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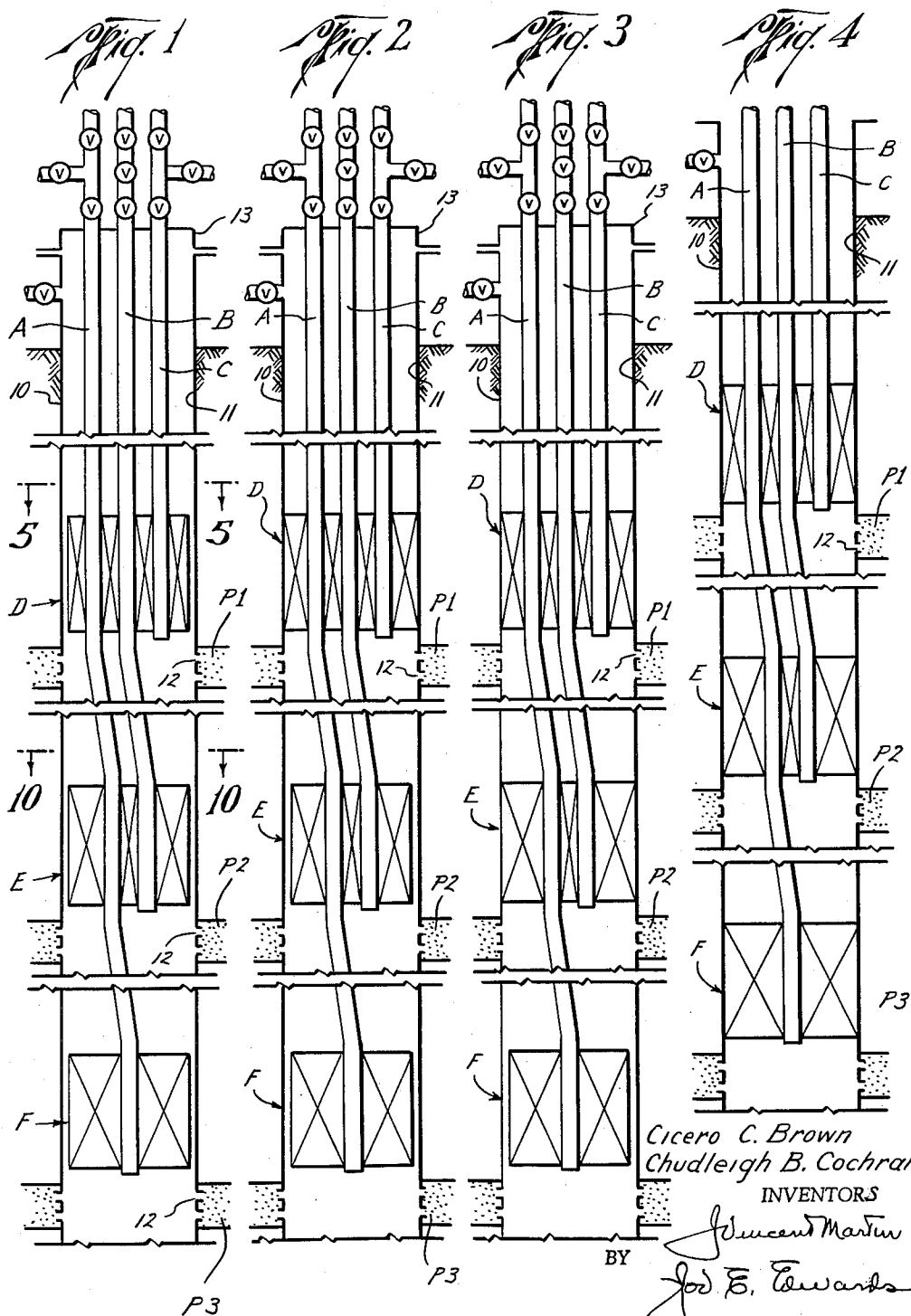
C. C. BROWN ET AL

