

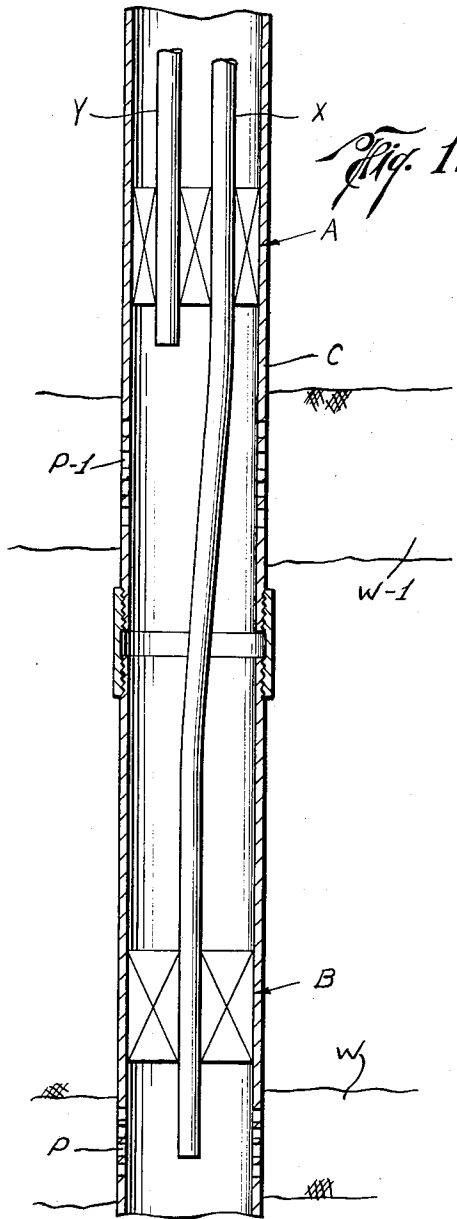
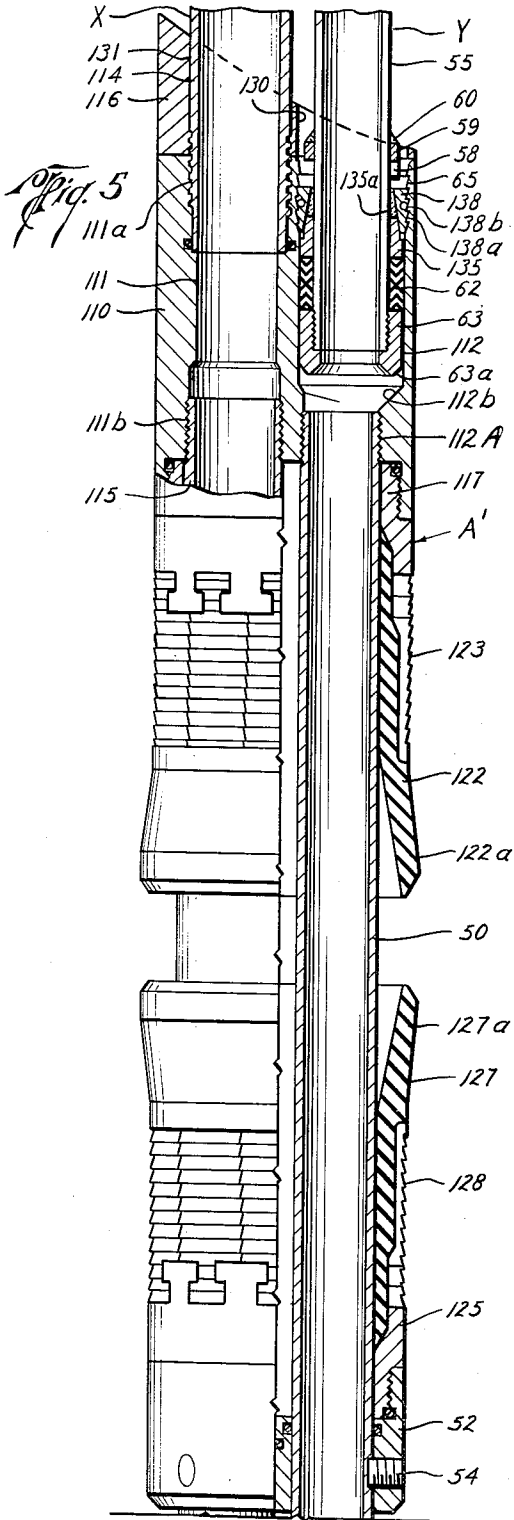
Dec. 20, 1960

