invention is directed to an improved screen assembly and a method for arranging same in a well casing in a well bore traversing a long producing assembly.

The apparatus of the present invention may be described as involving a plurality of screen sections adapted to be arranged in a cased well bore one upon another, each of the screen sections having a valve in an upper end thereof adapted to be held in an open position. Each of the plurality of screen sections is provided with a releasing means on an upper end of the screen section adjacent the valve for releasing a screen section from a pipe string to which the screen section is attached. The screen sections have a latching means arranged on an exterior surface thereof adjacent the upper end and an engaging means on a lower end of each of the sections other than a lowermost of said sections. A retrievable wash pipe which defines with an outer surface adjacent its upper end withdrawing means engageable with an inner surface of a lower end of said pipe string for withdrawing said wash pipe is arranged sequentially in the lowermost of said sections and thence in a next higher of said sections. The wash pipe holds the valve in an open position when the wash pipe is in a particular section and the valve in each section is adapted to close on withdrawal of the wash pipe therefrom. The latching means on the upper end of each section is adapted to engage with an engaging means on the lower end of a next higher section to connect said sections and to form a continuous internal passageway.

The invention also involves a method for arranging the screen sections in a casing in a borehole traversing a long producing interval and includes the steps of perforating the casing at a lower point therein in the producing interval. A first cavity is washed out in the producing interval adjacent the perforations following which gravel is deposited in the casing and in the cavity to fill substantially completely the cavity and to provide a bed of gravel in the casing to a point above the cavity. Thereafter a tubing string is lowered in the casing to which is attached a first screen section. The screen section has arranged

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therein a retrievable wash pipe. The tubing string carrying the screen section is then washed down through the gravel in the casing until a lower screen section is washed down opposite the perforations in the casing. The tubing string is then released from the first screen section and the wash pipe withdrawn from the first screen section. The casing is then perforated above the first perforation and a second cavity is washed out in the producing interval adjacent the second perforations. Gravel is deposited in the casing and in the second cavity to fill substantially said second cavity and to provide a bed of gravel in the casing above the first screen section. The tubing string having a second screen section attached thereto in which the wash pipe is arranged is then lowered in the casing and the second screen section is washed downwardly through the gravel until a lower end of said second screen section engages with the upper end of the first screen section. The tubing string is then released from the second screen section and the wash pipe is withdrawn from the second screen section. The sequence of operations is repeated until a desired number of screen sections have been arranged in the casing one upon another. An internal passageway is then established through the screen sections and thereafter the well may be produced. During the time the screen sections are in the bed of gravel in the well casing, the screen sections are maintained substantially free of gravel.

The present invention will be further described by reference to the drawing in which

Fig. 1 is a sectional view of a lower screen section of a plurality of screen sections;

Fig. 2 is a cross-sectional view of screen sections adapted to be engaged with the screen section of Fig. 1; and

Figs. 3 through 11 are illustrations of the sequence of operations in which the screen sections are arranged in a cased well bore.

Referring now to the drawing, numeral 11 designates a first screen section which is provided with centralizers or stabilizers 12. The screen section 11 terminates at its lower end in a back pressure valve 13. At an upper end of the screen section is a valve, such as a clapper-type valve 14 normally urged into a closed position by springs 14', which is pivotally connected at points 15 to

the upper end of the screen section. Arranged in the screen section 11 is a retrievable wash pipe 16 which defines with an upper outer surface a shoulder 17 and which is provided with a sealing means, such as a rubber seal 18. As shown, the wash pipe 16 holds the clapper-type valve 14 in an open position. At an upper end of the screen section 11 is a releasing means 19 which serves to connect to and release the screen section 11 from a lower end of a pipe string 20. The pipe string 20 is shown as being increased in size from the portion 21 but it is to be understood that the pipe string 20 may be of uniform size, if desired. Below the releasing means 19 on the outer surface of the screen section 11 are latching means 22, such as dogs. The pipe string 20 is provided with a member or engaging means 23 which is adapted to engage with the shoulder 17 to allow the wash pipe 16 to be withdrawn when the pipe string 20 is released from the screen 11 and pulled upwardly in the casing.

Referring now to Fig. 2 in which identical numerals will be employed to designate identical parts to those of Fig. 1, numeral 30 designates a second screen section provided with stabilizers or centralizing means 12 in which is arranged wash pipe 16. The second screen section 30 is attached to pipe string 20 by releasing means 19 as has been described with respect to Fig. 1. The second screen section 30 is also provided with clapper-type valves 14 which are held in an open position by wash pipe 16 when it is in second screen section 30. Like screen section 11, screen section 30 is provided with dogs 22. Screen section 30 has an expanding sleeve 31 on a lower end thereof which is adapted to engage with the upper end of screen section 11. The expanding sleeve fits over the upper end of screen section 11 and engages with dogs 22. Arranged in the screen section 30 is a ring 32 defining recesses 33 in which is arranged an O-ring 34. O-ring 34 allows a tight seal to be made between the wash pipe 16 and the lower end of screen section 30 and between the pipe 16 and lower end of screen section 30'.