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METHODS OF AND APPARATUS FOR COMPLETING MULTIPLE ZONE WELLS

Filed April 26, 1957

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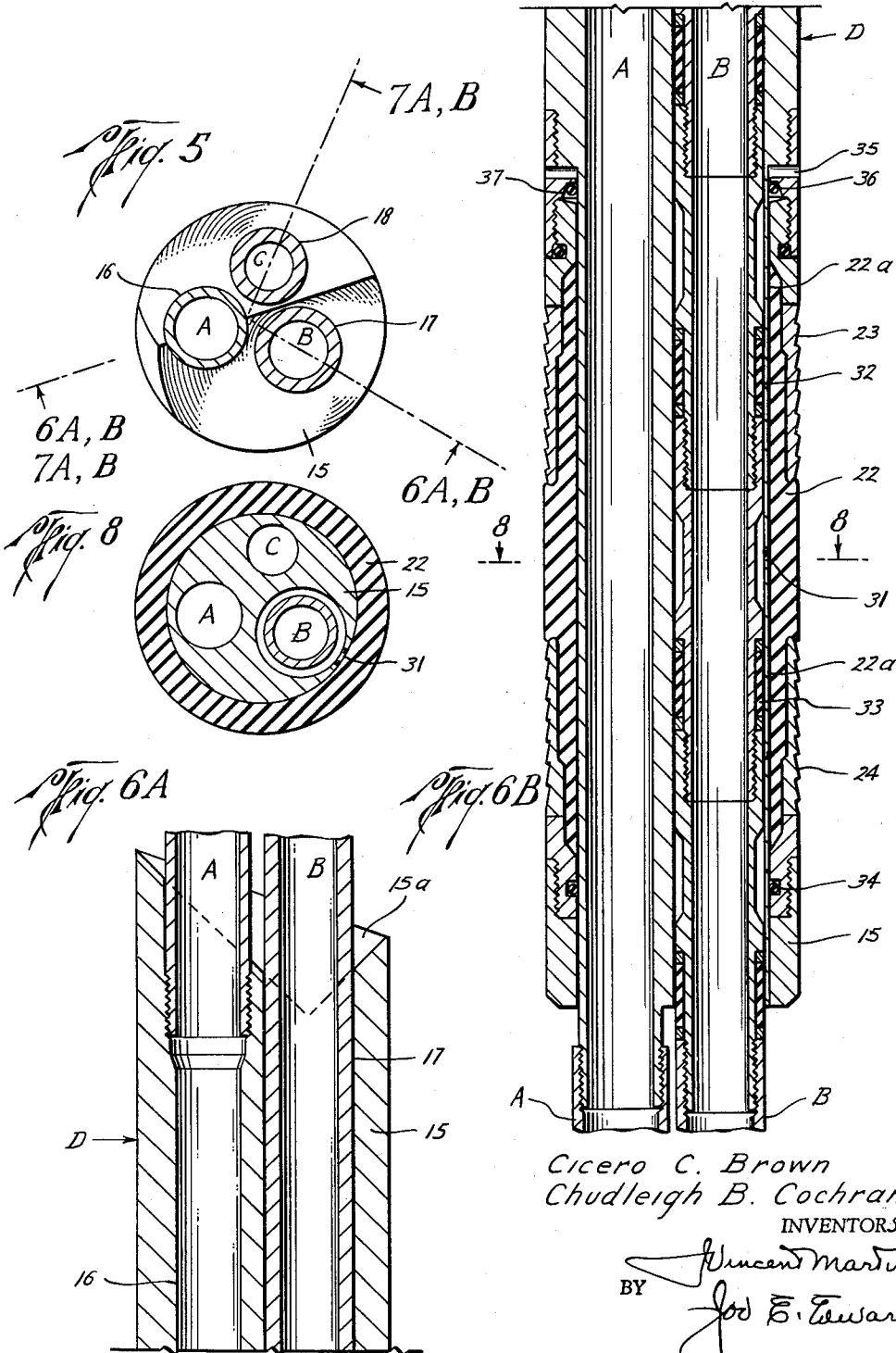
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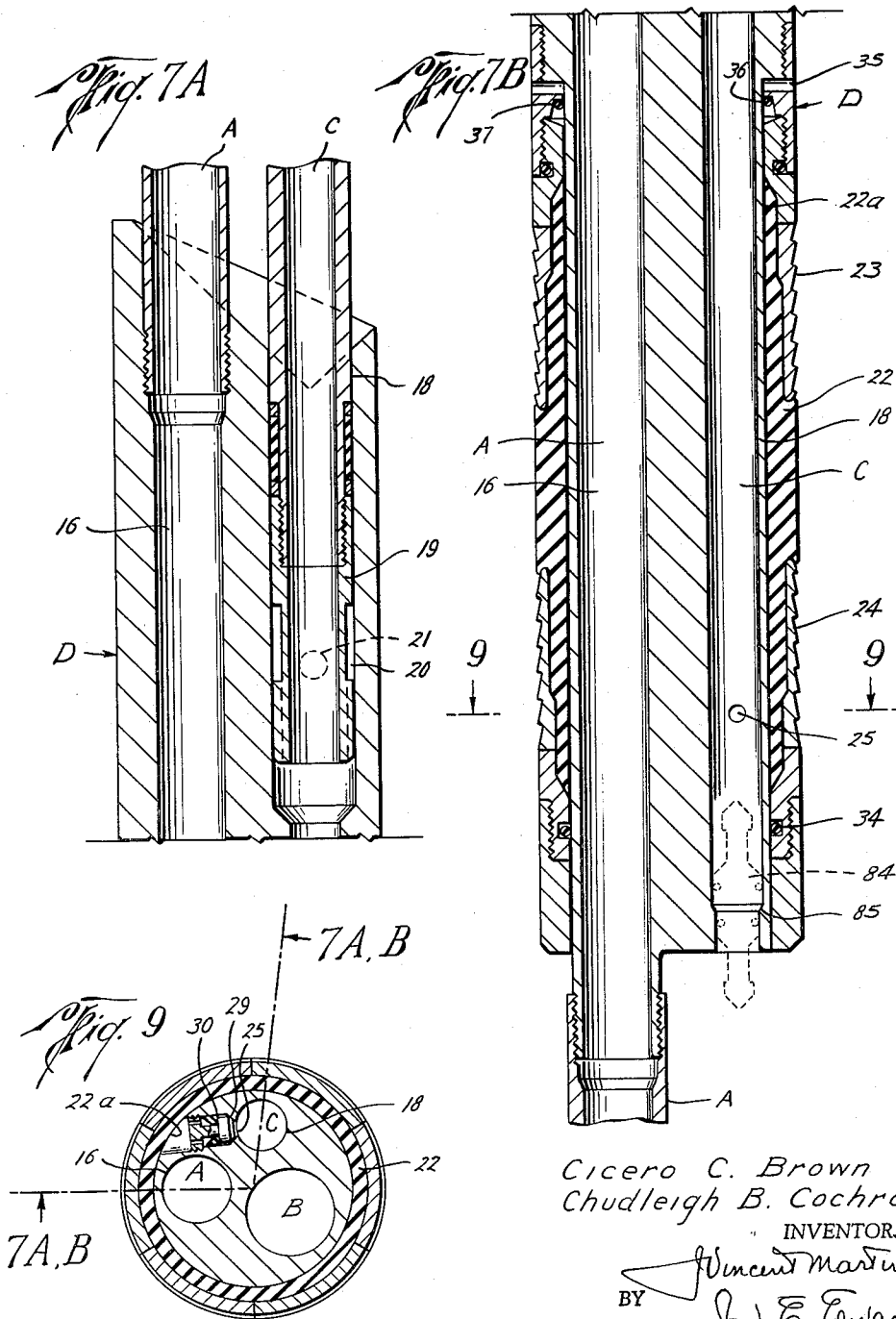
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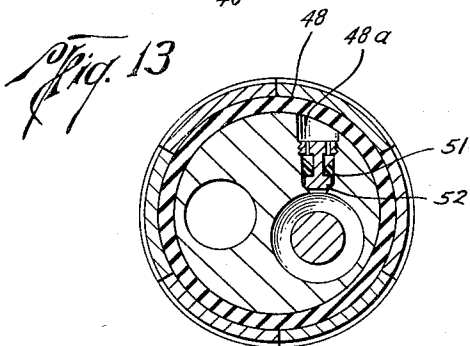