C. C. BROWN
WELL APPARATUS AND METHODS OF SETTING
A PLURALITY OF TUBING STRINGS
IN A WELL BORE

2,965,173

Original Filed Dec. 6, 1954

2 Sheets-Sheet 1



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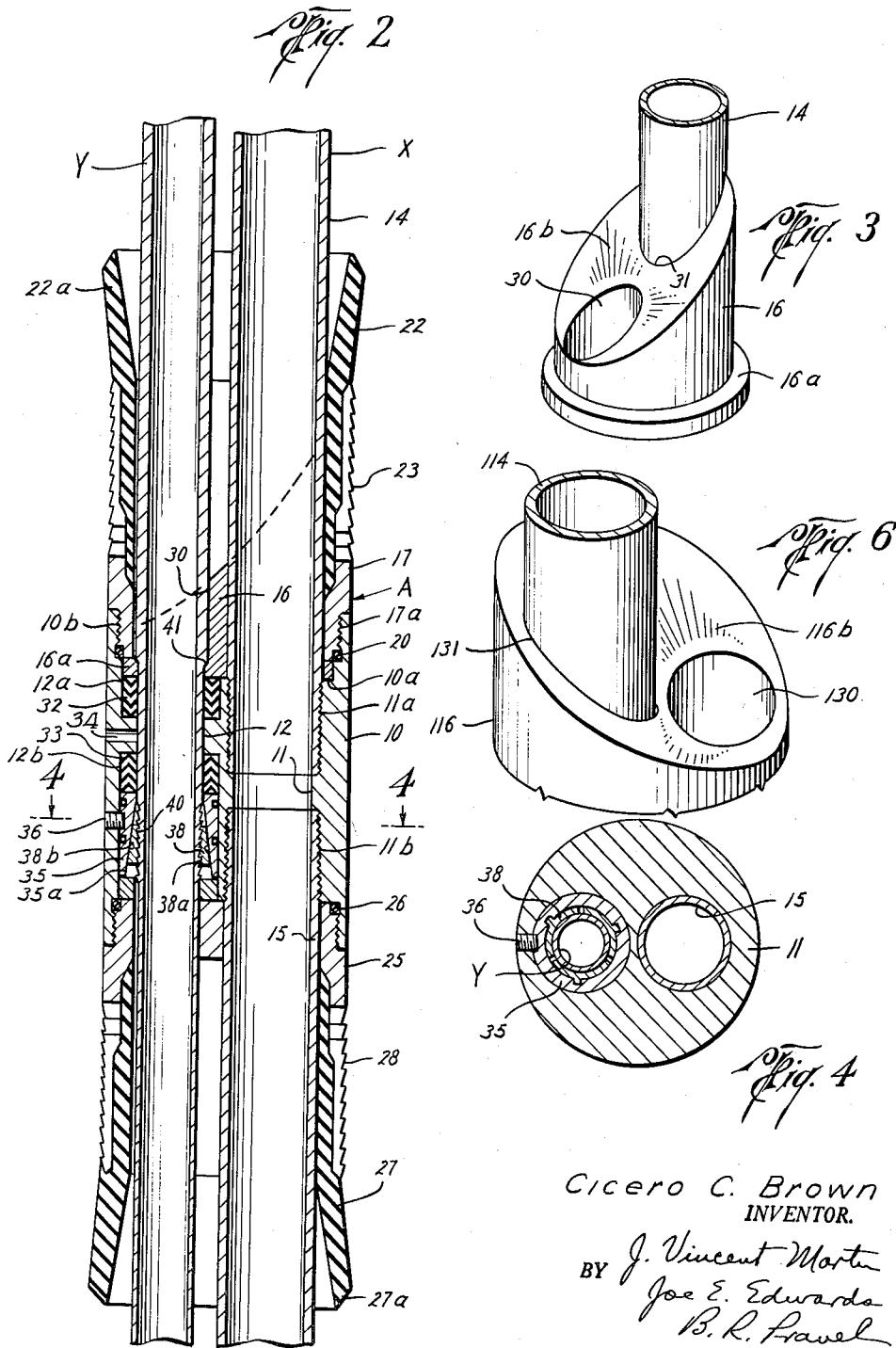
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WELL APPARATUS AND METHODS OF SETTING A PLURALITY OF TUBING STRINGS IN A WELL BORE

