Dec. 21, 1965 C. B. COCHRAN 3,224,508

HYDRAULIC PACKER WITH SAFETY JOINT RELEASE

Filed Dec. 26, 1962 3 Sheets-Sheet 1

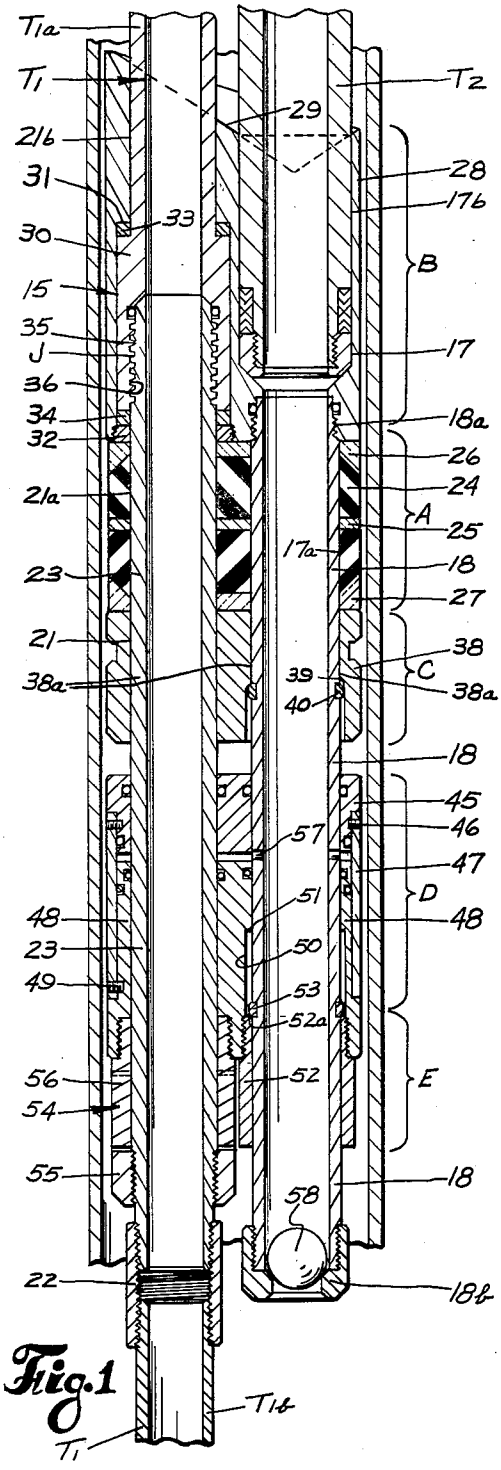


Fig. 1

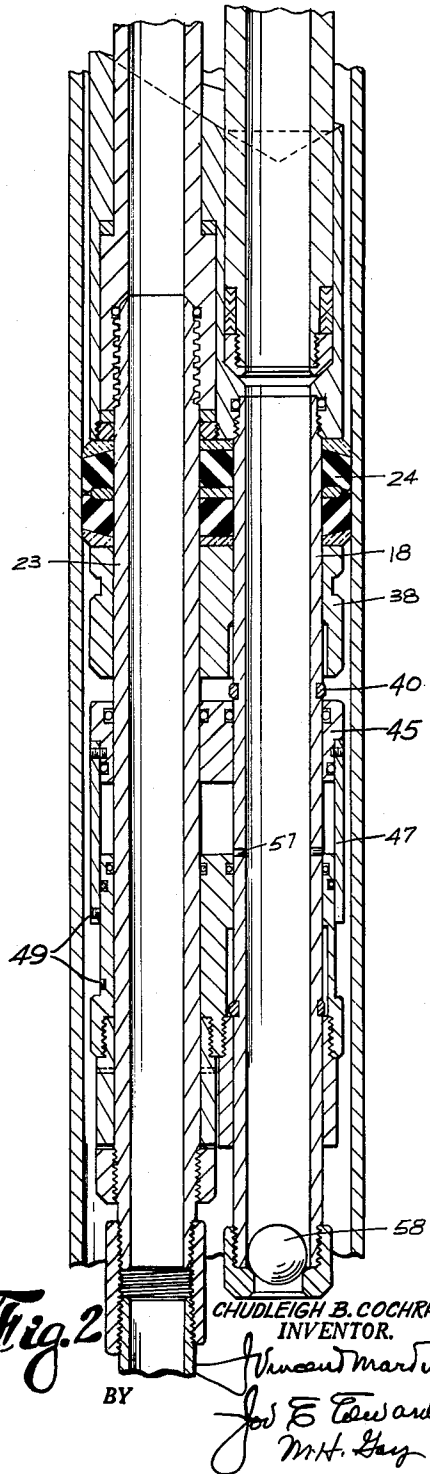


Fig. 2

CHUDLEIGH B. COCHRAN
INVENTOR.