Referring now to Figs. 3 through 11, a stepwise description of the mode of using the apparatus of Figs. 1 and 2 will be given. In step 1 of Fig. 3 a well bore 39 in the earth's surface has penetrated a desirable producing interval 40. This producing interval 40 contains areas A, B, and C from which it is desired to obtain production. A casing 41 has been landed in the well bore 39 and perforated in area A to provide perforations 42. A cavity 43 has been washed out in the area A and gravel deposited in the cavity 43 to fill it substantially completely and to provide a bed of gravel 44 extending above the cavity 43. The tubing string 20 having attached thereto a screen section 11 is lowered into the casing 41 and washed downwardly through the gravel 44 by circulating salt water and the like downwardly through wash pipe 16 and outwardly through back pressure valve 13. The salt water proceeds up the annulus 50 between the pipe string and the casing, and thence to the well head. After the screen section 11 has been landed the pipe string 20 is disconnected by backing off to the right and the pipe string and the wash pipe pulled from the casing. As the wash pipe is pulled from the screen section 11 the clapper-type valve 14 closes, preventing entry of gravel and leaving the screen section 11 arranged in the casing as shown in step 3, the foregoing operations being illustrated by steps 1 and 2. Gravel is deposited to a height in the casing 41 to cover the screen section 11 and extend to about a foot above the clapper-type valve 14. Thereafter, as illustrated in step 4, the casing 41 is perforated at a point above the first cavity to form perforations 51. This can be accomplished by lowering a gun perforator in the casing 41 and shooting as is well known. The area B is then washed out employing a suitable washing tool to form a cavity 52 which is substantially completely filled with gravel, as shown in step 4, by depositing gravel in the casing 41 and washing gravel outwardly into the cavity 52; thus a bed of gravel is formed in the casing 41 that extends upwardly in the casing 41 to a point at least as high as the second cavity 52, salt water being used to wash the second screen section downwardly. The second screen is washed downwardly in the casing 41 until the expanding sleeve 31 engages with dogs 22 on the upper end of screen section 11. The pipe string 20 is then rotated to the right to release the second screen section 30 at releasing means 19. This causes wash pipe 17 to be pulled from the screen section 30 and causes the clapper-type valves 14 in screen section 30 to close. These operations are shown in steps 5 and 6 of Figs. 7 and 8.

Thereafter the casing 41 is perforated at a third point therein above the perforations 51 by lowering a gun perforator or the like and shooting to form perforations 60. A cavity 61 is then formed by washing out the area C employing a wash tool of a suitable nature. Gravel is deposited in the casing 41 to fill substantially completely the cavity 61 and to extend the height of the bed 44 to a point at least as high as the upper point of cavity 61. It will be noted that the clapper-type valve 14 in screen section 30 is closed thereby preventing gravel from falling into the screen section 30.

The pipe string 20 to which is attached a third screen section which is similar to screen section 30 and which may be designated by the numeral 30' is lowered into the casing 41 and the screen section 30' is washed downwardly through the gravel bed 44 by circulating salt water or the like downwardly through wash pipe 16. The screen section 30' is washed downwardly until the expanding sleeve 31' engages with the dogs 22 of screen section 30. The pipe string 20 is then backed off to the right and the screen section 30' released therefrom, the wash pipe 16 being withdrawn as the pipe string 20 is raised. On withdrawal of wash pipe 16 the clapper-type valve 14 of screen section 30' closes preventing gravel from falling into the screen section. Gravel may then be deposited in the casing 41 to extend the bed 44 to a point above the clapper 14 of screen section 30'. The sequence of operations may be continued, if desired, to arrange any number of screen sections one upon the other, as has been described. When it is desired to produce from the formations of sections A, B, and C, the clapper valves 14 in the several screen sections may be drilled or milled out to establish a continuous internal passageway. Rather than drilling or milling out the valves 14, it may be desirable to construct the clapper-type valve 14 of a corrodible metal, such as aluminum and allow them to be corroded out by electrolytic action. In any event, a continuous internal passageway is provided by removing the clapper-type valves.

From the foregoing description taken with the drawing it will be seen that long producing intervals may have screen sections arranged therein. It is also possible to perforate at selected points in a casing and arrange screen sections therein.

Our invention eliminates the problem of arranging screen sections in long producing intervals which, in some fields, may be as much as 1000 feet vertically. Where sand production is a problem it is difficult to arrange screen sections in a perforated casing other than by the practice of the present invention.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and to secure by Letters Patent is:

1. A screen assembly for use in long producing intervals which comprises, in combination, a plurality of screen sections adapted to be arranged in a cased well bore one upon another each having a valve in the upper end thereof normally urged into a closed position, releasable connecting means on each of said sections adjacent the valve for connecting to and releasing a section from a pipe string, latching means on the exterior surface of each section adjacent the upper end, engaging means on the lower end of each of said sections other than the lowermost of said sections, and a retrievable wash pipe carried by the lower end of said pipe string slidably arranged in the section connected to the pipe string holding the valve in said section in an open position, said engaging means and latching means being engageable with each other to connect said sections and form a continuous internal passageway.

