

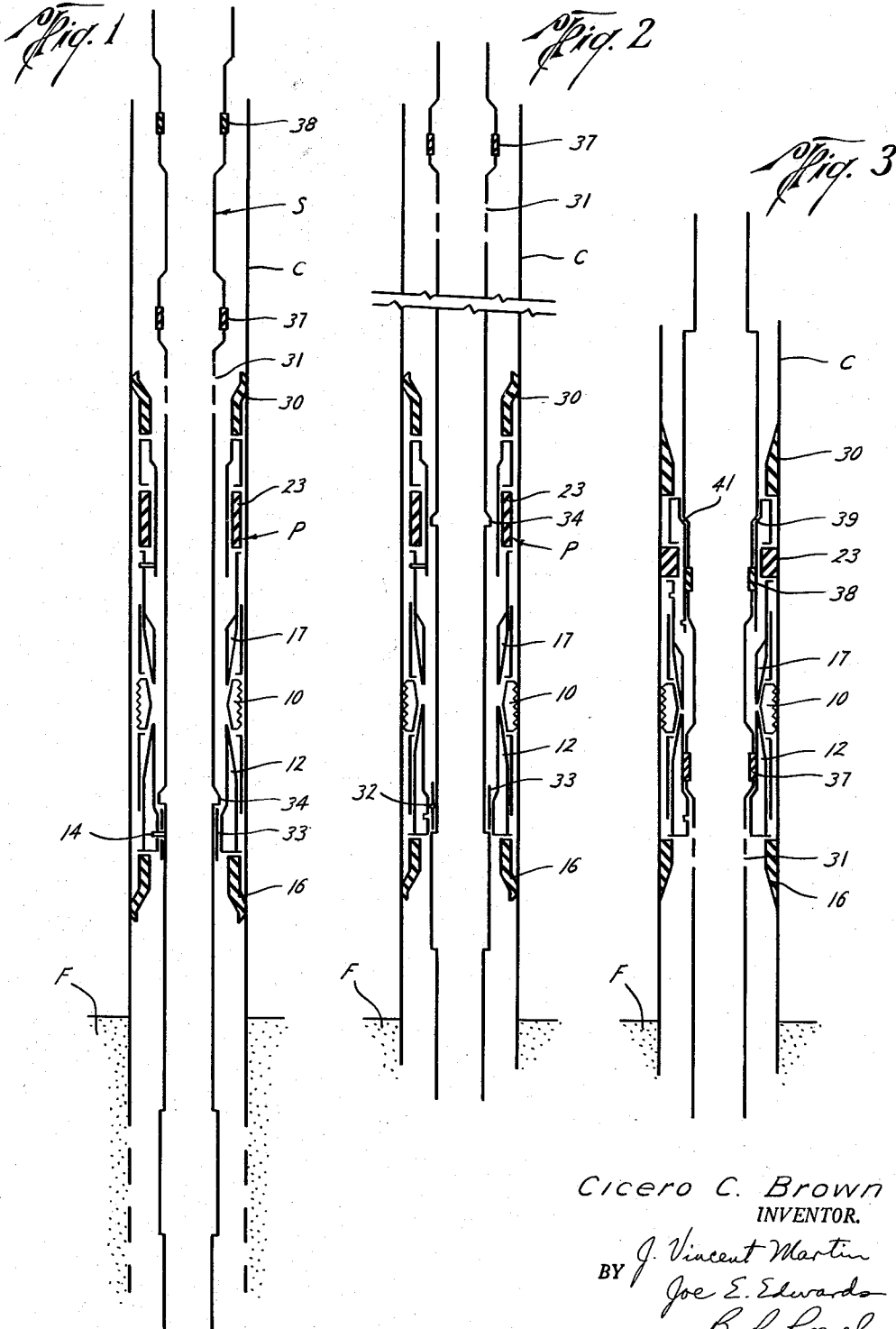
July 4, 1961

C. C. BROWN
WELL PACKERS

2,990,882

Filed Jan. 25, 1956

8 Sheets-Sheet 1



Cicero C. Brown
INVENTOR.

BY J. Vincent Martin
Joe E. Edwards
B. L. Prael
ATTORNEYS

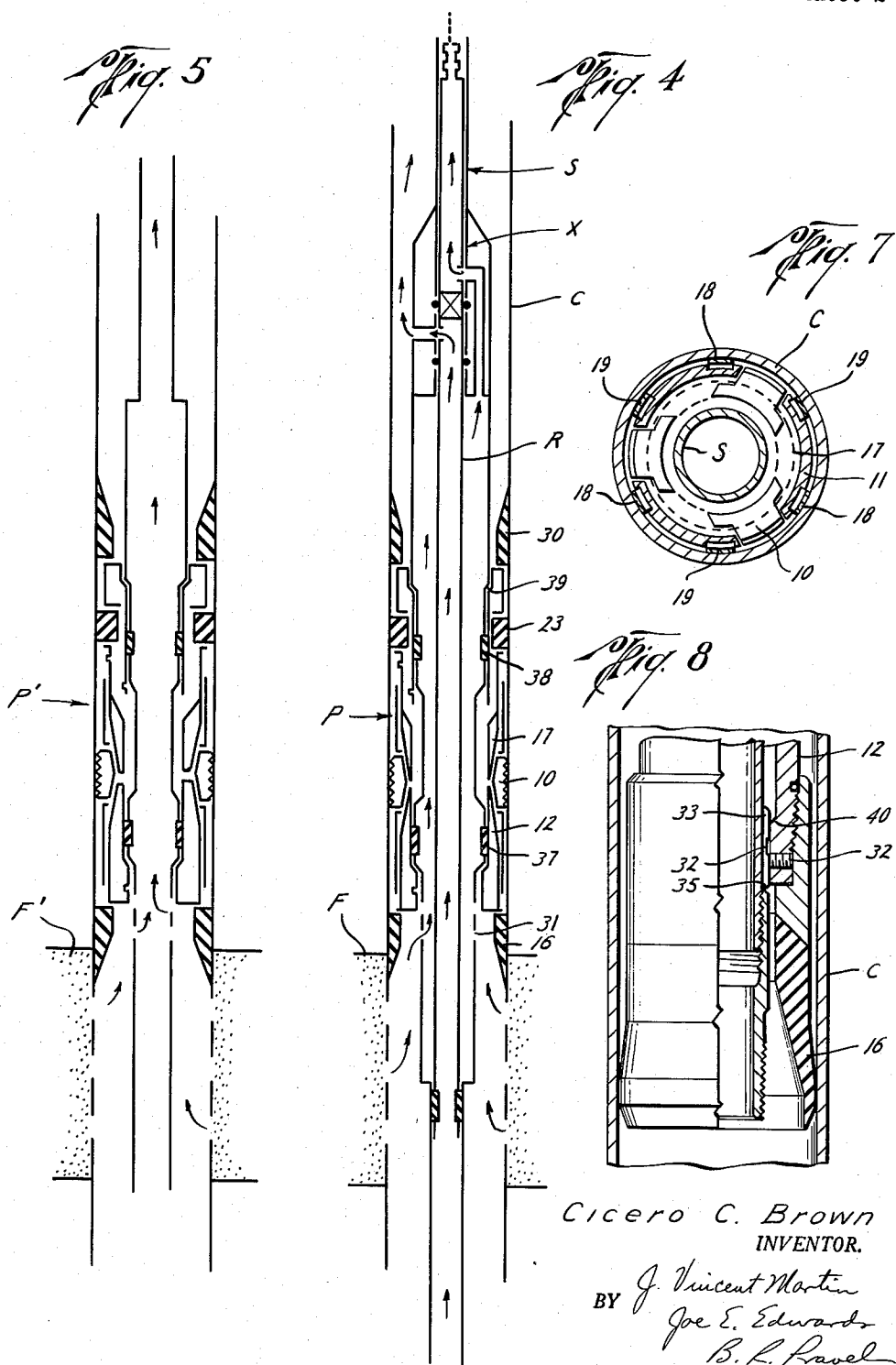
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Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. L. Ravel
ATTORNEYS