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Continuation of application Ser. No. 473,303, filed Dec. 6, 1954. This application Apr. 28, 1955, Ser. No. 504,512

12 Claims. (Cl. 166—46)

This invention relates to new and useful improvements in well apparatus and methods of setting a plurality of tubing strings in a well bore.

This application is filed as a continuation of my co-pending application Serial No. 473,303, filed December 6, 1954, now abandoned.

An object of this invention is to provide a new and improved well packer apparatus which is adapted to be positioned in a well pipe or casing in sealing contact therewith.

An important object of this invention is to provide a new and improved well packer apparatus wherein the packer is adapted to be lowered into the well bore on one string of tubing, and wherein means are included with the packer for attaching a second string of tubing therewith after the packer has been positioned in the well bore, whereby each tubing string may be handled individually and independently of the other in running and removing said string from the well bore.

Another object of this invention is to provide a well apparatus and method, wherein one packer is adapted to receive a tubing string which has connection with a second packer, and wherein the second packer has means for receiving in engagement therewith a second tubing string.

A further object of this invention is to provide a new and improved well packer apparatus which has connected therewith a tubing string which is adapted to extend through an opening in a second well packer and which is detachable therefrom while the second packer is in the well bore.

A particular object is to provide an improved method for running and setting a plurality of tubing strings within a well bore which includes initially locating and setting a lower packer within the bore to seal off between upper and lower producing formations, lowering a second packer on a first tubing string and setting said second packer above the upper producing formation, thereafter lowering a second tubing string and connecting the same to a flow passage in the upper packer, and establishing communication between the lower producing formation and one of the tubing strings and also between the upper producing formation and the other tubing string.

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 the apparatus of this invention in a well pipe or casing.

Figure 2 is a sectional view illustrating one form of the apparatus of this invention.

Figure 3 is an isometric view illustrating the means for guiding the second string of tubing into the well packer.

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Figure 4 is a horizontal section view taken on lines 4—4 of Figure 2.

Figure 5 is a view, partly in elevation and partly in section, illustrating a modified form of an improved packer of this invention.

Figure 6 is an isometric view illustrating the means for directing the second string of tubing into the well packer of Figure 5.

In the drawings, the letter A designates the improved packer of this invention which is adapted to be lowered into a well pipe or casing C in an oil well or the like. The packer A has extending therethrough and connected therewith a first tubing string X (Figure 1) which is depending therefrom and which extends downwardly through the central opening in the well packer B which is of conventional construction and is preferably a packer which has been previously lowered and set in position in the well casing C on a wire line, such as disclosed in my co-pending U.S. patent application Serial No. 260,859, now Patent No. 2,739,651. As will be explained, the packer A is so constructed that a second tubing string Y is attached to the packer A for conducting fluids there-through to or from a point below the packer A.

The packer B is set between well formations W and W-1 while the packer A is set above formation W-1. The well casing C is, of course, perforated in the usual manner so that perforations P establish communication between the lower producing formation W and the interior of the casing below packer B and perforations P-1 establish communication between the upper producing formation W-1 and the area interiorly of the casing between the packers A and B. With this arrangement, flow may occur from the lower producing formation through the tubing X and at the same time flow from the upper producing formation is conducted through the tubing string Y.