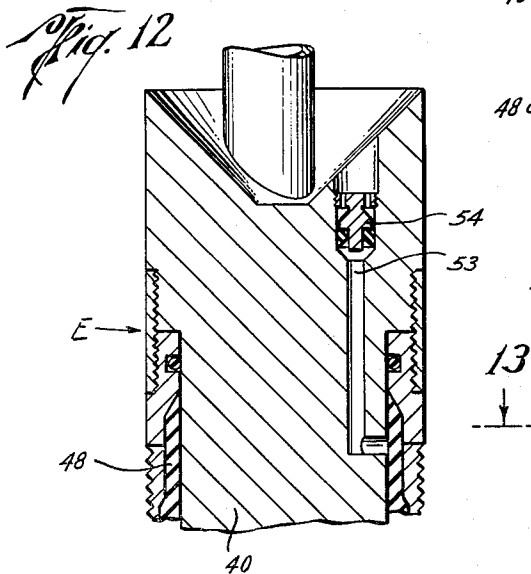
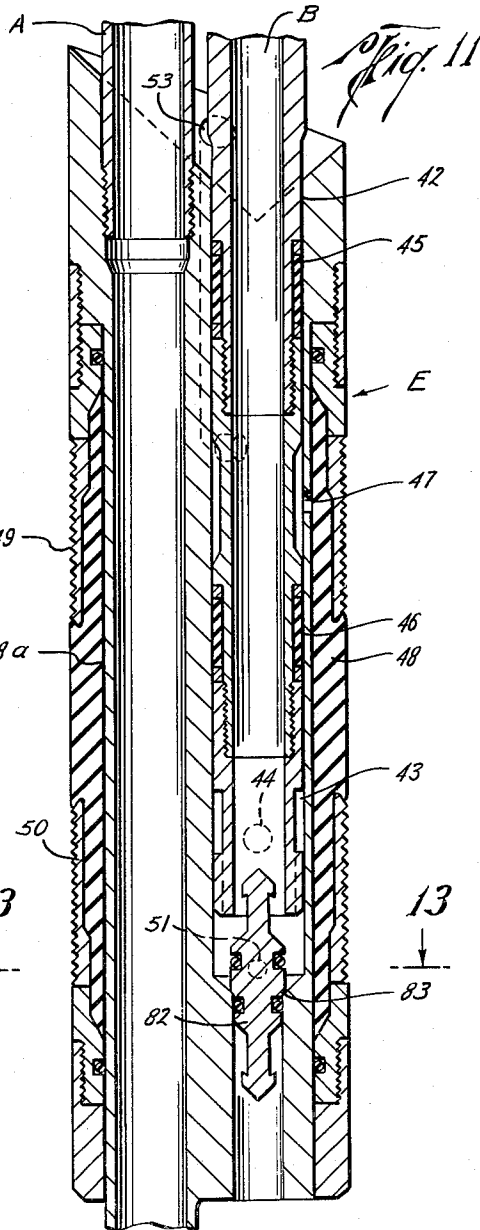
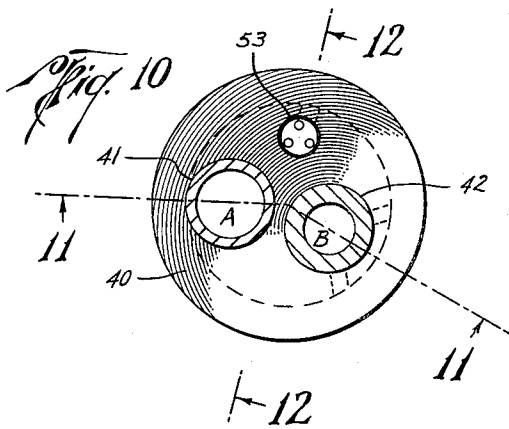
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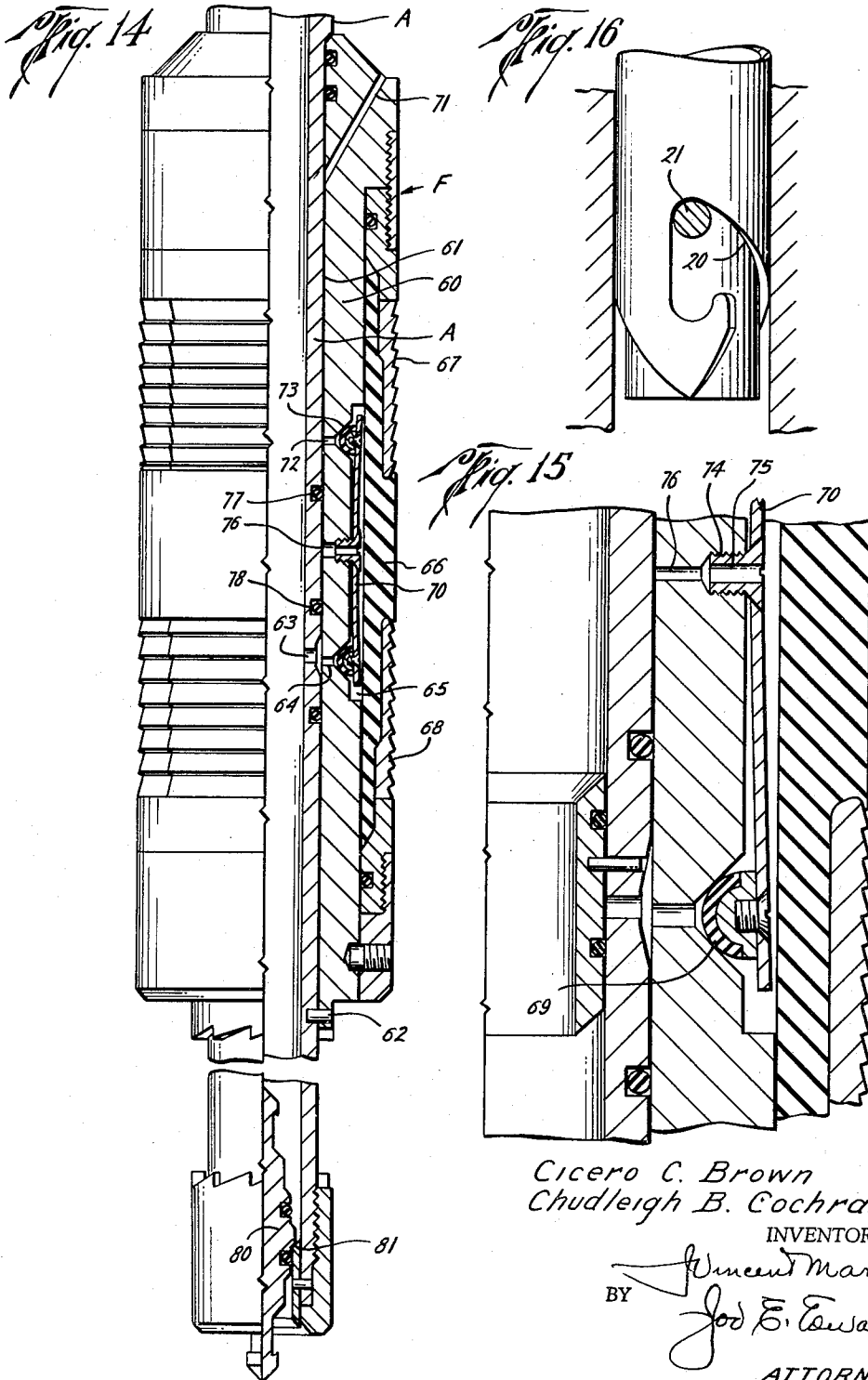
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METHODS OF AND APPARATUS FOR COMPLETING MULTIPLE ZONE WELLS