BY Vincent Martin
Jos E Edwards
M.H. Gay
ATTORNEYS

Dec. 21, 1965 C. B. COCHRAN 3,224,508

HYDRAULIC PACKER WITH SAFETY JOINT RELEASE

Filed Dec. 26, 1962 3 Sheets-Sheet 2

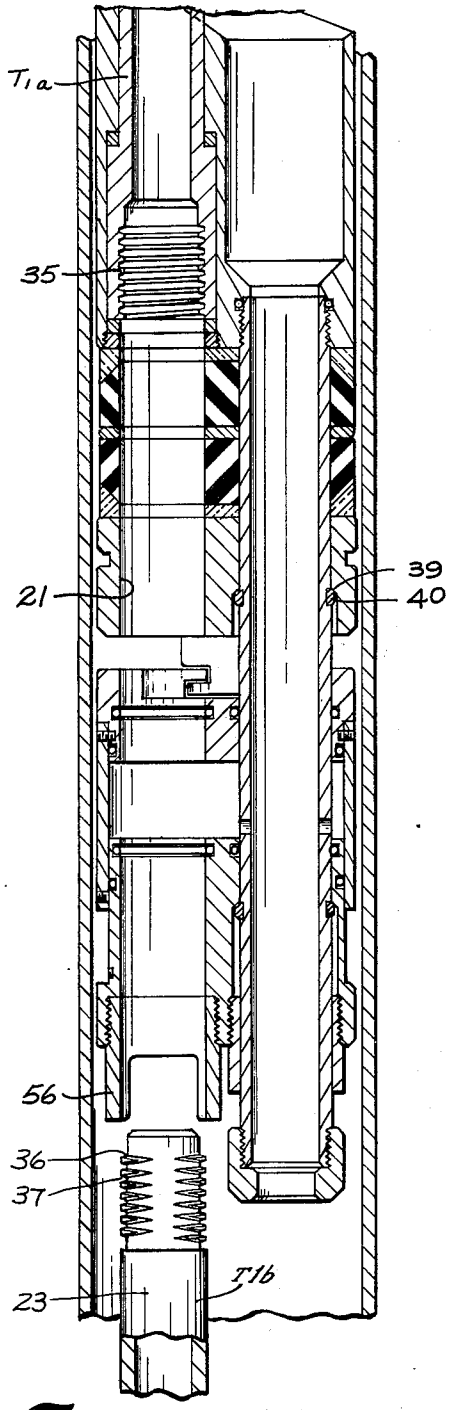


Fig. 3

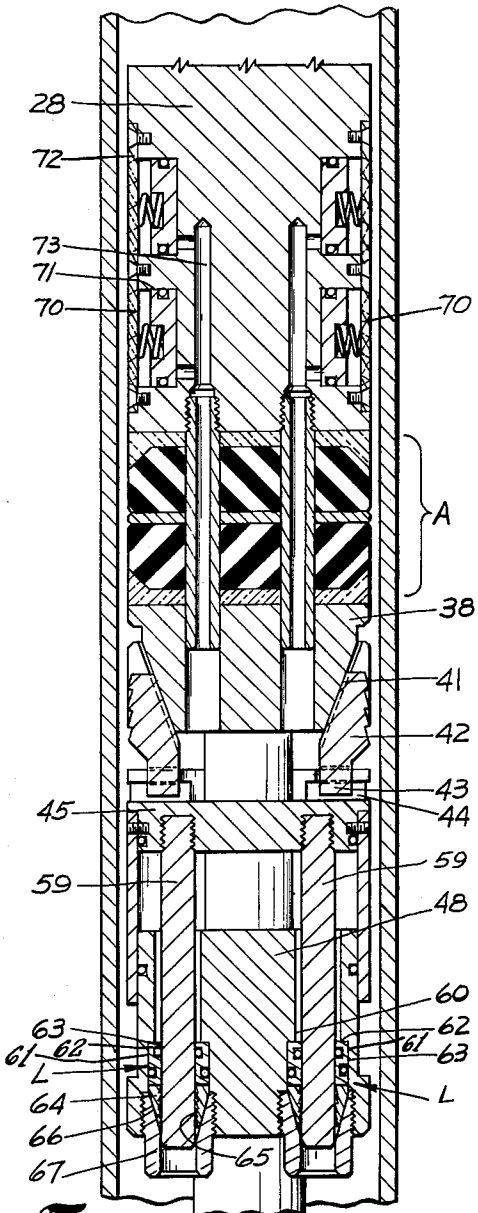


Fig 4

CHUDLEIGH B. COCHRAN
INVENTOR.