In Figures 2-4, the details of one form of the upper packer A are illustrated. The packer A has a packer body 10 which has a longitudinal opening 11 and a second longitudinal opening 12, which are adapted to receive the tubing strings X and Y, respectively, as will be explained. The longitudinal opening 11 has an upper threaded portion 11a which is threadedly engaged with the external threads on the lower end of the tubing 14 which forms a part of the first tubing string X. Additional threads 11b, are formed in the bore or opening 11 for threaded engagement with the external threads on the upper end of the pipe or tubing 15 which forms the downward extension of the tubing string X. It is, therefore, apparent that the tubing string X is firmly attached to the central body member 10.

The upper internal portion of the body 10 is formed with an annular shoulder 10a which provides a rest or supporting surface for a guide shoe or mule shoe member 16. The guide shoe 16 is retained in position against upward movement relative to the body 10 by means of an annular ring 17 which has external threads 17a which interengage with the threads 10b on the body 10 to connect the ring 17 to the body 10. The lower end of the ring 17 extends above the annular flange portion 16a of the guide shoe 16 and also confines a seal ring 20 which is formed of rubber or other resilient material. An upper sealing cup or element 22 formed of rubber or other resilient material is molded or otherwise connected to the annular retaining ring 17, with gripping members 23 being connected therewith for sliding lateral movement, whereby upon a lateral or radial distortion of the sealing element 22 into sealing contact with the well pipe or casing C, the gripping elements 23 engage in gripping contact with such pipe or casing C. The sealing cup or element 22 is annular in construction with the upper end

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22a being flared outwardly into contact with the pipe C. The gripping members 23 are preferably formed in arcuate segments so as to form together an annular member while permitting separate movement of each of the segments outwardly as the sealing cup 22 is expanded by fluid pressure.

Below the body 10, a retaining ring 25 which is similar to the retaining ring 17 is provided and also a sealing ring 26 is confined by such retaining ring 25. The lower sealing cup or element 27 is molded or otherwise connected to the retaining ring 25 and is formed of rubber or other resilient material which is in the form of a cylinder with the lower end 27a flared outwardly so that fluid pressure acts to expand same outwardly. The gripping members 28 are formed in segments which together form a cylinder while permitting such segments 28 to expand outwardly as explained above in connection with the gripping segments 23.

The guide shoe 16, previously referred to, serves to guide the second string of tubing or pipe Y into the longitudinal opening 30 (Figure 3) which is aligned with the longitudinal opening 12 in the body 10. For this purpose, the upper surface 16b of the guide shoe 16 is concave or dished and is inclined so that a pipe contacting the same from above is always guided to the longitudinal opening 30. Therefore, the second tubing string Y can be lowered into the well casing C after the well packer A has been positioned in the casing C to properly position the tubing string Y in the opening 30 and the aligned opening 12 of the packer body 10. Thus, the tubing string Y can be readily positioned in its proper relationship with the rest of the packer structure by simply lowering same into the well casing. A fluid seal is provided around the second tubing string Y by chevron packing rings 32 and 33 which are positioned in annular grooves 12a and 12b, respectively, in the longitudinal opening 12. An equalizing port 34 between the packing rings 32 and 33 is thus closed when the tubing string Y is in the bore or opening 12 with its external surface in contact with the rings 32 and 33 so that the bore 12 is not in fluid communication with the area between the seal cups 22 and 27 whereby a differential in well fluid pressure above and below the packer effects the setting or outward expansion of the cups 22 and 27 into sealing contact with the well casing C. Of course, when the tubing string Y is removed from the opening 12, then the fluid pressure between the cups 22 and 27 is equalized with the fluid pressure above and below the packer.