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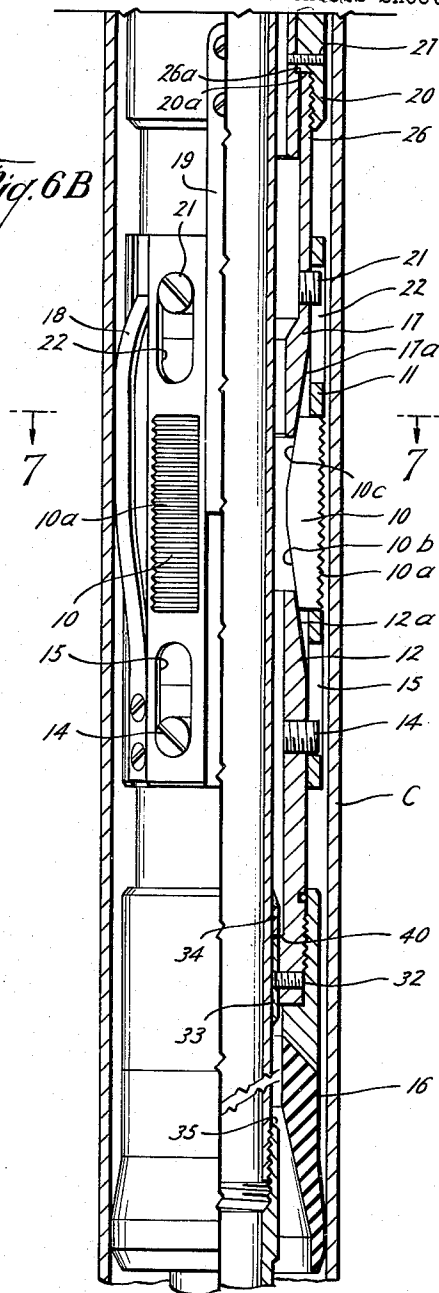
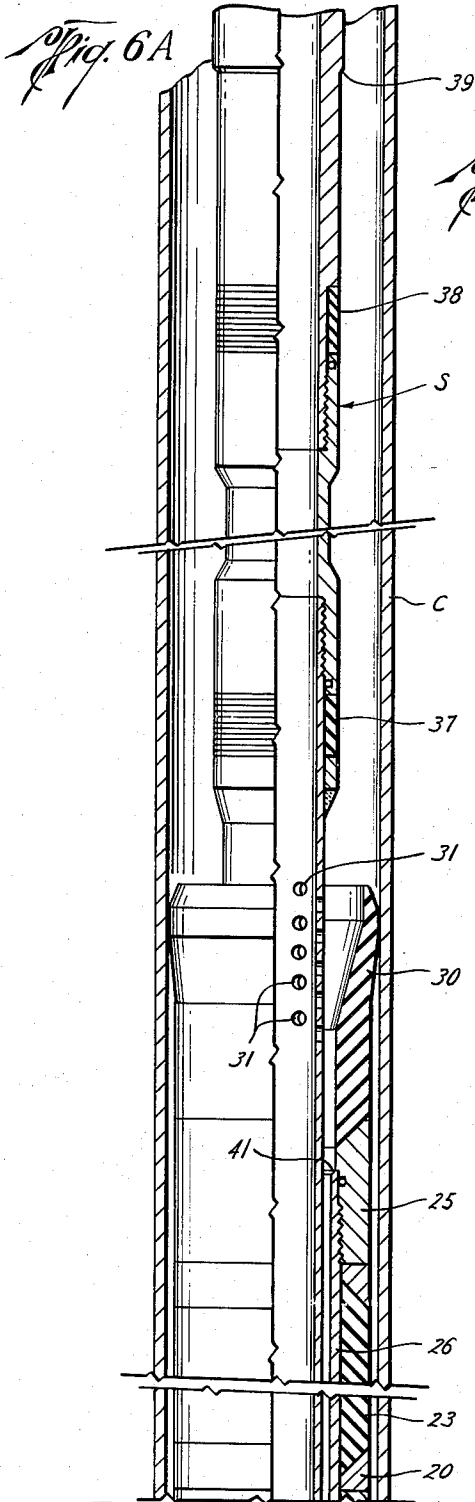
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Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Favel
ATTORNEYS

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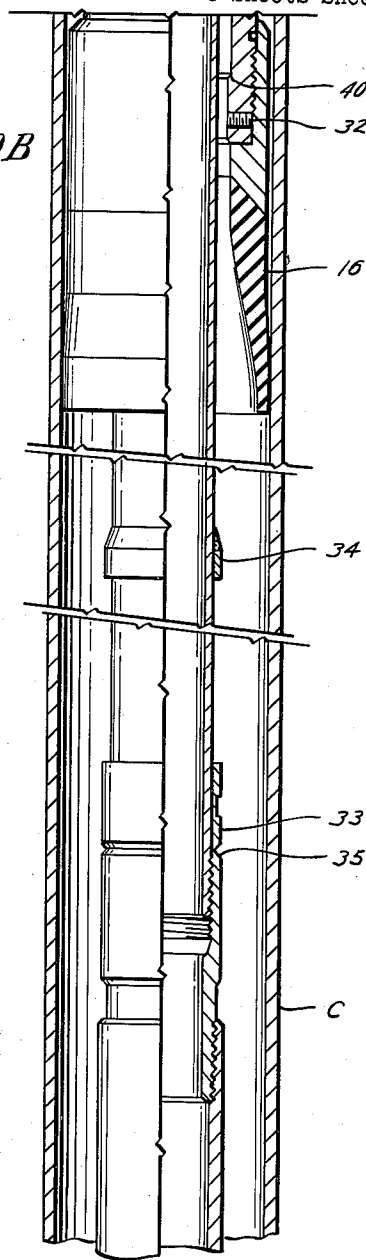
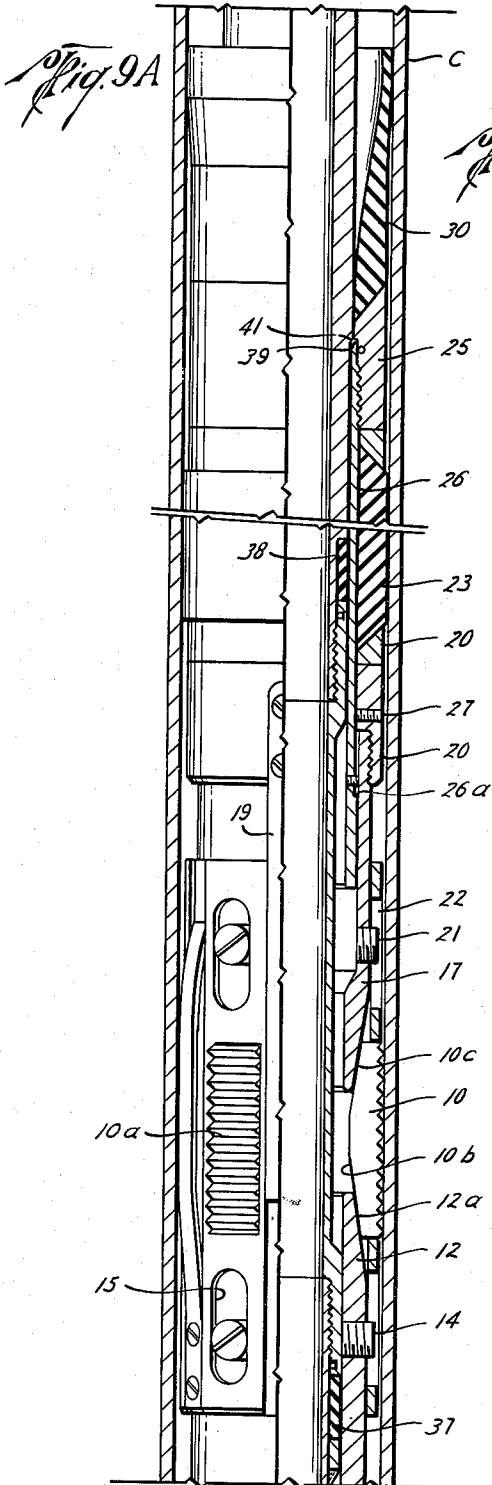
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Filed Jan. 25, 1956

8 Sheets-Sheet 4



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. L. Travel
ATTORNEYS

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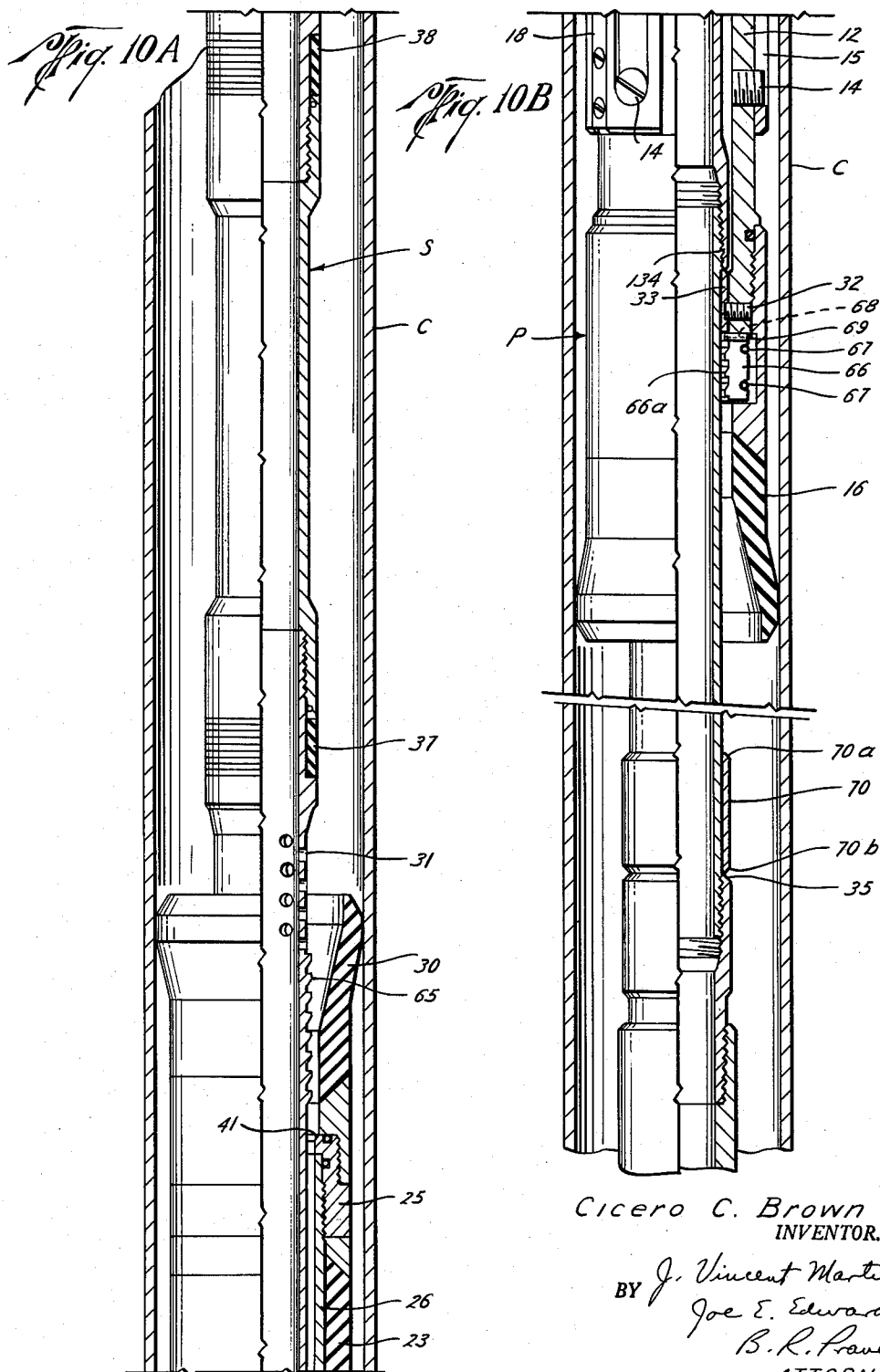
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Filed Jan. 25, 1956