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6 Claims. (Cl. 166—46)

This invention relates to new and useful improvements in methods of and apparatus for completing multiple zone wells.

It is one object of this invention to provide an improved method and apparatus for completing multiple zone wells wherein a plurality of well tubing strings, which conduct the well fluids from the various formations, may be landed in final position in the well head equipment and thereafter need not be disturbed in order to wash the well or perform other necessary operations or in order to effect a setting of the well packers which separate the producing zones.

An important object is to provide an improved method and apparatus wherein a plurality of well packers, which subsequently function to separate producing zones, may be run into the well bore on a single tubing string, after which additional tubing strings may be run into the well and properly connected with respective packers and then all strings may be permanently landed in the well head equipment, all prior to setting of any of the well packers.

Another object is to provide a well completion apparatus of the character described wherein the multiple production strings and the well packers are located in final position in the well and thereafter various well operations may be carried out followed by selective setting of the well packers; setting of said packers being accomplished hydraulically so that no movement of any of the production strings is necessary.

A further object is to provide an apparatus, of the character described, having fluid pressure actuated well packers, each of which is moved into a set or sealing position by the application of fluid pressure thereto and is thereafter retained in set position by the differential of pressures above and below said packer whereby release of the packer may be accomplished only by equalizing the pressures thereacross.

Still another object is to provide an improved well completion apparatus in which a plurality of well packers are lowered into the well on a single production string, after which additional production strings are lowered and removably connected with their associated packers; the arrangement being such that so long as a removable string is in position within a well packer, said packer cannot be released from set position but upon removal of the string pressures across the packer are equalized to automatically retract the packer from its set position.

A further object is to provide an improved type of well packer in which the actuating pressure, which moves the packer to a set position, is trapped behind the expanded packing element of the packer until such time as said pressure is selectively released.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIGURE 1 is a schematic view illustrating a plurality of production strings connected with a plurality of well

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packers within a well bore, with said well packers in an unset or released position and the production strings landed in final position in the well head equipment,

FIGURE 2 is a similar view with the upper well packer in set position,

FIGURE 3 is a similar view showing the upper and intermediate well packers in set position,

FIGURE 4 is a similar view illustrating all of the well packers in set position within the bore,

FIGURE 5 is a plan view of the upper packer, taken on line 5—5 of FIGURE 1,

FIGURES 6A and 6B are longitudinal sectional views of the upper packer element, the section being taken along the line 6A,B—6A,B of FIGURE 5,

FIGURES 7A and 7B are longitudinal sectional views of the upper packer, the section being taken along the line 7A,B—7A,B of FIGURE 5,

FIGURE 8 is a horizontal cross-sectional view taken on the line 8—8 of FIGURE 6B,

FIGURE 9 is a horizontal cross-sectional view taken on the line 9—9 of FIGURE 7B,

FIGURE 10 is a plan view of the intermediate packer, being taken on the line 10—10 of FIGURE 1,

FIGURE 11 is a longitudinal sectional view of the intermediate packer, said section being taken on the line 11—11 of FIGURE 10,

FIGURE 12 is a partial sectional view of the upper portion of the intermediate packer, taken on the line 12—12 of FIGURE 10,

FIGURE 13 is a horizontal cross-sectional view taken on the line 13—13 of FIGURE 11,

FIGURE 14 is a longitudinal sectional view of the lower packer,

FIGURE 15 is an enlarged detail illustrating the one-way check valve employed in the lower packer and

FIGURE 16 is an enlarged detail of the J-slot connection which is made between the removable production strings and the respective well packers.