BY Vincent Martin
Jos E Edwards
M. H. Gay
ATTORNEYS

Dec. 21, 1965 C. B. COCHRAN 3,224,508

HYDRAULIC PACKER WITH SAFETY JOINT RELEASE

Filed Dec. 26, 1962 3 Sheets-Sheet 3

Fig. 5

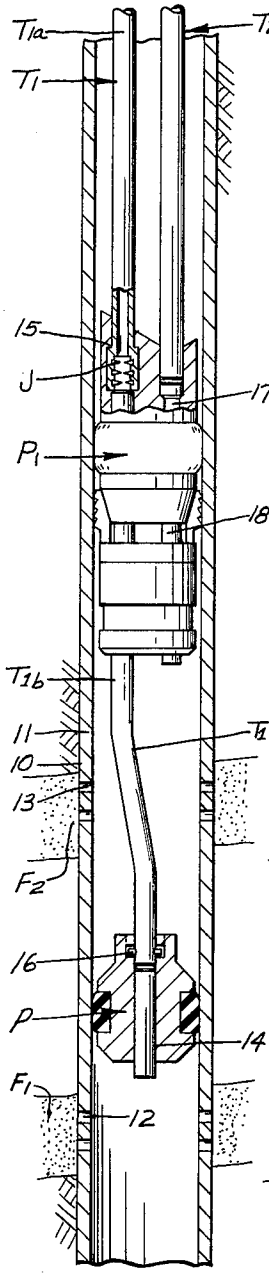


Fig. 6

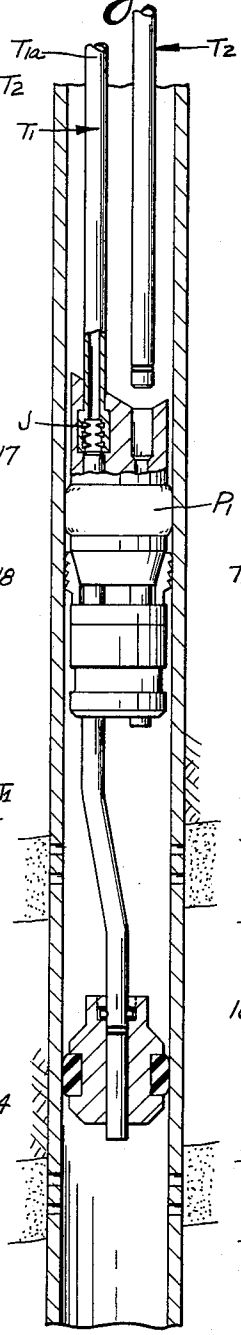


Fig. 7

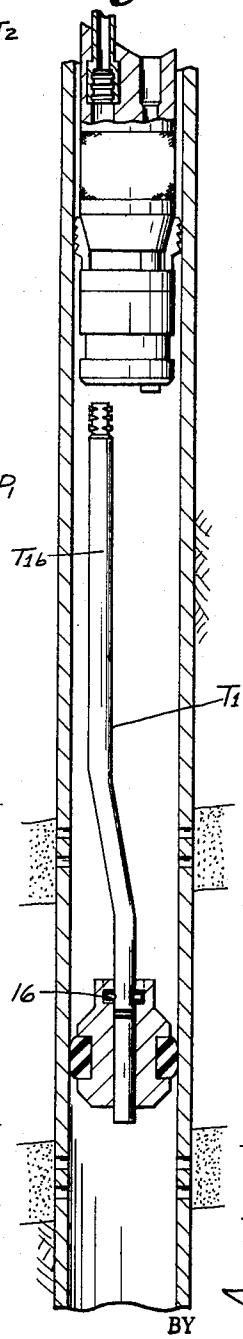
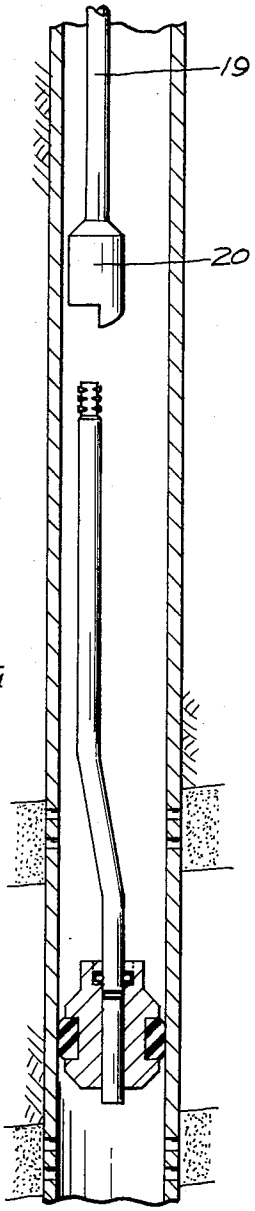


Fig. 8



CHUDLEIGH B. COCHRAN
INVENTOR.

BY

Thurman Martin
Jos E Edwards
M. H. Gay
ATTORNEYS

United States Patent Office 3,224,508
Patented Dec. 21, 1965

3,224,508

HYDRAULIC PACKER WITH SAFETY JOINT RELEASE

Chudleigh B. Cochran, Houston, Tex., assignor to Cicero C. Brown, Houston, Tex.

Filed Dec. 26, 1962, Ser. No. 247,195
12 Claims. (Cl. 166—120)

This invention relates to new and useful improvements in well packer apparatus and relates particularly to multiple production well packers. The invention is an improvement upon the well packer apparatus disclosed in my co-pending application Serial No. 167,312, filed January 19, 1962.

In multiple production wells where well fluids are produced from two producing formations traversed by a bore hole, it has been the practice to set a lower packer having a single axial bore therethrough at an elevation between the two producing formations to separate the same and thereafter run and set an upper dual passage packer at a point above the upper producing formation. The upper dual packer is normally lowered by means of a first pipe or tubing string and one of the passages in the packer has a depending pipe or tubing section which is engaged and sealed with the axial passage in the lower packer to communicate with the area below said lower packer. No difficulty is experienced in lowering the depending tubing section with the upper packer and the length of said depending section is such that proper seal with the lower packer is made when the upper packer reaches its final position in the well bore. A second pipe or tubing string is then lowered and seated in one of the passages in the upper packer, after which said upper packer is set and the two formations may be separately produced through independent tubing strings.

Although lowering of the depending tubing section along with the upper packer presents no problem, its removal by means of the upper packer, when the latter is subsequently released and removed, may involve some difficulty. Normally, the packers remain in the well bore for a period of time and since the well fluids are being produced, an accumulation of sand above the lower packer and around the depending tubing section may occur. For this or other reasons, it is desirable that means be provided for permitting a separation of the depending section from the upper packer at the time that the upper packer is to be released and removed from the well bore. Prior practice has incorporated a threaded safety joint, which it is released by left-hand rotation of one of the strings, in the upper portion of the depending section, whereby substantially the entire section may be disconnected from the upper well packer; however, such use of a safety joint requires that at least one of the tubing strings be rotatable within the entire passage of the upper well packer. Such an arrangement presents sealing problems and complicates the over-all structure. In other instances, such as illustrated in my above referred to co-pending application, a shear pin type safety joint, as distinguished from a threaded type which requires rotation, has been employed, but said shear pin type has certain limitations. For example, if a relatively long depending tubing section is required, the weight of such long string may shear the pin prematurely; or, if the pin is of sufficient strength to support said string, then difficulty may be experienced in fracturing the pin at the desired time.

The well packer apparatus disclosed in my co-pending application is set by the application of fluid pressure, is locked in set position by a mechanical locking means, and is released from set position by rotation of one of the tubing strings. As above noted, separation of the released packer from the depending tubing section is

effected through a shear pin type of safety joint having the limitations outlined above. It is one object of this invention to provide an improved well packer apparatus having all of the advantages of that shown in said co-pending application but eliminating the disadvantages of and limitations imposed by the use of a shear pin type safety joint.

An important object of the invention is to provide an improved multiple production well packer apparatus wherein the releasing means which, upon rotation of one of the tubing strings, accomplishes a release or unsetting of the well packer assembly and also functions as a thread-type safety joint which effects a separation of said packer assembly from the usual depending or lower tubing section whereby said packer assembly may be removed from the well independently of said lower tubing section.