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Cicero C. Brown
INVENTOR.

BY J. Vincent Martin
Joe E. Edwards
B.R. Pavel
ATTORNEYS

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C. C. BROWN

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Filed Jan. 25, 1956

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Fig. 11A

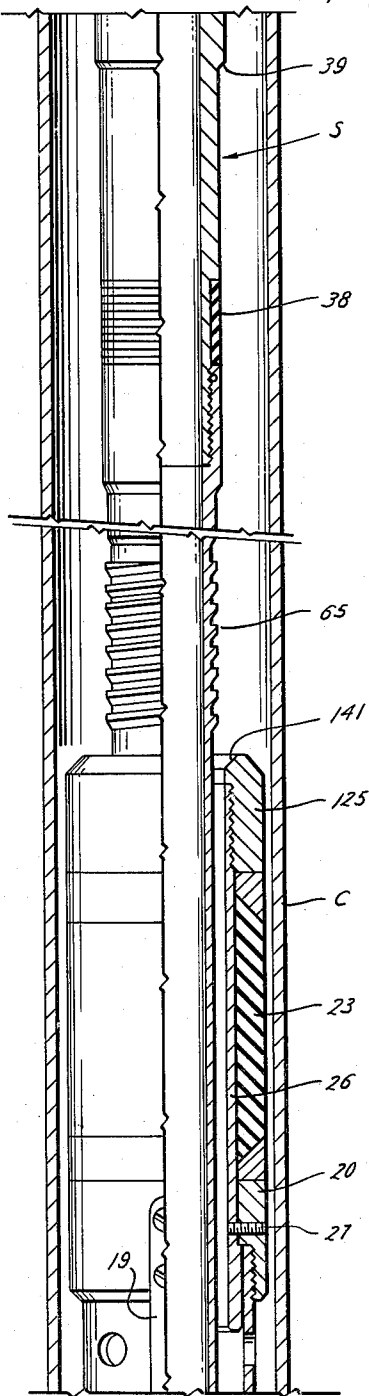
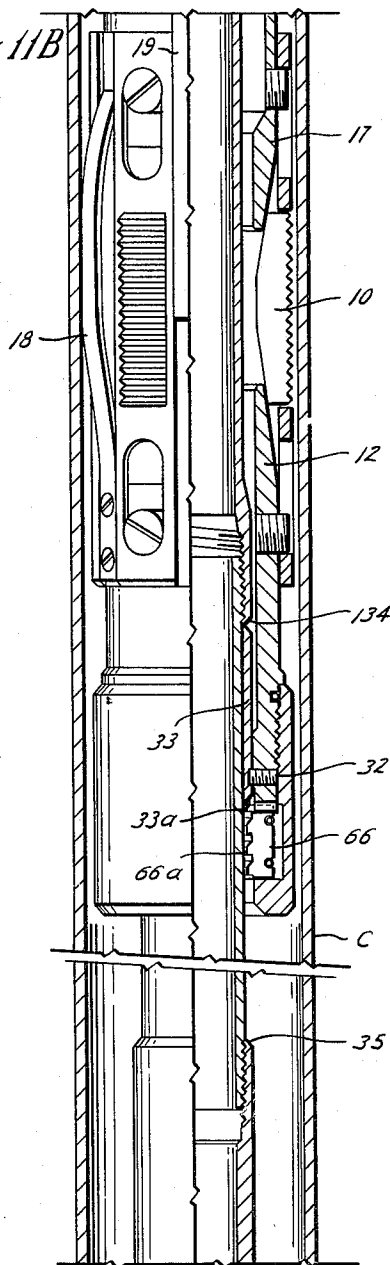


Fig. 11B



Cicero C. Brown

INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. L. Pavel
ATTORNEYS

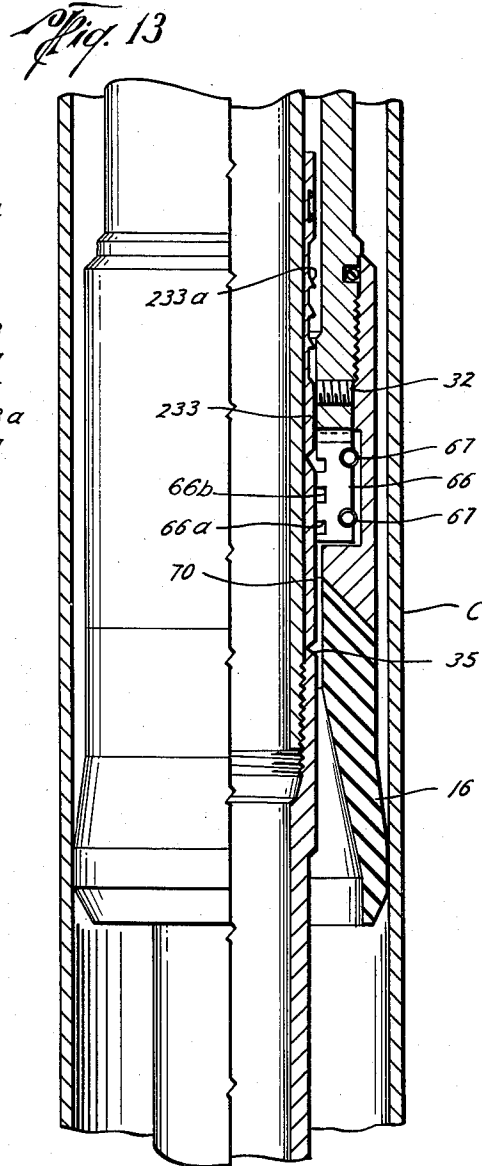
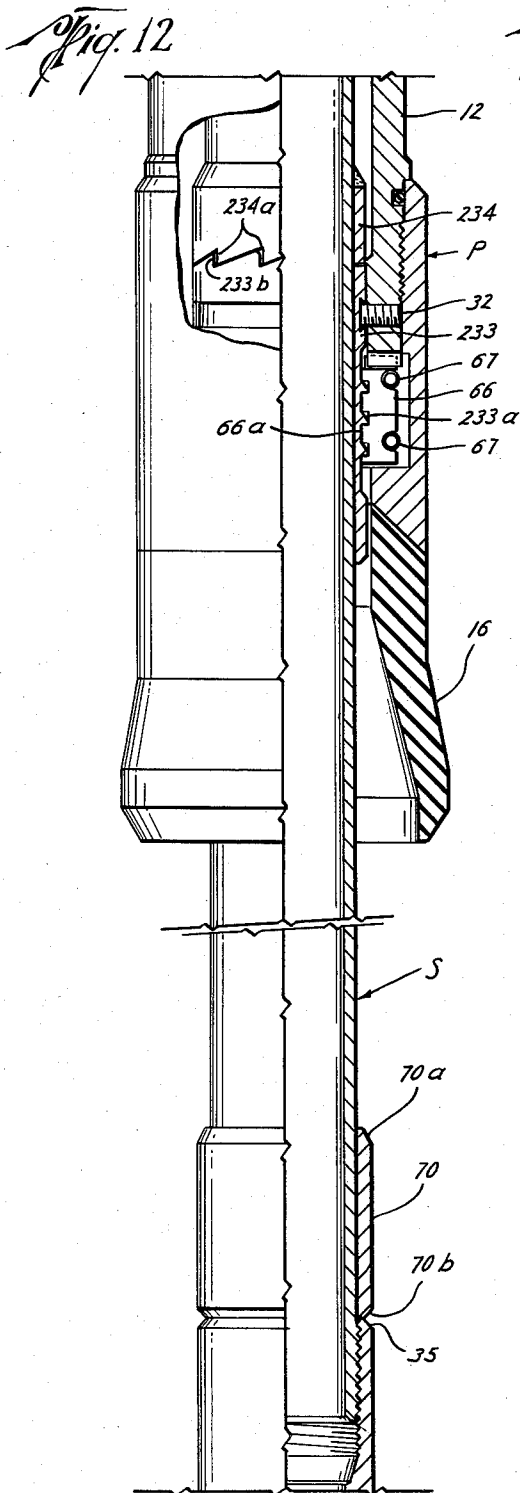
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C. C. BROWN