In order to lock the tubing string Y relative to the packer structure after the string Y is in the proper position, an automatic bottom thread device is used which includes a wedge member 35. The wedge member is formed with a substantially cylindrical outer surface and a curvilinear or frusto-conical wedge surface 35a which is downwardly and outwardly inclined. The member 35 is positioned in the recess 12b below the packing 33. A set screw 36 retains the wedge member 35 in position. A plurality of arcuate nut members 38 having internal threads 38a are slidably mounted within the wedge member 35 for longitudinal movement relative to the wedge member 35. An annular spring 38b urges the nut members 38 inwardly so that they maintain a cylindrical shape. The tubing string Y has a plurality of external threads 40 formed thereon which engage with the internal threads 38a of the nut members 38. Upon a non-rotative upward movement of the tubing Y the nut members 38 slide upwardly along the wedge surface 35a of the wedge cylinder 35 to lock the members 38 against upward movement whereby the tubing string Y is also restrained against upward movement.

Upon a lowering of the tubing Y, the nut members 38 are expanded outwardly by the threads 40 so that the threads 40 slide into threaded engagement with the threads 38a. An annular shoulder 41 is provided on the tubing string Y for limiting the downward movement of

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the tubing string Y relative to the rest of the packer structure. However, upon a rotation of the tubing Y to the right, assuming the threads 38a and 40 are left-hand threads, the tubing Y is released for detachment from the packer A. The threads 38a and 40 can of course be right-hand threads, in which case the release of the tubing Y would be effected by a left-hand rotation of the tubing Y.

In the operation or use of the apparatus and in carrying out the improved method, the well packer A is lowered into the well casing C on the first tubing string X and the lower end of the tubing string X is inserted through the central opening in the wire line packer B which was previously run and set so as to provide for conducting well operations below the well packer B. With the first tubing string X thus in position in the lower well packer B, the second tubing string Y is lowered into the well bore and the lower end thereof initially is guided into the upper portion of the packer 22 by reason of the upper flared end 22a of such sealing element 22. Upon continued lowering of the tubing string Y, the lower end thereof is guided into the opening 30 by the concave guide surface 16b of the guide shoe 16 and thereafter the tubing string Y is further guided and lowered through the opening 12. Ultimately, the second string Y seats on the shoulder 41 and the threads 40 engage with the thread segments 38 so that the tubing string Y is locked against the movement relative to the packer A. The lower end of the tubing string Y extends below the packer A and, therefore, well operations can be conducted between the packers A and B through the second pipe string Y. The packer A is set into sealing and gripping engagement with the well casing C by a differential in the well fluid pressure above and below the packer A, and, therefore, such setting occurs after the second tubing string Y has been properly landed or positioned in the packer A (Figure 2).

After the desired well operations such as acidizing, sand-fracing or the like are performed in the well, the additional well operation of producing well fluids from the formations W and W-1 through the two tubing strings may be accomplished. When desired, the second tubing string Y is selectively detachable from the packer A by a rotation of the tubing string Y to the right, assuming that the threads 40 and the internal threads 38a on the slip segments 38 are left-hand threads. The string Y may thus be detached and removed individually or independently of the string X which is of advantage because only one string is being handled at the surface at one time. With the tubing string Y removed, the pressure above and below the packer A is again equalized and the packer A can, therefore, be moved upwardly in the casing C by lifting upwardly on the tubing string X, whereby subsequent removal of the string accomplishes removal of the packer. The upward movement of the tubing string X as said string is removed from the bore moves the lower end thereof which is below packer A upwardly and out of the central opening in the packer B, whereby the packer B is exposed for subsequent removal by the known wire-line operation.

From the foregoing, it will be seen that the apparatus and method facilitates the use of dual strings of tubing without the requirement that both strings be run in and removed from the well simultaneously. Each string is handled separately at the surface whereby the running and removal operations are simplified. In accordance with the method, the lower packer B may be initially set, preferably by wire-line operation, after which the upper packer A is lowered by means of one of the tubing strings; thereafter the second tubing string is run into position and connected to the upper packer and communication is established between the formations and the tubing strings. It is noted that although the lower formation is illustrated as producing through the tubing X the communication between the formations W and

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W-1 and the two strings X and Y may be reversed so that production from the lower zone may be conducted to the surface through the tubing string Y.