In the drawings, the numeral 10 designates a well bore having the usual well casing 11 extending therethrough. The well bore is illustrated as traversing an upper producing formation P1, a second producing formation or zone P2 and a third producing formation or zone P3. The casing is formed with suitable perforations 12 opposite each producing zone whereby the well fluids from that zone may enter the bore of the casing. A plurality of production strings or well tubings A, B, and C are illustrated as extending downwardly within the casing 11 of the well bore and these tubing strings are landed or supported in suitable well head equipment 13. Each tubing string has the usual control valve associated therewith. As illustrated in FIGURES 1 to 4, the strings are shown as extending parallel to each other and in alignment; however, in actual practice the three tubing strings would be located within the well casing in a manner more clearly illustrated in FIGURE 5 because the normal diameter of the casing may not permit all three strings to be in adjacent parallel relationship.

Associated with the production strings A, B and C is an upper well packer D, an intermediate well packer E and a lower well packer F. As shown in FIGURE 1, the upper well packer D, is adapted to seal the space around all three production strings A, B and C with the production string C terminating at the lower end of this upper packer. The two production strings A and B extend downwardly to the next below or intermediate packer E with the string A continuing downwardly to be associated with the lowermost packer F. The string B terminates adjacent the lower end of the intermediate packer E.

In carrying out the present method, and as will be

explained in detail, the three packers D, E and F are mounted upon or carried by the production string A, so that said production string may be lowered downwardly through the well casing to position the packers within the well bore. It is, of course, evident that the packers D, E and F will be properly spaced on the production string A so that when in final position within the bore, the uppermost packer D will be above the upper formation or zone P1, the intermediate packer E will be between the producing zones P1 and P2 and the lower packer F will be between the producing zones P2 and P3. After the string A has been lowered into the well to its final position to locate the packers D, E and F as illustrated in FIGURE 1, the second string B is then lowered through the well casing until it reaches its final position. The string B is passed downwardly through the upper packer D and is landed into the intermediate packer E as will be explained. The production string B has its lower end in communication with the area between the intermediate packer E and the lower packer F, while the first production string A has its lower end in communication with the production zone P3 below the lower packer F.

Following the running of the second string B, the third production string C is then lowered into the well casing and has its lower end landed in the uppermost packer D so that the lower end of the production string C is in communication with the space between packers D and E, that is the area communicating with the uppermost production zone P1.

All three packers are located as shown in FIGURE 1 and the three production strings A, B and C are landed in their final position within the control head equipment 13. As will appear hereinafter, any of the packers D, E or F may be set selectively. However, before setting said packers, it may be desirable to wash the well or to perform other operations. This may readily be done by pumping downwardly through the production string A into the lower portion of the well and returning upwardly around all three packers which are in an unset position. Of course, some return could be had through either of the other two conductors B and C. If it is desired to wash between packers E and F, circulation could be downwardly through the second production string B or it may be desirable to circulate downwardly through string C. Obviously, the operator has any choice and may perform any operation which might be indicated as being necessary.

After any well operations, such as washing, have been completed, it is preferable to initially set the upper packer into its sealing position as shown in FIGURE 2. This is accomplished without any movement of any of the production strings and, as will be explained, once the packer D is set, it will remain in set position until such time as either the production strings B or C are removed. After the upper packer D is set, as shown in FIGURE 2 it may be desirable to carry out additional washing operations, and this can be done by circulating downwardly through the string A and returning through string B, or vice versa. Also by closing one of the strings and applying a pressure below the set packer D, the efficiency of the seal of said packer may be checked.

Following setting of the upper packer D, the intermediate packer E is then moved into a set or sealed position and this too is accomplished without any movement of the production strings. Once the packer E is set, it will remain in its set position until removal of the production string B.

Following setting of the second packer, it is possible to test the sealing efficiency thereof by applying a pressure through the string A and closing off string B. Thereafter, the lowermost packer is moved into a set or sealing position as is illustrated in FIGURE 4. This setting is accomplished hydraulically and without any motion of the production strings or the upper packers and when

the lower packer is finally set, the producing zones P1, P2 and P3 are efficiently separated from each other. As explained, the upper zone is in communication with the production string C, the intermediate zone P2 is in communication with the conductor or production string B and the lower zone P3 communicates with production string A. Each zone may thus be independently produced and its production will not be admixed with the production from the other zones.

When the apparatus is to be removed from the well, the production string C is detached from the upper packer and is removed and such removal will permit pressures to equalize across the upper packer to retract the same. Upon removal of the second string B, pressures across the intermediate packer are equalized and this packer is retracted. Following removal of the string B, an upward movement of the production string A will effect a release of the lower packer F and all three packers may be removed from the casing.

It is noted that although three productions strings and three packers are illustrated, the invention could be carried out with two production strings and two packers where it is desired to produce only from two formations. Also, if the casing is of sufficient size, it would be possible to run four production strings and four packers whereby production from four different zones could be accomplished independently of each other through separate production strings. The use of three strings and three packers is, therefore, exemplary only.

Although the particular packers, which are employed in carrying out the improved method and which form a part of this apparatus, are subject to variation, the particular type of packers, which have been found suitable, are illustrated in FIGURES 5 to 14. Referring to FIGURES 6A and 6B, such figures illustrate the uppermost packer D. This packer comprises a generally cylindrical body 15 which has three longitudinal bores or passages 16, 17 and 18 extending completely therethrough. The passage 16 has its upper end threaded (FIGURE 6A) and has the production string A connected thereto. The lower end of passage 16 is formed with external threads so that a continuation of said production string A may be attached thereto.

The second passage 17 extends entirely through the body 15 as is illustrated in FIGURE 6B. The conductor or production string B is arranged to extend entirely through the bore or passage 17. The third bore or passage 18, which is formed in the body 15, also extends entirely through the body in the manner shown in FIGURE 7B. The production string C (FIGURE 7A) is adapted to enter the bore 18 and it is pointed out that the bore or passage 18 is of less diameter than the bore or passage 17 which receives the production string B. Thus, when the production string B is being run into the well bore, it strikes the upper end 15A of the body 15 of the upper packer, and due to inclined guide surfaces formed on this upper end, it is guided into the passage 17. The production string B, being of a larger diameter than the passage or bore 18, cannot enter this bore, and, therefore, it can only enter and pass through the larger bore or passage 17.