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Filed Jan. 25, 1956

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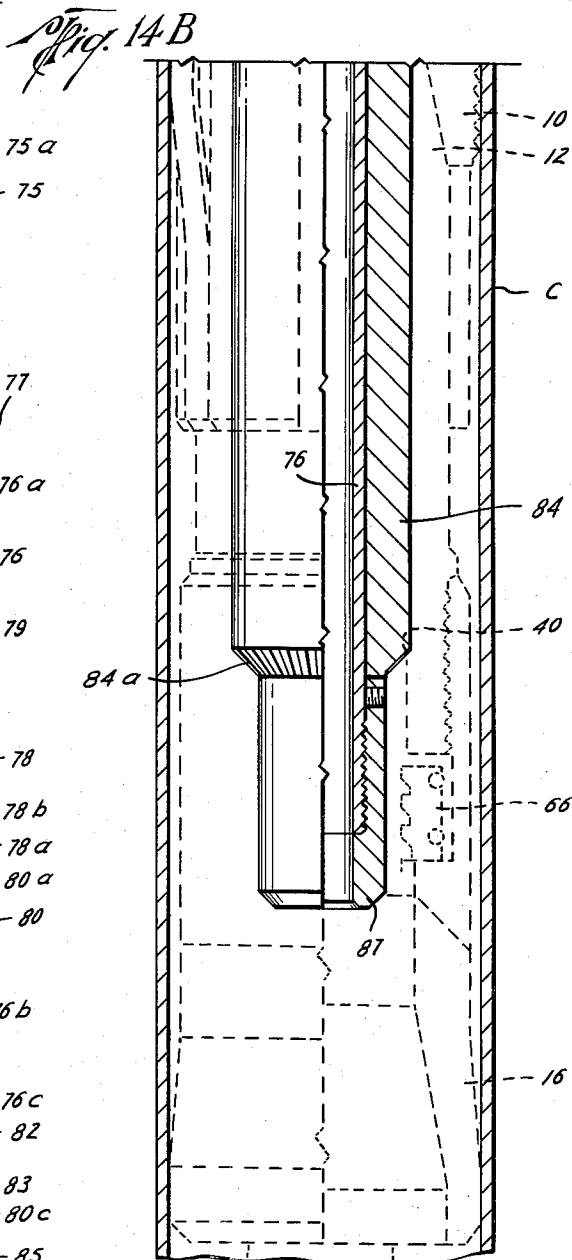
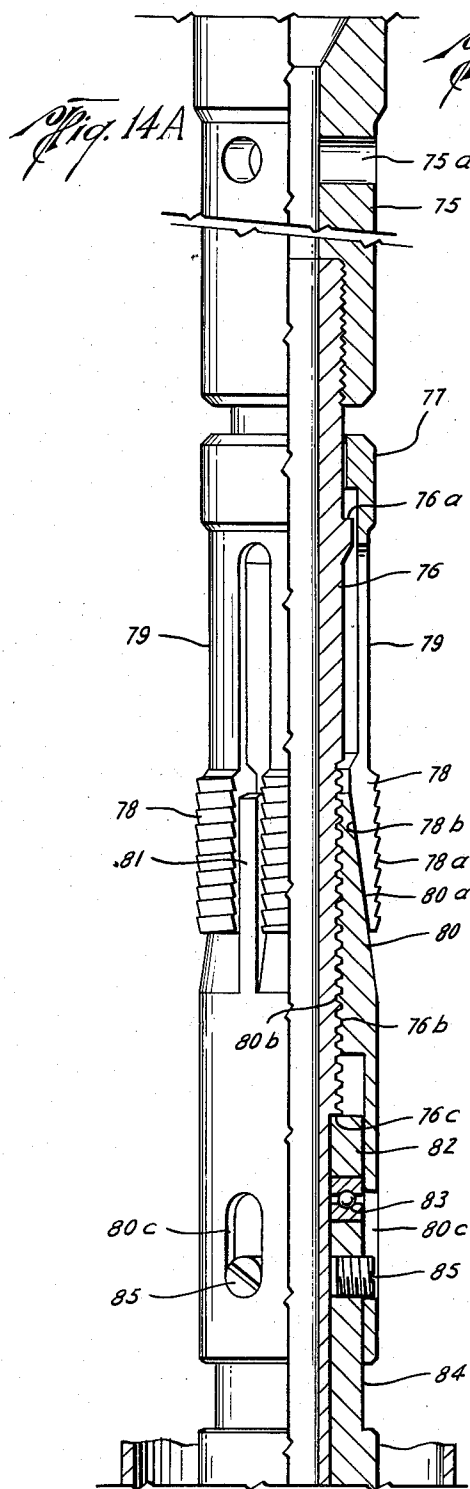
Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Favel
ATTORNEYS

C. C. BROWN
WELL PACKERS

Filed Jan. 25, 1956

8 Sheets-Sheet 8



Cicero C. Brown
INVENTOR.

BY *J. Vincent Martin*
Joe E. Edwards
B. R. Lavel
ATTORNEYS

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2,990,882

WELL PACKERS

Cicero C. Brown, 2216 Campbell St., Houston, Tex.

Filed Jan. 25, 1956, Ser. No. 561,321

11 Claims. (Cl. 166-119)

This invention relates to new and useful improvements in well packers.

An object of this invention is to provide a new and improved well packer which is adapted to be lowered into a well bore on a removably attached support pipe.

An important object of this invention is to provide a new and improved packer wherein the tubular support pipe therefor coacts with the packer for setting the packer in a well and for also conducting fluid therethrough after the packer is set without requiring the removal of the support pipe from the well.

Another object of this invention is to provide a new and improved packer which is adapted to be lowered and set in a well on a removably attached tubular support having means for directing fluid flow therethrough after the packer is set, whereby production or other well operations may be carried out with the support in the well and whereby the support subsequently may be removed from the well.

Another object of this invention is to provide a new and improved packer construction wherein a plurality of packers are positioned on a support pipe in a predetermined spaced relationship for the proper location thereof in the well relative to said multiple formations, whereby said packer construction is advantageously used for dual, triple or other multiple completion of a well having multiple formations to assure the perfect spacing of the packers in the well.

A further object of this invention is to provide a new and improved packer assembly wherein a plurality of packers are lowered into a well on a support pipe for the multiple completion of the well, and wherein a crossover device is included with the support pipe for controlling and directing the fluid flow between the well formations and the well surface.

A still further object of this invention is to provide a new and improved well packer having a support pipe which can be manipulated from the surface for setting the packer and then locking same in the set position in the well bore.

An additional object of this invention is to provide a new and improved retrieving tool for removing from a well a well packer or the like having an open bore into which the retrieving tool is adapted to be positioned for the retrieving operation, such retrieving tool being releasable from said packer in the event the packer cannot be moved from its set position in the well.

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 diagrammatic view illustrating the packer construction of this invention as it is lowered into a well casing or bore on its support pipe.

FIGURE 2 is a view similar to FIGURE 1, but illustrating the packer construction of this invention in an intermediate position during the setting of the packer in the well casing or bore.

FIGURE 3 is a view similar to FIGURES 1 and 2, but illustrating the packer construction of this invention

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with the packer in the set position in gripping and sealing contact with the well casing or bore.

FIGURES 4 and 5 are diagrammatic views illustrating the packer construction of this invention as utilized for multiple well completion or production, with FIGURE 4 illustrating the upper packer disposed above the upper well formation and FIGURE 5 illustrating the lower packer disposed between the upper and the lower well formations.

FIGURES 6A and 6B are views, partly in elevation and partly in section, which together illustrate the details of the packer construction of this invention in the lowering or running-in position.

FIGURE 7 is a horizontal sectional view taken on line 7-7 of FIGURE 6B.

FIGURE 8 is a view, partly in elevation and partly in section, of a fragment of the packer construction of FIGURES 6A and 6B, illustrating in particular the intermediate stage of the setting operation.

FIGURES 9A and 9B are views, partly in section and partly in elevation, which together illustrate the same tool as illustrated in FIGURES 6A and 6B, but illustrating the tool in the set position in gripping and sealing contact with the well casing or bore.

FIGURES 10A and 10B are views, partly in elevation and partly in section, which together illustrate a modification of the tool shown in FIGURES 6A and 6B, such modification including a lock-down means and a releasing sleeve in addition to the structure of FIGURES 6A and 6B.

FIGURES 11A and 11B are views, partly in elevation and partly in section, which together illustrate a tool similar to the modified tool of FIGURES 10A and 10B, except that the tool illustrated in FIGURES 11A and 11B has no fluid pressure-actuated sealing means.

FIGURE 12 is a view, partly in elevation and partly in section, which shows the lower end of a packer construction of the type shown in FIGURES 6A and 6B, but wherein a modified connector means between the running-in tube or pipe and the packing structure is provided.