In Figures 5 and 6, the details of a modified packer construction A' are illustrated, such packer A' being usable with a detachable string of pipe in a similar manner to that described above in connection with the well packer A. The packer A' also employs a pair of sealing cups 122 and 127 which are similar to the sealing cups 22 and 27 of packer A, but the sealing cups 122 and 127 of the packer A' are opposed to each other (Figure 5) instead of extending away from each other as in the packer A (Figure 2).

The upper packer 122 has a downwardly-extending flared portion 122a which faces toward an upwardly-extending flared portion 127a on the lower packer 127. Both packers are, of course, made of rubber or other resilient material whereby fluid pressure acting on same distorts them into sealing contact or engagement with the well pipe or casing C. With an opposed arrangement such as illustrated in Figure 5, if the fluid pressure acting upwardly is in excess of the fluid pressure acting downwardly, the fluid will pass around the exterior of the flared portion 127a and into the interior of the flared portion 122a to distort the upper sealing cup or element 122 into sealing contact with the well pipe. On the other hand, if the fluid pressure above the packer A' is in excess of the pressure therebelow, the fluid will pass around the exterior of the lip or flared portion 122a and will pass into the interior of the flared portion 127a to thereby distort the lower sealing cup or element 127. The upper sealing cup or element 122 has connected therewith a plurality of arcuate gripping members 123 which are urged outwardly with the sealing cup 122 to engage in gripping contact with the well casing C. The sealing cup 122 and the gripping elements or members 123 are carried by a retainer ring 117 which is molded or otherwise suitably secured to such sealing cup 122 and gripping members 123. The retaining ring 117 is threaded to an annular body member 110 which has a pair of openings 111 and 112 therethrough.

The opening 111 has internal threads 111a at its upper end and 111b at its lower end, with a section of the tubing string X, which is identified by the numeral 114 being threaded to the threads 111 and a second section 115 being threaded to the threads 111b, whereby the tubing section 114 extends to the surface of the well and the section 115 extends below the packer A' for insertion into the opening through a packer such as the packer B (Figure 1). The lower end of the opening or passage 112 has internal threads 112a which engage with threads at the upper end of a section 50 of pipe which forms the lower end of the pipe string Y. It will be noted that the packer A' thus differs from the packer A in that the pipe section 50 is fixed to the packer A' and always extends therebelow.

The lower sealing cup or element 127 surrounds both the pipe section 115 and the pipe section 50. The sealing element 127 carries gripping segments 128 which are secured to the retaining ring 125 which in turn is threaded to a collar 52. Lock screws 54 hold the collar 52 in a fixed position on the pipe sections 115 and 50 so that the sealing element or cup 127 does not move longitudinally relative to the pipe sections 115 and 50.

The upper portion of the tubing string Y is formed by a detachable pipe section 55 which is adapted to be guided into the opening 112 in the body member 110 by means of a guide shoe 116 (Figures 5 and 6). The guide shoe 116 is mounted on the upper end of the body 110 by welding or any other suitable means of attachment. Such guide shoe 116 has parallel openings 130 and 131 therethrough, with the opening 112 in the body member 110 and the opening 131 being longitudinally aligned with the opening 111. The upper surface 116b of the guide shoe 116 is concave or dished

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and sloped toward the opening 130, whereby it serves to guide the section of pipe 55 into the opening 130 as it is lowered downwardly by reason of the contact of the lower end of the pipe 55 with the surface 116b.

The lower end of the pipe section 55 of the second pipe string Y is provided with an automatic bottom thread device which includes a plurality of thread segments 138 which have external threads 138a which are preferably left-hand threads. The thread segments 138 are urged inwardly to form a cylinder by an annular spring 138b. The segments 138 are slidable relative to a wedge ring 135 and the weld portion 135a, with the segments 138 being retained against rotation by means of a key 58, one of each being supplied for each segment 138. A ring 59 is welded at 60 to the pipe 55 to limit the upward movement of the segments 138 relative to the wedge member 135.