The passage 18 is arranged to receive the lower end of the production string C in the manner illustrated in FIGURE 7A. The lower end of the production string C is provided with a coupling member 19 having a J-slot 20 therein. A pin 21, which projects into the bore 18, is adapted to co-act with the J-slot in the manner illustrated in detail in FIGURE 16. Thus, when the production string C is lowered into place, the J-slot connection will attach the production string C to the upper packer D.

The body 15 of the upper packer carries a packing or sealing sleeve 22, and this sleeve may have sectional or segmental slip members 23 and 24 imbedded in its upper and lower portions. The packing or sealing element 22 is actually an elastic packing element, which is adapted to be moved radially outwardly into sealing con-

tact with the well casing 11 when pressure fluid is introduced into the bore 22A of said element. In order to introduce pressure fluid into this space within the packing element, the bore or passage 18 (FIGURE 7B) is formed with a pressure inlet port 25. This port, as shown in FIGURE 9, extends from the bore 18 to the bore or inner surface 22A of the packing element. A suitable check valve 30 is provided within the passage 25 so that pressure fluid, which is applied from the bore 18, may enter the interior of the packing element but cannot return into the bore 18. Therefore, any pressure fluid, which is applied, to the interior of the packing element or sleeve 22, will be trapped within the packing element and will serve to maintain the same in its expanded position.

Release of the pressure fluid from behind the packing sleeve or element 22 can be effected through a pressure relief port 31, which is shown in FIGURES 6B and 8. This port 31 communicates with the bore or passage 17. However, when the production string B is in place, said production string is formed with packing elements 32 and 33 which seal with the wall of the passage 17 on each side of the pressure release port 31 and serve to prevent any escape of such pressure fluid. It will thus be obvious that when the production string B is in position within the bore or passage 17, the pressure release port 31 is effectively closed.

After pressure fluid is applied to the interior of the packing element 22, said element is expanded outwardly into a sealing position and this pressure fluid is trapped by the one-way check valve 30. The pressure fluid can not escape from the interior of the packing element around the lower end thereof because of an O-ring seal 34 provided on the lower slip segments 24 and sealing with the body 15. However, pressure fluid from above the expanded packer may enter the area within the packing element through a radial port 35 which is formed in the upper portion of the body. This port communicates with the bore 22A of the packing element 22 by flowing past an O-ring 36. The O-ring is confined in a beveled groove 37 and said O-ring actually functions as a one-way check valve. In other words, pressure fluid from above the element 22 may by-pass the O-ring 36 and many enter the space behind the packing element to further expand the same.

It will thus be seen that after the pressure fluid is applied to the packing element to expand the same, the pressure fluid is trapped behind said element to maintain it in its sealing position. The pressure fluid within the bore 18 may continue to enter the space through passage 29 and past the check valve 30 whenever the pressure within bore 18 is greater than the pressure behind the element 22A. However, if the pressure within the bore 18 decreases below the pressure which is acting through port 35, which is the pressure above the packing element, then the pressure fluid from above the packing element will move into the area behind the packing element to maintain it in a sealed position. Thus, the differential between the pressure above the packing element and the pressure in the bore 18 will maintain the packing element in its sealing position so long as the production string B is in place.

Whenever the production string B is removed from the bore 17 in the body 15 (FIGURE 6), then the release opening or port 31 establishes communication between the bore 17 and the area behind the annular packing element 22. When this occurs, the pressure fluid behind the element may escape and pressures around said element may become equalized whereby the element is retracted.

The intermediate well packer E operates on a similar principle to that of the upper packer D. The intermediate packer is illustrated in FIGURES 10 to 13. Referring to FIGURES 10 and 11, the intermediate packer comprises a body 40 having a bore or passage 41 and a second bore or passage 42 extending entirely there-

through. The bore 41 is threaded at its upper and lower ends whereby it may be connected into the production string A so that it may be lowered with said string. The second bore 42 of the body 40, is arranged to receive the lower end of the production string B. This production string has a J-slot coupling 43 on its lower end which is arranged to co-act with a connecting pin 44, this J-slot connection being similar to that shown in FIGURE 16. Above the J-slot connection, the production string B is provided with spaced packing elements 45 and 46 which seal off a release port 47. A packing element 48, similar in construction to the annular packing element 22 of the upper packer, is mounted on the body 40 and has gripping slips 49 and 50 imbedded therein.

The area within the packing element 48, that is the bore 48A of said element, is in communication with the bore or passage 42 of the body, through a pressure inlet port 51 located nearer the lower end of the bore 42. When pressure fluid is introduced through the port 51, it passes a check valve 52 shown in FIGURE 13 and is applied to the interior of the packing element 48 to cause the same to expand outwardly into sealing engagement with the wall of the well bore. The bore 48A of the packing element 48 is also in communication with the area above the intermediate packer through an elongate passage 53 which extends downwardly from the upper end of the body 40. The passage is clearly shown in FIGURE 12 and may have a one-way check valve 54 mounted therein, with the lower end of the passage communicating with the space between the body 40 and the packing element 48.

When pressure fluid is applied through port 51, the packing element 48 is expanded and the pressure fluid behind the packing element is trapped therein by reason of the one-way check valve 52. If the pressure above the packer exceeds the pressure which is holding the packing element in its expanded position, then additional pressure fluid may enter through the passage 53 to assure that the packing element will remain in a sealing position. Since the pressure fluid is trapped behind the packing element and since the release port 47 is closed so long as the production string B is in place (FIGURE 11), the element will remain in its set position.

When the production string B is removed from the bore 42 of the body 40, then the release port 47 establishes communication between the bore 42 and the area behind the packing element 48. When this occurs, pressures around the packing element may be equalized and the packing element will be moved to a retracted position.