FIGURE 13 is a view similar to FIGURE 12, but showing the parts in an intermediate position for effecting the separation or removal of the inner tube or pipe from the packer.

FIGURES 14A and 14B are views, partly in elevation and partly in section, which together illustrate a retrieving tool for use with the packers previously referred to in the drawings and for use with similar devices to effect the withdrawal or retrieving of such packers or other devices from the well casing or bore.

In the drawings, the letter P designates the packer or packer construction of this invention which has therewith a support pipe or tube S which extends from the surface of the well for the running-in and manipulation of the packer P in the well casing or bore C. As will be explained in detail, the packer apparatus includes a packer assembly, the main element of which is a packing member 23 for sealing between the inner support pipe and the casing or bore C and an anchoring unit having gripping slips 10 for anchoring the entire apparatus within said casing or bore. The packer P is so constructed and co-acts with the support pipe S in such a manner that the support pipe S functions to set the packer P upon a manipulation of that support pipe from the surface of the well and also it functions to permit well operations and fluid production after the packer has been set without requiring the removal of the support pipe S from the well. Thus, with this invention, the same pipe which effects the setting of the packer P also is utilized for the producing of the well and for the conducting of the vari-

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ous well operations in connection with such production.

Additionally, the packer P is so constructed that it is particularly adapted to be used in the dual, triple or multiple completion and production of wells having multiple well formations as schematically indicated in FIGURES 4 and 5 wherein the packer P is shown in position above the upper well formation F and the packer P' is in position between the upper well formation F and the lower well formation F'. The packers P and P' are substantially identical in construction and the details thereof will be described hereinafter. The particular arrangement or assembly of FIGURES 4 and 5 for the multiple completion or production includes a crossover device therewith which is preferably of the type shown in my United States Patent No. 2,717,041, granted September 6, 1955. Therefore, such crossover device is indicated in FIGURE 4 by the letter X and it schematically shows a removable member R which would preferably be constructed in accordance with said Patent No. 2,717,041. Thus, with the assembly of FIGURES 4 and 5, the packers P and P' are connected together through the support pipe S which extends from the surface of the well and therefore the packers P and P' are spaced from each other a predetermined distance which is in accordance with the required distance for positioning the packer P above the upper formation F and for positioning the lower packer P' between the upper formation F and the lower formation F'. Since the same support pipe S is utilized for running-in, setting and for the well completion and production in both of the packers, or in the plurality of packers if more than two are utilized, the packers remain in the predetermined space relationship in the well casing or bore C and therefore it is assured that they are properly spaced with respect to the well formations when the completion and production are carried out.

One form of the packer or packer apparatus P of this invention is illustrated in detail in FIGURES 6A and 6B. Such packer construction includes an anchoring unit comprising pipe gripping slips 10, a carrier sleeve 11 having external friction springs 18, a lower slip expander 12, and an upper slip expander 17. The pipe-gripping slips 10 are mounted for lateral or radial movement in the slip carrier or sleeve 11 so that the gripping teeth 10a of each of the slips is adapted to move into and out of engagement with the inside of the well casing C. A lower slip expander 12 is provided below the slips 10 for longitudinal or axial movement relative to the slips 10 to wedge the slips 10 laterally or radially outwardly into engagement with the casing C by a coaction between the inclined external surface 12a of the expander 12 with the lower inclined surface 10b of the slips 10. A pin 14 is connected to the expander 12 below each of the slips 10 and such pins 14 move in slots 15 in slip housing 11 so as to prevent separation of the expander 12 from the slip housing 11 while permitting relative longitudinal movement therebetween. The slip expander 12 has an annular downwardly-directed sealing cup 16 connected therebelow by any suitable means. Such lower sealing cup 16 is actuated by fluid pressure in the well, as will be explained, so as to move same into sealing engagement with the inside of the casing C. The sealing cup 16 is made of rubber or other similar resilient elastic material.

The upper slip expander 17 having an inclined surface 17a which coacts with an upper inclined inner surface 10c of each of the slips 10 functions in the same manner as the slip expander 12 for wedging or moving the slips 10 into a tight gripping engagement with the well casing C. During the setting of the slips 10, the friction springs 18 which are connected to the lower end of the slip housing or carrier 11 prevent movement of the slip housing or carrier 11 in the casing C. Also, as will be more evident hereinafter, the springs 18 prevent downward movement of the slips 10 relative to the slip expander 12 during the

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lowering or running-in of the packer of this invention so as to prevent a premature wedging of the slips 10 into engagement with the casing C by the lower expander 12.

The upper slip expander 17 is connected to the lower confining collar 20 of a packer assembly, which assembly includes said collar 20, a flexible packing member or sleeve 23, an inner tubular mandrel 26, carrying said packer member and collar, an upper confining sleeve 25 connected to the upper end of mandrel 26 and an upper seal cup 27 connected to sleeve 25. A plurality of upper friction springs 19, which are attached to the collar 20 of the packer assembly, prevent the upper slip expander 17 from moving downwardly relative to the slips 10 as the packer apparatus P is lowered or run into the casing C. The movement of the upper slip expander 17 is limited by pins 21 which are positioned in slots 22 in the housing or carrier 11 in a similar manner to the pins 14 being disposed in the slots or openings 15.

The packing member or element 23 of the assembly is sleeve-like and annular in construction and is formed of rubber or a similar elastic material. The lower end of the packing member 23 is confined by the collar 20 which, as has been noted above, is connected to the upper end of the upper slip expander 17. The packing member 23 is disposed between the collar 20 and an upper confining sleeve 25 and all of these parts surround an inner mandrel or support tube 26 which is threaded or otherwise connected to the upper confining sleeve 25; the mandrel 26 is releasably connected to the lower confining collar 20 by means of a shear pin 27 or any suitable shearable or severable means. The upper seal cup 30 of the packer assembly is directed upwardly and is formed of rubber or similar resilient elastic material. Said seal cup is attached by any suitable means to the upper confining sleeve 25. Said upper sealing cup 30 is actuable by fluid pressure in the well when a fluid pressure differential exists across the packer. In other words, the packing elements 16 and 30 are urged towards each other when the pressures above the packer and below the packer are different. However, during the running-in or lowering of the packer into the well casing or bore C, the fluid pressure is equalized above and below the packer by the passage of well fluid through the bypass openings or ports 31 in the support pipe S which extends through the packer and which is open at the bottom thereof.

The support pipe S is releasably attached to the lower end of the packer by means of a shear pin 32 or any other similar shearable construction which is adapted to be sheared only upon the application of a predetermined force. Such shear pin 32 extends from the lower end of the expander 12 and into a sleeve or ring 33 which forms an internal abutment slidably mounted on the exterior of the support pipe S. A second ring 34 is welded or otherwise secured to the support pipe S and is positioned above the ring 33 so as to impose the weight of the support string S on the lower end of the packer to push or force the packer downwardly in the well bore to lower same to a predetermined position in such casing or well bore.

At some distance below the ring 34, an annular external shoulder 35 is provided on the support pipe S which, as will be explained, is utilized for bumping or moving the sleeve 33 relative to the shear pin 32 for shearing such pin 32 to release the support S from the rest of the packer apparatus. The support pipe S is also provided with annular fluid-pressure seals 37 and 38 which are spaced from each other so as to prevent fluid flow between the exterior of the support pipe and the bore or interior of the packer. Also, it is pointed out that the packer is provided with an internal annular seat 40 on the inside of the slip expander member 12 for supporting a retrieving tool of the type shown in FIGURES 14A and 14B, which will be described in detail hereinafter.

In the operation of the packer apparatus of this invention, it is lowered or run into the casing or well bore C on the support pipe S when in the connected position

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(FIGURES 1 and 6A, 6B) with the shear pin 32 maintaining the connection with the ring 33. During such lowering of the packer into the well bore or casing C, the bypass openings 31 are positioned as shown in FIGURES 1 and 6A so as to permit the flow of fluid from the inside of the support pipe S to the area externally thereof, whereby the pressures above and below the packer P are equalized to prevent the urging of the upper and the lower sealing cups 30 and 16, respectively, toward each other. When the packer P has been lowered to its desired position in the well bore or casing C above the formation F, the support pipe is raised relative to the packer P so as to move the shoulder 35 upwardly into contact with the lower end of the latching ring 33. An upward force is thus applied to the ring 33 which is imparted to the slip expander 12 through the shear pin 32. The expander 12 and the parts connected thereto are moved upwardly with the pipe S to cause the expander 12 to urge the slips 10 into gripping engagement with the casing C. When the slips 10 have been thus set, a predetermined upward force is applied to the ring 33 and the pin 32 by continuing to raise the pipe S so that sufficient force is applied to shear or sever the pin 32. The position of the parts of the packer construction of this invention during the intermediate stage just subsequent to the shearing of the pin 32 is shown in FIGURES 2 and 8. When the pin 32 has been sheared, then the support pipe S is lowered relative to the packer P.