Another object of the invention is to provide a well packer apparatus, wherein the well packer assembly includes a coarse thread system which co-acts with the upper end of the depending or downwardly extending tubing section in such manner that rotation of the main or upper part of the tubing string with which said section is associated first effects a release or unsetting of the packer assembly and thereafter completely separates said section from the packer assembly and the main or upper part of the tubing string, thereby permitting removal of said main part of the tubing string and packer assembly while leaving the lower section within the well bore.

A particular object is to provide a packer apparatus, of the character described, wherein the upper portion of the downwardly extending tubing section is normally within one of the passages of the packer assembly and forms a part thereof; the extreme upper end of said tubing section having a course thread system including both left-hand and right-hand threads, with the left-hand threads being normally engaged by the main or upper portion of the tubing string, whereby right-hand rotation of said upper portion of the tubing string initially causes relative movement of said upper portion with respect to the downwardly extending section to effect a release or unsetting of the packer assembly and thereafter causes complete separation of said upper portion from said downwardly extending section. After such separation, the right-hand threads on said downwardly extending section, being located at the upper end thereof, are subsequently available for connecting with a coupling at the lower end of a retrieving pipe, whereby subsequent removal of said section is facilitated.

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 vertical sectional view of a dual passage packer employed in the well packer apparatus of this invention and showing the packer in unset position;

FIGURE 2 is a similar view with the packer in set position;

FIGURE 3 is a view similar to FIGURE 1 and illustrating the packer elements in released position with the lower portion of one tubing string disconnected therefrom;

FIGURE 4 is a view of the packer in released position with said view being taken at a right angle to that shown in FIGURE 3; and

FIGURES 5 through 8 are schematic views of the improved well packer apparatus and illustrating the se-

quence of steps by which removal of the packer and subsequent removal of the lower portion of one of the tubing strings is accomplished.

In the drawings, FIGURES 5 through 8 schematically illustrate the improved well apparatus and the manner of manipulating the same within the well bore **10**. As shown in such figures, the well bore **10** has the usual casing **11** extending therethrough and traverses two producing formations F1 and F2. Perforations **12** and **13** are provided in the casing **11** opposite the producing formations whereby well fluids may enter the well bore from said formations.

A lower well packer P which may be of the wireline type is set within the casing **11** and is located between the producing formations F1 and F2. This packer may be of any suitable construction and includes a central bore or passage **14** which is located axially of said packer. An upper packer P1, which will be hereinafter described in detail, and which is generally known as a dual packer, is adapted to be set within the well casing **11** at a point above the producing formation F2. The upper or dual packer P1 is lowerable into the well bore by means of a first tubing string T1. The tubing string T1 has an upper section T1*a*, the lower end of which has a rotatable or swivel connection indicated at **15** with the upper portion of the packer P1. A lower section T1*b* of the tubing string T1 has its upper end connected through a special threaded joint J, which will be hereinafter described in detail, with the lower end of the upper section T1*a*; in this way the sections T1*a* and T1*b* form the complete first tubing string T1 by means of which the packer P1 is lowered into position. As illustrated, the lower section T1*b* of the first tubing string T1 extends downwardly from the packer P1 and projects downwardly through the bore **14** of the lower packer P. A latching means, such as the well known J-type latch or other suitable connection, indicated generally at **16** in FIGURE 5, latches the lower portion of the first tubing string T1 within the lower packer P. Obviously the well fluids from the lower formation may flow upwardly through tubing T1 to the surface.

A second tubing string T2 is arranged to be lowered into position to seat within a longitudinal passage **17** which is formed within the upper packer P1. A tubular support or mandrel **18** is disposed within passage **17** and functions as the main support for the various elements comprising the packer assembly of said upper packer P1. The mandrel also communicates the area between packers P and P1 with the second tubing string T2, whereby well fluids from the second formation F2 may be conducted to the surface through the second tubing string T2. The apparatus shown in FIGURE 5 illustrates the two packers and the two tubing strings in position, and with the packers in set or sealing engagement with the casing, it will be evident that independent flow of well fluids from each of the formations may occur through the separate tubing strings T1 and T2.

The upper packer P1 may be of any suitable construction, but is preferably a packer which may be set hydraulically by fluid pressure conducted downwardly to the setting means thereof through one of the tubing strings. The packer is also of such a construction that it may be released from its set position by rotation of the first tubing string T1 so that the action of the threaded joint J will function to effect a release of the packer P1. Because the packers P and P1 normally remain within the well casing for a considerable time after their initial setting, an accumulation of sand and other material may occur on top of the lower packer P and around the lower section T1*b* of the tubing string T1. For this, or for other reasons, it is desirable that when removal of the upper packer P1 is desired, such removal can be accomplished without having to remove the lower section T1*b* of the tubing string T1. In order to permit removal of the upper dual packer P1 without at the same time having to remove the lower section T1*b* of the first tubing string T1, the threaded joint J has an additional function. As above noted, the joint is arranged so that upon rotation of the upper section T1*a* of the first tubing string T1 a release of the setting means and packing element of packer P1 is effected. After the release of the packer has been accomplished, rotation of the upper section T1*a* of tubing T1 may be continued to completely disconnect the lower section T1*b* from the section T1*a*. When this occurs, the upper packer P1 may be completely removed from the well by means of the upper section of the first tubing string T1, leaving the lower section T1*b* of said first tubing string in position with its lower portion attached to the lower packer P.

The sequence of operation in removing the upper packer, and thereafter removing the lower section T1*b* of the first tubing string, is illustrated in FIGURES 6 to 8. The first step in the sequence of operation is shown in FIGURE 6 wherein the second tubing string T2 is lifted upwardly and removed from the well bore; at this time the upper packer P1 is still in its set position and the first tubing string T1 remains in its position extending through the well bore. After the second tubing string T2 has been completely removed, the upper section T1*a* of tubing string T1 is rotated in a direction to the right and, as will appear from a description of the threaded joint J, this initial rotation of the section T1*a* with respect to the lower section T1*b* will result in effecting a release of the setting means and the packing element of packer P1, whereby the packer P1 is moved to an unset or released position which will permit its removal from the well casing.