Below the wedge member 135, an annular packing 62 is carried by the pipe 55 and is retained in position by a packing ring 63 which is threaded to the lower end of the pipe section 55. The lower annular shoulder 63a of the packing ring 63 is adapted to contact an inner annular shoulder 112b to limit the downward movement of the pipe section 55 into the opening 12. With the automatic bottom thread arrangement described, the pipe 55 is adapted to be engaged with the surface 63a in contact with the surface 112b upon a downward non-rotative movement of the pipe 55 through the opening 130 in the guide shoe 16. During the lowering movement, the thread segments 138 are in the raised position and are thus in a retracted position so that they slide downwardly relative to threads 65 on the interior of the upper end of the bore 12. However, upon an upward movement of the pipe 55, the threads 138a engage with the threads 65 and the wedge 135 urges such threads into tight engagement whereby the pipe 55 cannot be removed by a non-rotative movement thereof. Upon a rotation of the pipe Y to the right, assuming that the threads 138a and 65 are left-hand threads, the threads are disconnected so that the pipe 55 is detachable from the packer A'. It will be appreciated, of course, that the threads 138a and 65 could be right-hand threads if so desired, in which case the release would be by a rotation of the pipe 55 to the left.

The operation or use of the packer A' is substantially the same as the operation or use of the packer A, except that in the form of the invention shown in Figures 5 and 6, the second pipe string Y has only the upper portion 55 thereof detachable. However, from the operational standpoint, the procedure is the same. Thus, with the wire-line packer B (Figure 1) in position in the well casing C, the well packer A' is lowered into a position corresponding to that shown for the packer A in Figure 1 so that the lower end of the pipe section 115 of the string X is extending through the central opening in the packer B. The well operations below the packer B are then performed and thereafter the second pipe string Y is lowered so as to anchor the lower end of the pipe section 55 in the packer A'. The pipe section 55 is, of course, automatically guided into the anchored position by the guide shoe 116, as previously explained. Well operations are then performed between the packers A' and B in a manner similar to that explained above in connection with packer A.

For removing the second pipe string Y from the packer A', the section 55 of the pipe string Y is rotated in a direction to release the threaded segments 138 from the internal thread 65 on the body member 110. With the pipe string Y thus removed, the packer A' is released from its sealing and gripping contact with the well pipe C due to the fluid pressure equalization above and below the packer A'. Thus, the packer A' can be moved upwardly and the first pipe string section X is removable therewith from the packer B so as to leave the packer B for removal by the usual wire-line equipment.

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 is claimed is:

1. A well apparatus in a well bore including, a first lower well packer having an opening therethrough, a second upper well packer having a pair of non-concentric openings therethrough, a pair of parallel non-concentric tubing strings, means connecting one of said strings to one of the openings in the upper packer, means for detachably connecting the other of said strings to the other opening in said second well packer, and conduit means extending between the packers for establishing communication between one opening in the upper packer and said opening in the first well packer to establish communication between one of the tubing strings and the area below the first well packer, the other opening in the upper packer communicating the other tubing string with the area between the first and second well packers.

2. A well apparatus as set forth in claim 1, wherein the depending conduit has communication with that opening in the upper packer in which the first tubing string is connected.

3. A well apparatus as set forth in claim 1, together with an inclined guide surface at the upper end of the second upper packer for guiding the second tubing string into the opening in said second packer.