The support pipe S is lowered until an external shoulder 39 formed on said support pipe engages the shoulder 41 provided at the upper end of the mandrel 26 of the packer assembly and thereafter continued lowering of the pipe S moves the expander 17 downwardly relative to the slips 10 for urging the upper portion of such slips 10 into tight engagement with the casing C. Thereafter, the pin 27, if utilized, is sheared and the packing member 23 is distorted laterally outwardly into sealing contact with the casing C. Also, during such lowering of the pipe S, the lower seal ring 37 on the pipe S enters the bore of the expander member 12 and the upper seal ring 38 enters the bore of the mandrel 26 to position the bypass ports 31 as shown in FIGURES 9A and 9B and in FIGURE 3 so that fluid passes from below the packer P into the interior of the support pipe S, but there is no longer any fluid communication between the interior of the support pipe S and the area above the packer P. Therefore, seal cups 16 and 30 are subjected to the fluid pressures below and above the packer P so that when such pressures are different from each other, the differential in the fluid pressure urges the packing cup 16 upwardly relative to the slips 10 and the packing cup 30 downwardly relative to the slips 10, whereby the fluid pressure across the packer P assists in maintaining the slips 10 in gripping engagement with the well casing C.

It will be evident that when the packing element 23 has been set, the support pipe S can no longer move downwardly relative to the packer P. Well operations for the completion of the formation and similar operations are then conducted and ultimately production of the well fluid such as oil or gas from the formation F is obtained through the bore or interior of the support pipe S to the surface of the well in the known manner.

In the event it is desired to remove the packer P from the well bore or casing C, the support pipe S is removed from the packer P by simply moving same longitudinally upwardly relative to the packer P. Since the pin 32 has been sheared, and since the maximum external diameter of the support pipe S and the parts carried thereby is less than the maximum internal diameter of the axial bore of the packer P, there is no obstruction to prevent such upward movement of the support pipe S. The packer P is thus left in the well casing or bore C in the set position and it can be retrieved, if desired, by various types of retrieving tools, an example of which is shown in FIGURES 14A and 14B, which will be described hereinafter.

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In the modification shown in FIGURES 10A and 10B, the parts thereof which are the same as in the form of the invention shown in FIGURES 6A and 6B have like numerals and letters. The intermediate portion of the tool between the packing member 23 and the lower slip expander 12 has been omitted from the illustration shown in FIGURES 10A and 10B, but such intermediate portion of the FIGURES 10A and 10B modification of the tool is identical with that shown in FIGURES 6A and 6B and therefore would include the slips 10 and the upper slip expander 17 and the related structure shown in FIGURE 6B particularly. In this modified form of FIGURES 10A and 10B, a lock-down means is provided for holding the packer in its set position after the weight of the support pipe or tubing string S has been imposed upon the packer by the seating of the shoulder 39 on the support pipe (FIGURE 6A) in engagement with the annular inner seat 41 on the mandrel of the packer assembly. Such lock-down means includes left-hand threads 65 on the support pipe S below the bypass openings 31. During the running-in of the packer apparatus P, said threads are disconnected from expansible nut members 66 which are mounted between the lower seal cup 16 and the lower expander 12, but when the packer has been fully set said threads engage the nut members to prevent the release of the packer from its set position until such threads 65 and the nut member 66 are disengaged. The nut members 66 are formed as arcuate segments which together form a complete cylinder and which are urged together to form such cylinder by annular springs 67 disposed around the exterior of the members 66. The members 66 have internal threads 66a which are of the same type as the threads 65 for coaction therewith. Such threads are shaped so that the threads 65 pass downwardly and expand the nut members 66 against the action of the spring 67 by a non-rotative longitudinal downward movement relative to the members 66. However, for releasing the engagement of the threads 65 from the nut members 66, right-hand rotation of the support pipe S is required, assuming the threads 65 are left-hand threads. Such thread construction is in itself known in the art. Also, it should be pointed out that the segments 66 are prevented from rotating relative to the rest of the packer P by reason of coating lugs 68 and 69. The lugs 68 are on the lower end of the slip expander 12 and the lugs 69 are on the nut members 66 so that the members 66 are free to move outwardly from their position in which they form a cylinder and also to return to such position, but the members 66 cannot rotate relative to the slip expander 12.

The modification of FIGURES 10A and 10B also includes an additional sleeve 70 which is slidably mounted on the exterior of the support pipe S below the latching sleeve 33 and above the releasing shoulder 35. Such sleeve 70 has an upper tapered surface 70a and a lower tapered surface 70b. A shoulder or sleeve 134 is also provided in this modification of FIGURES 10A and 10B which corresponds with the ring 34 of FIGURE 6B, but is formed as part of the joint above the ring 33 in the form shown in FIGURES 10A and 10B. Thus, during the running-in of the packer P of FIGURES 10A and 10B, the support pipe applies a lowering pressure to the packer P by the engagement of the shoulder or joint 134 with the ring 33. The amount of force required for the lowering is not sufficient to shear the pin 32, but when the tool has reached its desired position in the well bore, the tool is manipulated by raising the support pipe S so as to shear the pin 32.

The operation of the form of the invention shown in FIGURES 10A and 10B is believed evident from the foregoing description and is, of course, substantially the same as described above in connection with FIGURES 6A and 6B. Thus, as the packer P is lowered on the support pipe S, the force is applied through the joint 134 to the sleeve 33 which in turn is prevented from moving

by its connection to the packer P through the shear pin 32. When the packer P has reached its predetermined point in the well bore or casing C, the support pipe S is raised upwardly relative to the packer P since the friction springs 18 and 19 prevent the movement of the packer P with the support pipe S during the upward movement of the pipe S. The sleeve 70 is thus carried upwardly with the support pipe S since it rests upon the shoulder 35 and its upper inclined surface 70A engages the lower end of the nut member 66 to expand same outwardly against the action of its springs 67 and therefore it permits the sleeve 70 to enter the bore of the nut member 66. The support pipe S can therefore be continued in its upward travel and ultimately it engages the lower end of the latching ring 33 to raise the expander 12 upwardly to set the slips 10 and to thereafter apply a shearing force to the ring 33 which is sufficient to shear the pin 32. Upon the lowering of the support pipe S thereafter for the setting of the packer P, the lower inclined surface 70b of the sleeve 70 assures the passage of the latching sleeve 33 through the nut member 66 so as to permit the travel of the latch member or ring 33 as well as its shoulder 134 thereabove through the nut member 66 to a point therebelow. Thereafter, the support pipe S is continued in its lowering movement until the packing element 23 has been fully distorted or expanded into sealing engagement with the well bore or casing C and until the shoulder 39 of the support pipe S is resting upon the shoulder 41. As the packing element 23 is expanded into sealing position, the threads 65 are entering and passing downwardly with respect to the nut members 66 for threaded engagement therewith. Thus, when the packing element 23 has been fully expanded, the threads 65 are in the bore of the members 66 and are connected thereto so that they cannot move upwardly without a rotation of the support pipe S. It will thus be appreciated that the packer is fully locked against movement at that time and until the support pipe S is rotated for the release of the threads 65 from the nut member 66. Such release can be obtained by a right-hand rotation of the support pipe S relative to the packer P and, as in FIGURES 6A and 6B, this form of the invention can also permit the removal of the complete support pipe S from the well bore leaving the packer P in the well bore or casing in its set position. The retrieving tool such as shown in FIGURES 14A and 14B can then be utilized for removing the packer P.

In FIGURES 11A and 11B, another modification of the structure of this invention is illustrated, wherein such modification differs from the form of the invention shown in FIGURES 10A and 10B in that it does not have the fluid pressure expansible seal cups 16 and 30 as in FIGURES 10A and 10B. The parts of the form of the invention shown in FIGURES 11A and 11B which are the same as the parts of the form of the invention shown in FIGURES 10A and 10B have the same numerals.

In FIGURES 11A and 11B, the bypass openings or ports 31 are not utilized since the form of the packer shown in FIGURES 11A and 11B does not have the seal cups 16 and 30 which are set by a differential in fluid pressure. Also, only the single annular seal 38 on the pipe S is utilized in this form of the invention. The upper confining sleeve 25 of FIGURES 6A and 6B is replaced with the confining sleeve 125 which has an annular inwardly-tapered shoulder 141 corresponding to the shoulder 41 of FIGURE 6A. Such shoulder 141 is engaged by a shoulder 39 on the support pipe S when the packer is being set and when it is finally in its set position, as will be explained. Also, in this form of the invention, the sleeve 33 which serves to latch or connect the support pipe S to the packer P during the lowering of the packer P in the well, is provided with a tapered lower surface 33a which serves to expand the nut members 66 as the ring 33 moves downwardly relative thereto.

Thus, the additional sleeve 70 of FIGURE 10B is not used in this form of the invention.

In the operation of the form of the invention shown in FIGURES 11A and 11B, the assembly is lowered in the position shown in such figures. When the packer has been lowered to its desired elevation in the well bore or casing C, the support pipe S is raised upwardly and due to the engagement of the friction springs 18 and 19, the packer P remains fixed in the well casing relative to the support pipe S as it is raised upwardly. The shoulder 35 expands the nut members 66 since such shoulder 35 is tapered and it therefore moves into the bore of the nut members 66 and ultimately engages the lower end 33a of the latching sleeve 33 for effecting the setting of the slips 10 and the subsequent shearing of the pin 32. After the shear pin 32 is severed, the support pipe S is lowered downwardly and the guide surface or end 33a on the latching sleeve or ring 33 expands the nut member 66 as it enters into the bore thereof so as to hold same expanded for the passage of the shoulder or joints 134 through the nut member 66 also. The lowering of the support pipe S is continued until the shoulder 39 engages the annular seat or shoulder 141 at the upper end of the packer P. Such downward movement of the support pipe S is initially transmitted downwardly to the slip expander 17 to cause same to move relative to the slips 10 for assisting the slip expander 12 in wedging the slips 10 outwardly into their set position. When the slips 10 are thus finally seated in gripping position, the packing element 23 is then set.