Following release of the upper packer P1, rotation of the upper section T1*a* of the first tubing string T1 will completely separate said upper section T1*a* from the lower section T1*b* of said first tubing string, and thereafter the upper packer P1 may be removed from the well by means of the upper section of the first tubing string. This step is clearly shown in FIGURE 7 wherein the upper packer has been pulled upwardly with respect to the lower section T1*b* of the tubing string T1, the latter section being supported in the well bore by the latching means **16** which couples this section to the lower packer P.

After removal of the upper packer P1 from the well casing, a retrieving pipe **19** having a coupling member **20** on its lower end may be lowered within the well casing; the coupling member has right hand threads (not shown) within its bore and said threads are engageable with the right hand threads of the joint J at the upper end of the tubing section T1*b*. Thereafter, the latching means **16** may be disconnected and the lower section T1*b* of the tubing string may be pulled upwardly and removed from the well by means of said retrieving pipe.

From the foregoing it will be seen that the threaded joint J functions first to release or unset the packer P1 and to thereafter completely separate the upper section T1*a* from the lower section T1*b* of the first tubing string. This permits removal of the packer P1 by means of the upper tubing section T1*a*, after which a suitable retrieving pipe **19** and coupling **20** may be utilized to remove the lower section T1*b* from the well bore.

Although as noted any suitable type of packer which is adapted to be set by hydraulic pressure and released by a mechanical action, may be employed, a particular packer which has been found suitable for carrying out the present invention is illustrated in FIGURES 1 to 4, inclusive. Referring specifically to FIGURE 1, the letter A designates an elastic packing element which has an upper abutment or head member B disposed thereabove. Immediately below the packing element is an anchoring means C, and connected with the anchoring means is a hydraulically actuated setting means D. Below the hydraulically actuated means D is a lower abutment E. The elements A, B, C, D and E comprise the packer assembly, and each of these elements is provided with spaced parallel

openings which align with each other longitudinally to form two elongate passages extending throughout the length of the packer structure. One of the passages is the passage 17 within which the main support or mandrel 18 for the packer assembly is disposed; as illustrated the mandrel 18 is threaded at 18*a* to the upper abutment B and extends downwardly to project from the lower end of the packer structure. This mandrel carries a valve seat collar 18*b* at its lower end.

The second longitudinal passage formed by the various elements is indicated by the numeral 21, and it is this passage into which the upper end of the lower tubing section T1*b* extends. In actual construction, the lower section T1*b* has its upper end coupled by a collar 22 to a tubular mandrel 23 which when in position functions as a support in addition to the main support or mandrel 18 for the packer assembly; it is this mandrel or support 23 which is formed with threads comprising a part of the special threaded joint J. The upper section T1*a* of the first tubing string T1 has a swivel or rotatable connection 15 with the upper abutment B and has the complementary threads which complete the special threaded joint J. As shown in FIGURE 1, the second tubing string T2 is adapted to engage within the upper end of the passage 17 and to be seated therein.

The packing element A may take any desired form, but as illustrated includes two generally cylindrical bodies 24 of rubber, or other elastic material, spaced from each other by a spacing ring 25. The upper and lower ends of the packing bodies are confined by anti-extrusion end rings 26 and 27 which are constructed of soft metal, such as lead, and which are deformed radially outwardly when the packing element is in set position. The packing bodies have parallel openings 17*a* and 21*a* extending therethrough which form a part of the two longitudinal passages 17 and 21 through which the mandrel 18 and the mandrel or conductor 23 extend.

The upper abutment or head member B comprises a solid metallic body 28 having parallel openings 17*b* and 21*b* forming part of the passages 17 and 21. As noted, the tubular mandrel 18 is secured to the body 28 of the uper abutment by the thread 18*a* so that any movement of the upper abutment will result in a similar movement of said mandrel. The extreme upper end of the abutment body 28 is inclined or tapered at 29, and this taper or inclination is for the purpose of guiding tubing string T2 into the longitudinal passage 17.

The first tubing string T1 has the lower end of its section T1*a* provided with an enlarged portion 30 which is confined between a shoulder 31 in the passage 21*b* of the abutment body, and a ring nut 32 which is threaded into the lower end of the passage through said abutment body; suitable annular bearings 33 and 34 are interposed between the extremities of the enlarged portion 30 and the shoulder 31 and the ring nut 32, respectively, to form the swivel connection 15. The bore of the enlarged portion of tubing string T1 has a coarse left-hand thread 35 formed therein and this thread is adapted to engage left-hand threads 36 which are formed on the external portion of the upper end of the conductor or mandrel 23. The particular thread arrangement on the upper end of the mandrel or support 23 is illustrated in FIGURE 3, and includes, not only the left-hand threads 36, but also right-hand threads 37. However, since the threads 35 of the upper tubing section T1*a* of the first tubing string T1 are left-hand, the engagement of such threads is only with the left-hand threads 36 of the mandrel or support 23. As has been noted, the lower section T1*b* of the first tubing string T1 is coupled to the mandrel 23 and thus the left-hand coarse threads of the joint J connect the upper and lower tubing sections of the first tubing string when the parts are in the position shown in FIGURE 1.

It will be evident that since the upper section T1*a* of the tubing string T1 is rotatably confined within the upper abutment body 28, a right-hand rotation of this upper section, while the mandrel or support 23 is held against rotation, will result in a relative movement of the section T1*a* with respect to said mandrel or support 23. This movement will cause the upper section T1*a* of the tubing T1 to move upwardly relative to the stationary mandrel 23, and, as will be explained, this relative movement will effect a release of the packer anchoring means and the packing element. Also, as will be explained, this right-hand rotation of section T1*a* will result in complete separation of the upper section T1*a* from the mandrel 23 and the lower section T1*b* attached or coupled to such mandrel.