The lower packer F is illustrated in FIGURES 14 and 15 and includes a body 60 having a bore 61 extending therethrough. The lower portion of the production string A extends downwardly through the bore 61 and is connected to the body 60 through a shear pin 62. When so connected, a radial port 63 formed in the production string A is aligned with an inlet port 64 which communicates with the area 65 behind an annular packing element 66 which is mounted on the body 60. This packing element 66 is of a construction similar to the packing elements 22 and 48 of the upper and intermediate packers, being provided with slips 67 and 68 which are preferably moulded or imbedded therein.

With the parts in position shown in FIGURE 14, the application of a pressure fluid through the port 63 will pass through port 64 and then past a check valve 69 which is mounted upon one end of a spring member 70. The pressure fluid enters behind the packing element 66 and expands the same into a sealing position. This pressure fluid is trapped therein so long as the parts remain in the position of FIGURE 14 to assure that the packing element will remain expanded.

In order to assure that a pressure differential across the packer will maintain it in its sealing position, an inclined passage 71 is provided and communicates with the space between the production string A and the bore 61 of the

body 60. Thus, if the pressure above the packing element exceeds the pressure within the area 65 behind the packing element, the pressure fluid from above may pass downwardly between production string A and body 60 and enter a port 72 which is controlled by a check valve 73. The check valve 73 is mounted upon the upper end of the spring member or bar 70 which also carries the check valve 69. Upon entry of the pressure fluid through passage 71 and port 72, the pressure fluid is trapped behind the element 66.

The construction of the check valves 69 and 73 is a desirable feature because both valves may be carried by the single spring member 70 which has its central portion attached by a screw 74 to the body 60 of the packer. The screw 74 is formed with an opening 75 communicating with a release port 76, this port leading to the bore 61 of the body. In order to close the port 76 while the packer is in its expanded position, a pair of spaced O-rings 77 and 78 are mounted on the production string and are located on each side of the release port 76.

In order to set the lower packer, a plug 80 is dropped downwardly through the production string A and engages a seat 81 at the lower end thereof to close the bore. Pressure fluid within the string A may then be built up and will be introduced through port 63, past check valve 69 and into the area behind the packing element 66 to radially distort or expand the same into sealing position. The pressure fluid, which moves the packing element into sealing position, is trapped by the check valves 69 and 73 and thus the packer remains in its set position. In the event that the pressure above the packing element 66 exceeds the pressure of the fluid which has been introduced behind the packing element or the pressure within the bore of the production string, then a flow of pressure fluid may occur through passage 71, port 72 and past the check valve 73 to assure that the packing element will remain in its expanded or sealing position.

When it is desired to release the lower packer, the production string is pulled upwardly and since the packer is set, the pin 62 will shear, thereby permitting a relative upward movement of the production string from the position shown in FIGURE 14 with respect to the packing element. Such relative movement will move the port 63 in the production string opposite the opening or release port 76 so that a communication is established between the interior of the production string and the area 65 behind the packing element. With the plug 80 removed, pressures across the packer may equalize to permit the packing element to return to its retracted or normal position.

As has been pointed out with respect to the lower packer, the pressure fluid which is applied to the packing element thereof, is applied through the production string A with a plug 80 in position in the lower end of the string. In order to set the intermediate packer, a plug is dropped downwardly through the bore 42 of the body 40 of the intermediate packer and this plug is illustrated at 82 in FIGURE 11. The plug is adapted to engage a seat 83 provided for the purpose in the lower portion of the bore or passage 42 of the packer body. With the plug in place, a pressure fluid applied to the intermediate production string B may pass downwardly and through the pressure inlet port 51, passing the check valve 52 and entering the area behind the packing element 48 to expand the same.

In order to effect a selective expansion of the upper packer element, a plug indicated in dotted lines at 84 in FIGURE 7B, is adapted to be dropped through the production string C and to fall downwardly through the passage 18 in the body 15 of the upper packer D. This plug is engageable with a seat 85 to close the passage 18. Upon such closure the application of pressure fluid through the production string C will effect an

expansion of the packing element 22 of the upper packer.

It is believed that the use of the apparatus and the practice of the improved method is obvious from the foregoing. Initially, the packers D, E and F are connected to the production string A in the manner described and are lowered into the well casing 11 by means of this production string. After the packers are positioned as illustrated in FIGURE 1, the second production string B is lowered within the well casing. As this string contacts the upper end 15A of the body 15 of the upper packer, it is guided into the bore or passage 17 which is provided in the body 15. As pointed out, the diameter of the bore 17 in the body 15 is larger than the bore 18 which receives the third production string C and, therefore, the production string B must enter and pass through the bore 17. As illustrated in FIGURE 1, the production string B extends entirely through the bore 17 of the upper packer, being provided with the spaced seals 32 and 33 which seal the release port of the upper packer. The lower portion of the production string B then extends downwardly into the bore or passage 42 of the intermediate packer (FIGURE 11). The lower end of the production string B is then connected through the J-slot and pin 43-44 connection and is secured to the intermediate packer. The spaced sealing elements 45 and 46 on the production string are located within the bore 42 of the intermediate packer and serve to close off the release port 47 of said intermediate packer.

The third production string is then lowered into the well and is guided into the opening 18 of the upper packer and is coupled thereto by the J-slot and pin connection 20-21, as shown in FIGURE 7A. All three production strings are then properly landed in final position within the control head equipment 13, and at this time none of the packers D, E or F are set. As explained, it is then possible to carry out a washing operation or any other kind of an operation which it may be desired to perform within the well bore. Since none of the packers are in set or sealing position, a free circulation around all packers is possible.

Following the completion of any circulating operations, which may have been necessary, it is then preferable to drop the plug 84 (FIGURE 7B) downwardly through the production string C. This closes the lower end of the production string C and permits the production string C to be pressured up in order to apply an internal fluid pressure to the packing element 22 of the uppermost packer D. As explained, this fluid pressure is trapped behind the packing element and, after the upper packer is set, the plug 84 may be removed, and the packer will remain in a set position.