When the packing element 23 has been fully expanded, the threads 65 have moved into the bore of the nut member 66 and into threaded engagement with the internal threads 66a of such nut member 66, whereby the tool is locked against the release of the set slips and the set packing element 23. Such release can be effected by the rotation of the support pipe S relative to the packer P, and assuming the threads 65 and 66a are left-hand threads, such disengagement is effected by a right-hand rotation of the support pipe S. The complete support pipe S is removable from the packer P as in the previous forms of this invention, which therefore leaves the packer P in the well bore or casing C in the set position for later retrieving by a retrieving tool.

In FIGURES 12 and 13, the lower end of the packer assembly shown in FIGURES 6A and 6B is illustrated with a modified connector means which is so constructed that it permits the reconnection of the support pipe S with the packer P for moving the packer P to a different position in the well bore or casing C. FIGURE 12 illustrates the lower end of the packer assembly with the parts in the position they assume during the running-in of the packer P to its position for subsequent setting in the well pipe or casing. As seen therein, the support pipe S has mounted thereon a slidable connecting sleeve 233 which is joined to the packer P through the shear pin 32. Such sleeve 233 has threads 233a which are in threaded engagement with the nut members or segments 66. The nut members or segments 66 form an expansible annular element, the bore of which is provided with both right-hand threads 66a and left-hand threads 66b in the manner disclosed in my prior Patent No. 2,893,492, issued July 7, 1959. The threads 233a are preferably right-hand threads and engage the right-hand threads 66a so that upon rotation thereof to the right, the sleeve 233 moves downwardly relative to the nut member 66. The threads 233a are thus adapted to be rotated downwardly relative to the nut members 66 for releasing the engagement of the threads 233a and the threads 66a, but upon an upward movement of the sleeve 233, the nut members 66 are expanded radially outwardly without requiring any rotation of the sleeve 233, so that a disconnection of the threads 233a of the sleeve 233 from the threads 66a of the members 66 is effected by a non-rotative upward longitudinal movement of the sleeve 233 relative

to the members 66. For imparting a right-hand rotation to the sleeve 233 for moving same downwardly with respect to the nut members 66, the ring 234 has a plurality of ratchet teeth 234a formed thereon which coast with complementary teeth 233b. Thus, the support pipe S can move to the left without imparting any rotation to the sleeve 233, but upon a movement thereof to the right or clockwise (as viewed from the top of Figure 12), the sleeve 233 is also rotated to the right and the sleeve 233 will thus move downwardly and out of engagement with the nut members 66. The nut members 66 have the double threads 66a and 66b as referred to in my copending application, Serial No. 468,653, only if used with the form of the invention shown in FIGURES 10A and 10B or FIGURES 11A and 11B. In such instance, the left-hand portion 66b of the threads in the members 66 would be utilized for the release of the upper threads 65 on the stem S from the members 66, as is believed evident from the previous description.

In the use or operation of the form of the invention shown in FIGURES 12 and 13, the packer is lowered on the support pipe S in the same manner as described above in connection with FIGURES 6A and 6B, and the sleeve 233 is in threaded engagement with the nut members 66, as shown in FIGURE 12. When the packer P has reached its position in the well bore or casing C for setting same, a non-rotative upward longitudinal movement of the support pipe S is effected to move the releasing sleeve 70 upwardly for transmitting the upward force to the sleeve 233 and the shear pin 32, whereupon the shear pin 32 is sheared or severed as shown in FIGURE 13. Thereafter, the support pipe S is lowered relative to the packer P for setting same. During the lowering of the support pipe S, the threads 233a on the sleeve 233 enter the threads 66a of the nut member 66, but rotation of the sleeve 233 is required for engaging the threads 233a with the threads 66a of the members 66. Such rotation is imparted by the clutch or ratchet engagement of the ratchet teeth 234a and 233b. The rotation of the sleeve 233 is continued until it passes below the nut members 66. Thereafter, the support pipe S is moved downwardly through the packer P for setting the packer in the manner described above in connection with FIGURES 6A and 6B or FIGURES 10A and 10B, depending upon whether or not the threads 65 are included on the support pipe S. If such threads 65 are included, they move into the left-hand thread portion of the threads 66a of the nut members 66 without requiring any rotation of the support pipe S, and as described above, the packer is then locked in set position.

When the packer P of FIGURES 12 and 13 is to be removed, the threads 65 are disengaged from the threads 66 by a right-hand rotation of the support pipe S and thereafter the support pipe S is raised upwardly until the threads 233a enter the threads 66a of the nut members 66 at which time the lower end of the packer P is again connected to the support pipe S. The packer P can then be moved downwardly in the well bore to a different position and can be subsequently reset in the manner described above at the different location in the well casing or bore C. If it is desired to remove the support pipe S completely from the packer P, such can be accomplished since the threads 233a will move upwardly without rotation and thereafter the sleeve 70 and the parts therebelow will move upwardly through the nut member 66 and out of the packer P as previously described. A retrieving tool can then be utilized for completely removing the packer P from the well bore or casing C.

The retrieving tool shown in FIGURES 14A and 14B is merely an example of one type of retrieving tool which may be used for the retrieving of the several forms of the packer of this invention, as illustrated in the other figures of the drawings. As shown in FIGURES 14A and 14B, the retrieving tool has an upper adapter 75

with equalizing ports 75a therein; such adapter 75 is connected to a tubing or pipe (not shown) which extends to the surface of the well and is utilized for the lowering of the retrieving tool. A mandrel or inner tubular member 76 is connected to the adapter 75 and it extends through the entire retrieving tool. The mandrel 76 is provided with an annular shoulder 76a above which is positioned a slip ring 77 having slips 78 connected therewith through resilient fingers 79. Each slip 78 has teeth 78a formed thereon in the form of left-hand buttress threads extending upwardly as shown in FIGURE 14A so that such slips 78 can serve to grip the inside of a tubular member, as will be explained, but they also may be threaded upwardly by a rotation of the mandrel or supporting pipe for the retrieving tool in a right-hand or clockwise direction as viewed from the top of FIGURE 14A.

A slip expander or cone 80 is positioned below the shoulder 76a and inwardly of the slips 78 so that the inclined surface 80a of the slip expander 80 is engageable with the inclined inner surface 78b of each of the slips 78. To prevent the relative rotation between the slip expander 80 and the slips 78, the expander 80 has longitudinally extending bars 81 which are positioned between the slips 78. The slip expander 80 is rotatably connected to the mandrel 76 by the threaded engagement of threads 76b on the mandrel 76 with the threads 80b on the expander 80.

The lower end of the threads 76b is provided with a shoulder 76c which rests upon the upper surface of a bearing ring 82 which is attached to the upper end of the bearing 83. Such bearing 83 is positioned at the upper end of cylinder 84 to which the slip expander 80 is slidably connected by means of pins 85 which project through slots 80c. Such pins 85 prohibit relative rotational movement between the expander 80 and the cylinder 84, but by reason of their position in the slots 80c, the slip expander 80 is movable longitudinally relative to the cylinder 84 the distance permitted by the length of the slots 80c.

The cylinder 84 is maintained in position on the mandrel 76 by a retaining nut 87 which is threaded or otherwise secured to the lower end of the mandrel 76. The cylinder 84 preferably is serrated or roughened such as by knurling on its inclined seating surface 84a so as to provide a frictional engagement with the seat 40 in the packer P (such packer P is partially shown in dotted lines in FIGURE 14B).

In the use of the retrieving tool shown in FIGURES 14A and 14B, such tool is lowered in the position shown in such figures until the lower inclined seating surface 84a engages the seat 40, whereupon a downward force is applied to the lower slip expander 12 to move same downwardly relative to the slips 10 for releasing the wedging action of such expander 12 with respect to the slips 10. The teeth 78a of the slips 78 are in frictional engagement with the mandrel 26 of the packer P when the seating surface 84a of the retrieving tool is resting upon the seat 40. Also, as shown in FIGURE 14A, the retrieving tool is run into the packer P with the slip expander or cone 80 in the raised position, that is, with the pins 85 at or near the lower ends of the slots 80c. Therefore, after the lower slip expander 12 has been moved downwardly with respect to the slips 10, the slips 78 are set in the mandrel 26 by simply raising upwardly on the tube or pipe supporting the retrieving tool. Such upward movement causes the slip cone 80 to move upwardly relative to the slips 78 since the slips 78 are in frictional engagement with the inside surface of the mandrel 26. Once the slips 78 are set, a continued upward pull moves the mandrel 26 upwardly to release the packing element 23 from its sealing position and the lower shoulder 26a then engages the shoulder 20a to apply an upward lift to the upper slip expander 17 to release the engagement thereof with the slips 10. Therefore, the slips 10 are fully released from their set position.

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and the packing element 23 is also fully released so that the packer P is pulled out of the casing C with the retrieving tool as it is moved upwardly in the casing.