4. A well apparatus adapted to be lowered into a well bore including, a lower packer comprising a body having a bore therethrough and having sealing means mounted on the body for sealing with the wall of the well bore when said packer is lowered and set within said well bore, an upper packer assembly comprising a body having a pair of openings extending therethrough and also having sealing means mounted on the body for sealing with the wall of the well bore when said upper packer assembly is lowered and set within the well bore, a first tubing string connected with one of the openings in the body of said upper packer assembly whereby said upper packer assembly may be lowered into the well bore by means of said first tubing string to locate said assembly in spaced relation to the lower packer, a conduit connected to and depending from the lower end of the upper packer assembly and adapted to sealingly engage within the bore of the lower packer when said upper packer assembly has been properly positioned, said conduit having its lower portion communicating with the area below the lower packer and its upper portion in communication with one of the openings in the upper packer assembly, a second tubing string which is lowered within the well bore after the lower packer and upper well packer assembly and the first tubing string have been positioned therein, means attaching the lower end of said second tubing string to the upper packer assembly in communication with that opening in said assembly to which the first string is not connected, and means establishing communication between the area between the lower packer and upper packer assembly and that opening in said upper packer assembly which is not in communication with the conduit, whereby fluid from the area between the packers is conducted to one of the tubing strings and fluid from the area below the lower packer is conducted to the other tubing string.

5. A well apparatus as set forth in claim 4, together with means on the upper end of the body of the upper packer assembly for guiding the second tubing string into proper position for attachment to said body.

6. A well apparatus as set forth in claim 4, together with an inclined guide shoe disposed at the upper end of the body of the upper packer assembly for guiding the second tubing string into position for connection

of the attaching means with the body of said packer assembly.

7. A well apparatus as set forth in claim 4, wherein the sealing means on the body of said upper packer assembly comprises a pair of annular seal elements which are adapted to be distorted into sealing contact with the well casing when a fluid pressure differential exists across the well packer.

8. A well apparatus as set forth in claim 4, wherein the means attaching the lower end of said second tubing string to the upper packer assembly comprises interengaging elements on said string and on said assembly releasably coupling the string to said packer assembly, whereby the second tubing string is removable from the well bore independently of said first tubing string and upper packer assembly.

9. A well apparatus as set forth in claim 4, wherein the means for attaching said second tubing string to the body of the upper packer assembly comprises interengaging elements on said string and said packer assembly releasably coupling the string to said packer assembly, and means on said tubing string actuated by a rotation of said tubing string for uncoupling said interengaging elements to permit independent removal of said second tubing string.

10. The method of positioning a pair of well packers and a pair of tubing strings within a well bore including, setting a lower packer having a passage therethrough within a well bore, thereafter simultaneously lowering a first tubing string and an upper well packer which is mounted thereon into the bore to position said tubing and said upper packer within the bore with the upper packer spaced above the lower packer, setting the upper packer, establishing communication between the first tubing string and the passage in the lower packer after the upper packer and first tubing string reach their final positions within the bore, then lowering a second tubing string within the well bore and connecting its lower portion to the upper packer, and establishing communication between said second string and the area between the upper and lower packers subsequent to the positioning of said second string.

11. The method as set forth in claim 10, together with the additional steps of disconnecting the second tubing string from the upper packer and removing it from the well bore, thereafter removing the first tubing string and upper packer from the well bore, and finally removing the lower packer from said well bore.

12. The method of positioning a plurality of well packers and tubing strings within a two zone cased well bore having a fluid inlet from each zone wherein a first lower well packer is formed with one longitudinal bore extending therethrough and wherein a second upper well packer is provided with a pair of longitudinal openings therethrough, said method comprising, setting the lower well packer in sealing position between the two production zones within the well bore, connecting a first tubing string to the upper well packer with the interior of said string in communication with one of the longitudinal openings in said upper packer, lowering said upper well packer into the well bore by means of said first tubing string into a position spaced from the lower packer and above the upper producing zone, setting said upper packer in sealing position, establishing a communication between the opening of said lower packer and one of the openings in the upper packer when said upper packer is in final position, whereby flow from the zone below the lower packer may pass through the opening of said lower packer and to the opening in the upper packer which is in communication with the opening of the lower packer, thereafter lowering a second tubing string within the well bore and connecting the same to said upper packer, establishing communication between the lower portion of the second tubing string and that opening in the upper well packer which does not communicate with the first

tubing string, and finally establishing communication between that longitudinal opening in the upper packer which is not in communication with the bore of the lower packer and the area between the packers whereby flow from the producing zone between said packers is conducted to one of the tubing strings.

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