Immediately below and abutting the lower end of packing element A is the anchoring means C which is more clearly shown in FIGURE 4. This anchoring means includes an expander cone 38, the upper end of which is engaged by the lower end of packing element A. Vertical openings 38*a* are formed in the cone (FIGURE 1) and such openings are aligned with the other openings which form the longitudinal passages 17 and 21. The opening 38*a* through which the mandrel 18 extends is counterbored to form an annular shoulder 39 which is adapted to engage a snap ring 40 mounted upon the mandrel 18. During lowering of the packer into the well the snap ring 40 provides a shoulder supporting the expander cone 38, packing element and upper abutment upon said mandrels 18 and 23.

The external surface of the expander cone, as shown in FIGURE 4, is formed with inclined slip-expanding surfaces 41 which co-act with pipe-gripping slips 42. The lower ends of the slips are each formed with a T-shaped connection 43 which engages within a T-shaped slot 44 cut in the upper end of a slip carrier block 45. The block has parallel longitudinal openings which align with the openings in the expander cone, packing element and upper abutment, and through which the tubular mandrels or supports 18 and 23 extend. When the slip carrier block 45 is moved upwardly on the tubular supports or mandrels 18 and 23, the pipe-gripping slips 42 move upwardly along the inclined surfaces 41 of the cone 38 to effect a radially outward movement of the slips; thus, upward movement of the slip carrier effects an expansion of the slips into pipe-gripping position.

The slip carrier block 45 is connected by suitable screws 46 with the upper end of a cylinder 47 which forms part of the hydraulically-actuated means D. The cylinder extends downwardly to encircle the body 48 of the lower abutment E, and is sealed with the exterior of the body by means of an O-ring, or other suitable sealing means. Initially the cylinder is attached to said body by one or more shear pins 49 (FIGURES 1 and 2). The upper portion of the body 48 forms a stationary piston which is located within the cylinder 47. The body 48 is, of course, formed with a pair of parallel passages through which the mandrels or supports 18 and 23 extend, and suitable seals, such as O-rings, seal between the supports and the bores of said passages. The passage through which the mandrel 18 extends is counter-bored from the lower end of body 48 as shown at 50 to form an upper internal shoulder 51; a stop collar 52 is threaded into the lower end of the passage and is spaced from the shoulder 51 with the upper end of said stop collar forming a shoulder 52*a*. A snap ring 53 is secured to the exterior of the mandrel 18 and is movable in the counter-bore 50 between the upper and lower shoulders 51 and 52*a*. With the parts in the position shown in FIGURE 1, the engagement of shoulder 52*a* with the snap ring limits upward movement of the body 48 relative to the support, whereby an accidental setting of the packer is prevented during lowering. The mandrel or support 23, which extends substantially throughout the passage 21, projects below the lower abutment body 48 and is non-rotatably connected to said body by a clutch generally indicated at 54. This clutch is formed by a clutch collar 55 threaded onto the mandrel 23 and a clutch collar 56 threaded onto

the body 48; the clutch collars have interlocking clutch teeth. Since one part of the clutch is secured to the mandrel 23, which in turn is connected to the first tubing string T1, said clutch functions to support the entire packer assembly during lowering into the well.

In order to introduce pressure fluid into the cylinder 47 and into the area above the body 48 which forms the stationary piston, a plurality of ports 57 are formed in the lower portion of the mandrel 18. These ports are so located that when a closure ball 58 is dropped downwardly through the second tubing string T1 to seat upon the valve seat collar 18*b*, pressure fluid may be directed downwardly through the second tubing string T2 and through said ports into the cylinder above the stationary piston formed by the body 48. This pressure is applied to act upwardly against the slip carrier 45 and, as said carrier moves upwardly by reason of the body 48 being held against downward movement through its support by the first tubing string T1, the slips are moved into pipe-engaging position. As soon as the slips engage the wall of the pipe, the pressure thereafter acts downwardly on the upper end of the stationary piston formed by body 48, and this downward force is transmitted through the clutch 54 and mandrel 23 to the upper abutment body 28; the downward motion or pull on the upper abutment applies sufficient endwise force to the packing element to set the same into sealing position. This position of the parts is illustrated in FIGURE 2.

After the packing element A and anchoring means C have moved to a set position, it is desirable to release the setting pressure from the second tubing string T2, and, in order to maintain the packer in set position after the release of such setting pressure, a locking assembly, generally indicated at L in FIGURE 4, is provided. This locking assembly is located within the body 48 of the lower abutment, and includes a pair of locking rods 59 which have their upper ends threaded or otherwise secured in the under side of the slip carrier block 45. The locking rods are disposed in a transverse plane which is at substantially a right angle to the plane in which the passages 17 and 21 are located. Each rod extends downwardly through a vertical bore 60 in the body 48, and has its lower end projecting below said body. The bore 60 is of larger diameter than each rod 59, and the upper end of said bore communicates with the area between the stationary piston and the under side of the slip carrier block, whereby pressure fluid from this area may enter the annular space between each rod and its bore.

The lower portion of each bore 60 is counterbored and enlarged at 61 to form an internal shoulder 62. An annular piston 63 which surrounds the rod is slidable in this counterbore, and gripping elements 64 have inner buttress-type gripping teeth 65 are disposed below the piston. The outer inclined surface of each gripping element is confined within and co-acts with the inclined bore 66 of a supporting collar 67 which is threaded into the lower end of each bore 60. The buttress-type gripping teeth engage the outer surface of the locking rod and allow the rod to move upwardly relative thereto, but prevent reverse or downward movement of the rod with respect to the lower abutment.