In the event the retrieving tool cannot release the slip expander 17 (FIGURE 6B) from its set position, the retrieving tool can be recovered from the well by itself by applying a right-hand rotation to the tubing or pipe supporting the retrieving tool. Such rotation is imparted to the threads 76b, which are preferably left-hand threads and therefore such right-hand rotation causes a downward travel of the slip expander 80 relative to the mandrel 76. The slip expander 80 is prevented from rotating with the mandrel 76 because of the bars 81 which extend between the slips 78 which in turn are in gripping engagement with the inside of the tube or sleeve 26, as previously explained.

If for some reason, the threads 76b and 80b are jammed and will not permit relative rotation between the mandrel 76 and the expander 80, then the rotation of the tubing or pipe is imparted directly to the slip expander, its longitudinal bars 81 and therefore to the slips 78. Since the slips 78 are formed with left-hand buttress teeth 78a, the right-hand rotation causes the tool to travel upwardly until the threads 78a have moved above the packer assembly mandrel 26, whereupon the retrieving tool can be raised out of the well or casing.

It should also be pointed out that the retrieving tool in FIGURES 14A and 14B can be set by rotating the tubing or pipe supporting same. Such rotation would be to the left or counterclockwise, as viewed from the top of FIGURE 14A, assuming the threads 76b and 80b are the left-hand threads previously mentioned. Thus, assuming the expander 80 is in its lower position with the pins 85 at or near the upper ends of their slots 80c, and with the serrated seating surface 84a resting on the seat 40, then the left-hand rotation of the tubing imparts an upward movement to the cone 80 which, of course, forces the slips 78 into gripping engagement with the casing C.

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 packer assembly adapted to be positioned in a well bore including, a well packer having an annular packing element adapted to seal with the wall of the well bore upon outward lateral distortion thereof, an anchoring means connected with the packer having gripping slips adapted to grip the wall of the well bore and also having frictional drag means engageable with the bore wall, expander means forming part of the anchoring means and being mounted for longitudinal movement relative to said gripping slips to control movement of said slips into gripping engagement with the wall of the well bore, said packer having an axial bore therethrough, a support pipe extending through said axial bore, an annular element within the expander means and surrounding said support pipe, releasable means connecting said annular element to said expander means, an enlargement fixed on said support pipe and engageable with the annular element upon downward movement of the support pipe relative to the packer for lowering the packer in the well bore and for preventing the expander means from urging said slips into gripping engagement with the wall of the well bore during such lowering movement, and a second enlargement on said support pipe and spaced below said first enlargement and engageable with the annular element upon upward movement of the pipe relative to the packer for initially moving said expander means longitudinally relative to said slips to urge said slips into gripping engagement with the wall of the well bore and for subsequently releasing said releasable means to disconnect the annular element from the expander, whereby said

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support pipe may thereafter be moved longitudinally downwardly with respect to the packer to apply a downward force to the upper end of the packer element to move the same into sealing position.

2. The structure set forth in claim 1, wherein the releasable connecting means comprises a shear pin connecting said annular member and said expander means which shear pin is adapted to be severed by an upward movement of the support pipe relative to the packer after the slips are set in gripping engagement with the wall of the well bore.

3. The structure set forth in claim 1, wherein the releasable connecting means includes a threaded portion on said annular element, an expansible threaded nut mounted within said expander means and engageable with the threaded portion on the annular element, the threaded connection being releasable upon an upward non-rotative movement of said support pipe, and a threaded portion on the support spaced upwardly from the releasable connecting means and subsequently engageable with the threaded nut which is mounted within the expander by a rotative lowering of said support pipe whereby the packing element is set and the support pipe is connected to the set packer.

4. A well apparatus including, a well packer assembly comprising a mandrel, an annular packing element on the mandrel, an upper expander secured to the lower end of the mandrel, a carrier having gripping members and connected with said expander for limited longitudinal movement relative thereto, a lower expander also connected with said carrier for limited longitudinal movement with respect thereto, downward movement of the upper expander relative to the gripping members and upward movement of the lower expander relative to said gripping members expanding said members into gripping position, friction drag means secured to the carrier for the gripping members to resist movement of said members through the bore, the well packer assembly having an axial bore therethrough within which is disposed an internal abutment, a tubular support extending through the packer bore and having a projection engageable with the internal abutment within the packer assembly upon a predetermined downward movement of the support relative to the packer assembly to effect a downward movement of the upper expander relative to the gripping members to expand the same, an annular member, a releasable connection securing the annular member to the lower expander, an enlargement on the support engageable with the upper end of said annular member whereby the support may be utilized to lower the packer assembly to desired position within the bore, said enlargement being spaced downwardly below the projection on the support a sufficient distance so that when the enlargement is engaged with the annular member the support cannot move downwardly a sufficient distance relative to the expander to allow the projection on said support to engage the packer assembly and thereby expand the gripping members, and means on the support below the well packer assembly and engageable with the lower end of the annular member upon upward movement of the support with respect to the packer assembly to move said member and the lower expander upwardly relative to the gripping members to expand said gripping members into gripping position.

5. A well apparatus as set forth in claim 4, wherein the releasable connection between the annular member and lower expander is releasable by a continued upward movement of the support relative to the packer assembly after the gripping members have been expanded.

6. A well apparatus as set forth in claim 4, wherein the releasable connection between the annular member and lower expander is releasable by a continued upward movement of the support relative to the packer assembly after the gripping members have been expanded, a pressure sealing cup having its sealing lip directed up-

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wardly and connected to the upper expander, and a second pressure sealing cup having its sealing lip directed downwardly and connected with the lower expander, whereby the differential in pressures above and below the packer assembly acts to urge the expanders in a direction maintaining the gripping members in gripping position.

7. A well apparatus as set forth in claim 4, wherein the releasable connection between the annular member and lower expander is releasable by a continued upward movement of the support relative to the packer assembly after the gripping members have been expanded, said packing element being in the form of a deformable sleeve, the projection on the support which is normally disposed above the packing assembly but movable downwardly into engagement with the internal abutment within the packer assembly after the annular member is released applying a continuing downward force to the upper expander and to the packing sleeve, whereby the upper expander is urged in a direction maintaining the gripping members expanded and also whereby the packing sleeve is deformed into sealing position.

8. A packer apparatus including, a well packer assembly including a tubular mandrel having an annular elastic packing member thereon adapted to seal with the wall of the well and having an axial bore extending entirely therethrough, an anchoring unit connected to and located below the packer assembly and having an axial bore, said anchoring unit comprising a slip carrier, gripping slips carried by said carrier for gripping the well bore wall, upper and lower expanders movable longitudinally relative to the slips to control expansion and retraction thereof, releasable means connected to said upper expander and mandrel to maintain said packing member in retracted position, and separate friction drag means connected with the slip carrier and upper expander respectively to resist movement of the slips through the well bore, a tubular support extending through said packer assembly bore and through said anchoring unit bore and movable longitudinally relative to said assembly and unit within predetermined limits, an internal member releasably secured within the bore of the lower expander, an external projection on the support engageable with the upper end of said internal member whereby the support may be utilized to move the apparatus downwardly within the well, said support having an upper external abutment thereon which is spaced upwardly from said external projection and is disposed above the packer assembly when said projection is engaging the upper surface of the internal member within the anchoring unit bore, and means on the support below said external projection and engageable with the lower end of the internal member upon an upward movement of the support with respect to the apparatus, whereby an upward force may be applied to said internal member to disconnect it from the lower expander, after which the support may move downwardly a sufficient distance relative to the packer assembly to engage the upper external

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abutment with the upper portion of the packer assembly to thereby apply downward force to the packing member of the assembly and to the upper and lower expanders of the anchoring unit to expand the slips into gripping position and release the said releasable means connecting said upper expander and mandrel and deform the packer into sealing position.

9. A packer apparatus as set forth in claim 8, wherein the internal member within the bore of the anchoring unit is an annular member which is releasably secured in position by a shear pin.

10. A well apparatus as set forth in claim 8, together with a connecting means within the bore of the packer apparatus, and coacting connecting means on the support which is engageable with said first connecting means when the support has been lowered sufficiently to set the slips of the anchoring unit and deform the packing member of the packing assembly, whereby the support is connected to said packer apparatus after the latter is in set position.

11. A well apparatus as set forth in claim 8, together with a first connecting means within the bore of the packer apparatus and mounted between the lower portion of said packer and said lower expander and surrounding said support, and consisting of arcuate segments which together form a cylindrical nut when urged by annular springs disposed around the exterior of said segments, said segments having internal threads, and a second coacting connecting means on the support which is engageable with said first connecting means when the support has been lowered sufficiently to set the slips of the anchoring unit and deform the packing member of the packing assembly, said second coacting means consisting of left-hand threads on said support for coaction with the internal threads of said first connecting means, said left-hand threads being so shaped that while passing downwardly through said cylindrical nut they expand said arcuate segments against the action of said annular spring, whereby the support is connected to said packer apparatus after the latter is in set position, the connection between the first and the second connecting means being made by a straight longitudinal movement of the support relative to the packer apparatus to effect a mating of the threads on the support with those threads in the cylindrical nut, said threads being released from their mating position by a rotative movement of the support with respect to said packer apparatus.

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