After setting of the upper packer, as illustrated in FIGURE 2, any additional operations may be performed in the lower portion of the well bore. In order to set the intermediate packer, it is only necessary to drop the plug 82 (FIGURE 11) and close the lower end of the bore of the production string B. By applying the pressure fluid through the production string B, pressure fluid is introduced behind the annular packing element 48 of the intermediate packer and is trapped behind such element to maintain the same in its set position. Thereafter, the third or lowermost packer F may be set by dropping the plug 80 in the production string A and applying a sufficient fluid pressure to expand the lower packer. When this is accomplished, the plugs may be removed, each plug being preferably provided with a fishing neck whereby it can be readily removed by wire line and the production strings are thus opened to their respective producing formations.

Each string will produce the well fluids from its own formation independently of the other fluids and the packers will remain effectively sealed within the well bore. After the plugs have been removed, it is obvious that the packers will be maintained in a set position by the

pressure differential which is present across the packing element. Each packing element will have its annular space or bore exposed to the pressure within the bore of its production string because of the one-way check valve. At the same time, fluid pressure from above each packing element may also enter the space within the annular packing sleeve if such fluid pressure is greater than that holding the same in sealing position.

When it is desired to release the lower packer F, it is only necessary to pull upwardly on the production string A to shear pin 62 (FIGURE 14) which aligns the port 63 with the release port 76 to equalize pressures across the packing sleeve 66 and permit the same to retract. Retraction of the intermediate and upper packer may be accomplished by merely removing the production string B. Removal of the production string B from the bore 42 of the intermediate packer will establish a communication between the release port 47 and the area below the packer, whereby pressures across the packing element may equalize. As the production string B is removed from the bore 17 of the upper packing element, it exposes the release port 31 of the upper packer D and permits an equalization of pressures across the element so that the same may be retracted.

It is evident that the invention provides an apparatus which permits a plurality of production strings and well packers to be located in their final respective positions within a well bore, with the production strings finally landed in the well head equipment. After the well head equipment has been connected up in the usual manner, it is then possible to selectively set the various packers or to circulate in any desired manner to perform various well completion operations. After the packers are in set position, the fluid pressure, which is holding the packers set, is trapped and can not escape to release the packers until the operator intends that such release be accomplished. In the case of the intermediate and upper packers, the positioning of the production string B within these packers automatically closes the release opening and it is impossible to release the packers from their set positions until the production string B is removed. The lower ends of the various strings have been indicated as being closed by plugs which may be dropped and pumped downwardly to position and removed by a wire line. However, it is obvious that any suitable type of closure and any manner of bringing it to the surface, as by circulating it upwardly, could be employed. The packing elements or sleeves of the various packers are constructed of any suitable elastic material such as rubber, rubber compound or the like, and the use of the invented segmental slip members provide for a tighter setting of the packers in position. However, the invention is not to be limited to the use of the slip segments although they have been found preferable. Also, any suitable type of check valve may be employed in order to trap the fluid pressure within the packing sleeve to hold said sleeve in its expanded or sealing position.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What we claim is:

1. In a well completion apparatus, a well packer including, a body having a bore extending therethrough, an annular elastic packing element mounted on the body, gripping means embedded in the outer surface of said element and engageable with the pipe wall when the packing element is expanded radially, means in the wall of the body communicating with the interior of the packing element and establishing direct communication between the bore of the body and the interior of the packing element, whereby fluid pressure from the bore may be directed to the interior of the element to expand the

same, a check valve means in said communication-establishing means for trapping the fluid pressure which has been applied to the interior of the element to maintain the element in expanded sealing position, additional means in the body establishing communication between the area above the packing element and the interior thereof, and check valve means in said additional communication-establishing means permitting entry of fluid pressure from the area above the element but preventing escape of fluid pressure from within the element, whereby the element is maintained in expanded position by the differential in the fluid pressure present in the bore of the body and the fluid pressure present in the area above the element.

2. In a well completion apparatus, a well packer as set forth in claim 1, with a pressure release passage in the wall of the body extending from the pressure area within the packing element, and check valve means in said pressure release passage for selectively opening said release passage to release the pressure and effect a retraction of said packing element.

3. The method of completing a multiple zone well bore which traverses at least three producing zones and includes, lowering a trio of spaced well packers into the well bore on a first production string with said packers in a nonsealing position, said first string extending entirely through all of said packers and having its lower end communicating with the producing zone below the lower packer, thereafter running a second production string to extend through the uppermost packer, releasably connecting said second string to the intermediate packer to communicate with the producing zone between the lower and intermediate packers, thereafter running a third production string and releasably connecting the same to the uppermost packer to communicate with the producing zone between the intermediate and the upper packer, connecting control equipment including a tubing head to the upper end of the casing, landing all production strings in final position within the tubing head to suspend said strings in the well bore, then setting the uppermost packer by the application of fluid pressure from the third production string, then setting the intermediate packer by the application of fluid pressure from the second production string, and then setting the lower packer by the application of fluid pressure from the first production string.

4. The method as set forth in claim 3, together with the additional step of releasing the fluid pressure acting to maintain the lower packer in set position by a manipulation of the first production string.

5. The method as set forth in claim 3, together with the additional step of releasing the fluid pressure acting to maintain the lower packer in set position by manipulation of the first production string, and thereafter releasing the fluid pressure acting on the intermediate packer by disconnection and removal of the second production string from said intermediate packer.

6. The method as set forth in claim 3, together with the additional step of releasing the fluid pressure acting to maintain the lower packer in set position by a manipulation of the first production string, thereafter releasing the fluid pressure acting on the intermediate packer by disconnection and removal of the second production string from said intermediate packer, and also releasing the fluid pressure acting on the upper packer by removing the second string from its position extending through said upper packer.

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