When pressure fluid is applied to the slip carrier block 45 to move said block upwardly and thereby set the main slips, the locking rods 59 are raised with their prespective bore 60, and move upwardly relative to the gripping elements 64. However, downward movement of the rods relative to the abutment is prevented by the engagement of the gripping elements therewith. The pressure fluid which moves the carrier block upwardly also acts through the bore 60 against the upper end of each piston 63 to maintain the gripping element 64 in contact with the rods. Therefore, as soon as pressure fluid acting against the slip carrier block is relieved, any tendency of the block to move in a direction to release the main slips 42 is prevented because the rods 59 are locked against downward movement by their respective gripping elements. It is apparent that the locking rods function as a mechanical gripping means which will maintain the main gripping slips 42 of the anchoring means C in position, and even though a leakage might occur past the seals in the cylinder 47 and the stationary piston formed by body 48, the locking rods will assure that the packer remains in set position. To prevent excessive pressure from below the set packer from urging said packer upwardly in the well pipe, the assembly may be provided with pressure actuated hold-down buttons 70. As shown in FIGURE 4, a pair of buttons 70 may be mounted on each side of the assembly with each button being slidable within a recess 71 formed in the upper abutment body 28. A retaining strap 72 overlies each button and prevents complete outward displacement thereof from its recess. Each pair of hold-down buttons has its rear surface exposed to the pressure in the well casing below the set packer through a longitudinal passage 73. Each such passage extends downwardly through the packing element A and through the expander cone 38 and communicates with the area below the packer assembly. If the pressure below the set packer increases, the hold-down buttons are urged into pipe-gripping engagement with the wall of the pipe to prevent upward displacement of said assembly.

In removing the apparatus, the second tubing string T2 is first removed from the well as shown in FIGURE 6 and this equalizes pressures across the hold-down buttons to release their gripping engagement with the pipe. The upper packer is then released from its set position by rotating the upper section T1*a* of the first tubing string in a direction to the right; at this time the lower abutment body 48 is held stationary by reason of the pipe-gripping slips engaging the wall of the pipe and, because the mandrel or conductor 23 is non-rotatably connected to the abutment through clutch 54, this mandrel is also held stationary. Thus, upon right-hand rotation of the upper section T1*a* of the first tubing string T1, the coarse left-hand threaded connection between the left-hand threads 35 on section T1*a* and the left-hand threads 36 on mandrel 23 begins to impart a relative movement to the section T1*a* of the tubing T1. Such movement actually results in lifting or raising the section T1*a* relative to the mandrel 23 and to all other parts of the packer assembly except the upper abutment B to which section T1*a* is connected.

As the coarse threads of the threaded joint J continue to unscrew, there is an upward force applied to the upper abutment B, and at the same time a downward force is being applied to the mandrel or conductor 23. If the packers P and P1 are set relatively close to each other, the downwardly extending section T1*b* of the first tubing string will have minimum flexibility and will, in effect, be rigid; therefore the downward movement of the mandrel or conductor 23, which forms the upper portion of section T1*b*, is prevented. Therefore, further rotation of the tubing section T1*a*, resulting in further unscrewing of the left-hand threads of joint J, applies the upward force to the upper abutment body 28, which relieves the endwise force being applied to the packing element A. It is noted that upward movement of the upper abutment body 28, as well as upward movement of the second mandrel 18, is permitted because the latter mandrel has its snap rings 40 and 53 movable within limits with respect to the lower abutment body 48 and the expander cone 38, respectively.

Rotation of tubing section T1*a* continues until the upper abutment body 28 has released the force on the packing element, and by this time the snap ring 40 has moved against the shoulder 39 in the expander cone so that subsequent rotation will jack the mandrel 18 upwardly to actually pull the expander cone from between the slip members. The packer is thus completely released and the packer parts are in the position shown in FIGURE 3, with the entire packer assembly capable of

being supported by mandrel 18 through the rings 40 and 53.

After release of the packer, continued rotation of the upper section T1*a* of tubing T1 completely releases the joint J and the packer may be picked up and removed by means of the upper section T1*a*. As shown in FIGURE 3, the lower section T1*b* of the first tubing string, having the special threaded joint at its upper end, remains in the well bore.

In the event the packers P and P1 are set a considerable distance apart, the downwardly extending section T1*b* of the first tubing string, being of relatively greater length will have a greater flexibility. Such flexibility may be insufficient to resist bending under the force applied during initial rotation of the upper section T1*a* of the tubing. In such instance, initial rotation may result in diconnecting section T1*b* at the joint J before the upper abutment moves upwardly the distance required to release both the packing element and anchoring means C. If such occurs, it is only necessary to apply an upward pull to the upper tubing section T1*a* which pull will fully release the packing element and raise the expander from within the slips.

After the packer P1 has been removed, leaving the section T1*b* of the first tubing string T1 in the well bore, the retrieving pipe 19 and special coupling 20, as shown in FIGURE 8, may be lowered into the well bore and connection may be made with the right-hand threads 37 of the coupling at the upper end of the section T1*b*, after which said section may be retrieved.

The particular double thread arrangement illustrated as disposed at the upper end of the lower section T1*b* is of the type shown in my co-pending application Serial No. 743,803, filed June 23, 1959. Such a joint has both right and left-hand threads cut on the same area, and obviously, since the left-hand threads are connected with the upper tubing section T1*a*, disconnection may be effected by rotation in a right-hand direction of said tubing section. When the retrieving pipe is to be connected with the section T1*b* (FIGURE 8) the reconnection can also be made by right-hand rotation of the retrieving pipe, because in such case the connection is made with the right-hand thread.

From the foregoing it will be seen that a hydraulically set packer, which is arranged to be released by a mechanical motion is provided with a special joint. Such joint not only functions to effect the mechanical release of the packer from its set position, but, upon continued operation, functions to completely separate the upper tubing section from the lower tubing section of a tubing string. It might be said that the special joint is in effect a safety joint incorporated within the packer assembly which has the dual function, first, of releasing the packer, and, second, of accomplishing complete separation whereby the lower portion of the tubing string may be left in the well bore to be retrieved after the packer has been independently removed by the upper section of such string.