2. A screen assembly for use in long producing intervals which comprises, in combination, a plurality of screen sections adapted to be arranged in a cased well bore one upon another each having a valve in the upper end thereof normally urged into a closed position, releasable connecting means on each of said sections adjacent the valve for connecting to and releasing a section from a pipe string, latching means on the exterior surface of each section adjacent the upper end, expanding sleeves on the lower end of each of said sections other than the lowermost of said sections, and a retrievable wash pipe carried by the lower end of said pipe string slidably arranged in the section connected to the pipe string holding the valve in said section in an open position, said wash pipe being provided with a shoulder adjacent its upper end engageable with the inner surface of the lower end of said pipe string for withdrawing said wash pipe, said expanding sleeves and latching means being engageable with each other to connect said sections and form a continuous internal passageway.

3. A screen assembly for use in long producing intervals which comprises, in combination, a plurality of screen sections adapted to be arranged in a cased well bore one upon another each having a valve in the upper end thereof normally urged into a closed position, releasable connecting means on each of said sections adjacent the valve for connecting to and releasing a section from a pipe string, latching means on the exterior surface of each section adjacent the upper end, expanding sleeves on the lower end of each of said sections other than the lowermost of said sections, a retrievable wash pipe carried by the lower end of said pipe string slidably arranged in the section connected to the pipe string holding the valve in said section in an open position provided with a shoulder adjacent its upper end engageable with an inner surface of the lower end of said pipe string for withdrawing said wash pipe, said expanding sleeves and latching means being engageable with each other to connect said sections and form a continuous internal passageway, and a back pressure valve on a lower end of the lowermost of said sections.

4. A screen assembly for use in long producing intervals which comprises, in combination, a plurality of screen sections adapted to be arranged in a cased well bore one upon another each having a clapper-type valve in the upper end thereof normally urged into a closed position, pipe threads on each of said sections below said clapper-type valve for connecting to and releasing a section from a pipe string, latching dogs on the exterior surface of each section adjacent the upper end, an expanding sleeve on the lower end of each of said sections other than the lowermost of said sections, and a retrievable wash pipe carried by the lower end of said pipe string slidably arranged in the section connected to the pipe string holding the valve in said section in an open position provided with a shoulder adjacent its upper end means engageable with the inner surface of the lower end of said pipe string for withdrawing said wash pipe, said expanding sleeve and latching dogs being engageable with each other to connect said sections and form a continuous internal passageway.

5. A screen assembly for use in long producing intervals which comprises, in combination, a plurality of screen sections adapted to be arranged in a cased well bore one upon another each having a clapper-type valve in the upper end thereof normally urged into a closed position, pipe threads on each of said sections below said clapper-type valve for connecting to and releasing a section from a pipe string, latching dogs on the exterior surface of each section adjacent the upper end, an expanding sleeve on the lower end of each of said sections other than the lowermost of said sections, a retrievable wash pipe carried by the lower end of said pipe string slidably arranged in the section connected to the pipe string holding the valve in said section in an open position provided at its upper end with a shoulder adapted to engage with the lower end of said pipe string for withdrawing said wash pipe, said expanding sleeve and latching dogs being engageable with each other to connect said sections and form a continuous internal passageway, and a back pressure valve on a lower end of a lowermost of said sections.

6. In a method for arranging a plurality of screen sections in a casing in a borehole traversing a long producing interval in which the casing has been perforated at a lower point therein and a first cavity formed in said producing interval adjacent the perforations in said casing and said first cavity substantially completely filled with gravel and a bed of gravel formed in said casing to a point above said cavity, the steps of lowering a tubing string in said casing having a first screen section attached thereto at a lower end in which is arranged a retrievable wash pipe, washing said first screen section downwardly through the gravel in said casing, releasing said tubing string from said first screen section and withdrawing the wash pipe from said first screen section, perforating said casing at a point above the first perforations, washing out a second cavity in said producing interval adjacent said second perforations, depositing gravel in said casing and in said second cavity to fill substantially said second cavity, and to provide a bed of gravel in said casing above the first screen section, lower-

ing the tubing string in said casing having a second screen section attached thereto at a lower end in which is arranged the retrievable wash pipe, washing the second screen section downwardly through the gravel in said casing until a lower end of said second screen section engages with an upper end of said first screen section, releasing said tubing string from said second screen section and withdrawing the wash pipe from said second screen section, and repeating the sequence of operations until a desired number of screen sections have been arranged in the casing one upon another.

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