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 I claim is:

1. A well packer apparatus lowerable within a well bore including:

a well packer assembly comprising a support, a packing element mounted on the support, and an anchoring means, also mounted on the support, for anchoring said assembly within said bore, said packer assembly having a longitudinal passage extending therethrough,

an upper section of a tubing string having its lower portion extending into the passage and rotatably attached to the upper end of the packer assembly,

a lower section of said tubing string having its upper portion projecting into said passage with its lower portion extending downwardly below the packer assembly,

a threaded connection between said upper and lower sections of said tubing string to form a continuous tubing string extending through the packer assembly,

means for setting the packing element and anchoring means of the packer assembly to set the same within the bore,

the threaded connection being operable by rotation of the upper tubing section of tubing relative to the lower tubing section to cause movement of the sections with respect to each other,

co-acting means on said upper section and on the packer assembly to unset and release the latter upon a predetermined relative movement of the tubing sections with respect to each other,

said rotation of the upper tubing section relative to the lower tubing section completely separating said sections, whereby the upper section and packer assembly may be removed from the bore separately from the lower tubing string section.

2. A well packer apparatus as set forth in claim 1, wherein

the threaded connection between the upper and lower tubing string sections comprises relatively coarse, safety-joint type threads which are left-hand threads so that relative longitudinal movement of the tubing sections and complete separation thereof is accomplished by rotating said upper tubing string section in a direction to the right.

3. A well packer apparatus as set forth in claim 1, wherein

the lower portion of the upper tubing string section is formed with relatively coarse left-hand threads,

the upper portion of the lower tubing string section having relatively coarse left-hand threads engageable by the left-hand threads of the upper section, whereby disconnection of the sections can be effected by a right-hand rotation of said upper section,

and additional relatively coarse right-hand threads also formed on the upper portion of the lower tubing section, which threads are engageable by a retrieving pipe after the upper tubing string section and packer assembly have been removed from the well bore.

4. A well packer apparatus as set forth in claim 1, wherein

the lower portion of the upper tubing string section is formed with relatively coarse left-hand threads,

the upper portion of the lower tubing string section having relatively coarse left-hand threads engageable by the left-hand threads of the upper section, whereby disconnection of the sections can be effected by a right-hand rotation of said upper section,

and additional relatively coarse right-hand threads also formed on the upper portion of the lower tubing section, which threads are engageable by a retrieving pipe after the upper tubing string section and packer assembly have been removed from the well bore,

said right-hand and left-hand threads on the upper portion of the lower tubing section being formed on the same area of said upper portion.

5. A well packer apparatus as set forth in claim 1, wherein

the means for setting the packing element and anchoring means of well packer assembly comprises a fluid pressure operated means mounted on the support of the packer assembly for moving the packing element and the anchoring means into set position,

and means establishing communication between the support of the packer assembly and said fluid pressure operated means for conducting fluid under pressure to the latter to actuate the same.

6. A well packer apparatus lowerable within a well bore including,

a tubular support,

a lower section of a tubing string having its upper portion extending in parallel relation to said support with its lower portion depending therebelow,

an upper section of tubing string having its lower end connected to the upper end of the lower section by a threaded connection and extending upwardly to the well surface,

means rotatably connecting the upper tubing section to the support, whereby the lower tubing section is attached to the support through the upper section,

a well packer assembly carried by said support and including an elastic packing element, an anchoring means and fluid pressure-actuated setting means for setting said packer element and said anchoring means,

said packer assembly encompassing said tubular support and the upper portion of said lower tubing section,

means for directing fluid to the setting means of the packer assembly so that fluid under pressure may be conducted to the setting means to actuate the same and set the packing element and anchoring means,

the threaded connection between said upper and lower sections of said tubing string being operable by rotation of the said upper section relative to the lower section after the packing element and anchoring means have been set to cause relative movement between said upper and lower tubing string sections,

coacting means on the packer assembly and on the upper section of the tubing for effecting a release of the packer assembly when said tubing section undergoes movement relative to the lower tubing section,

said rotation of the upper tubing string section relative to the lower tubing string section also effecting a disconnection of the tubing string sections from each other, whereby said upper string section and packer assembly including said tubular support may be removed from the well bore separately from the lower tubing section.

7. A well packer apparatus as set forth in claim 6, wherein

the threaded connection between the upper and lower tubing sections comprises relatively coarse, safety joint type threads which are left-hand threads so that relative longitudinal movement of the sections and subsequent complete separation of the sections is accomplished by a rotation of said upper section in a direction to the right.

8. A well packer apparatus as set forth in claim 6, wherein

the lower portion of the upper tubing string section is formed with relatively coarse left-hand threads,

the upper portion of the lower tubing string section having relatively coarse left-hand threads engageable by the left-hand threads of the upper section, whereby disconnection of the sections can be effected by a right-hand rotation of said upper section,

and additional relatively coarse right-hand threads also formed on the upper portion of the lower tubing section, which threads are engageable by a retrieving pipe after the upper tubing string section and packer assembly have been removed from the well bore.

9. A well packer apparatus as set forth in claim 6, wherein

the lower portion of the upper tubing string section is formed with relatively coarse left-hand threads,

the upper portion of the lower tubing string section having relatively coarse left-hand threads engageable by the left-hand threads of the upper section, whereby disconnection of the sections can be effected by a right-hand rotation of said upper section,

and additional relatively coarse right-hand threads also formed on the upper portion of the lower tubing

section, which threads are engageable by a retrieving pipe after the upper tubing string section and packer assembly have been removed from the well bore,

said right-hand and left-hand threads on the upper portion of the lower tubing section being formed on the same area of said upper portion.

10. A well packer apparatus as set forth in claim 6, wherein

the packer assembly has a longitudinal passage the upper end of which communicates with the bore of the support, and a second tubing string adapted to removably seat within the upper end of said longitudinal passage.

11. A well packer apparatus lowerable within a well pipe including,

a packer assembly comprising, a tubular support, an elastic packing element mounted on the support, an anchoring means on the support below the packing element, which anchoring means include outwardly movable pipe gripping members for engaging a well pipe, and fluid pressure operated setting means on the support below said anchoring means,

means connecting the fluid pressure operated means with said anchoring means,

additional means connecting said fluid pressure operated setting means with the packing element, whereby actuation of said setting means moves the pipe gripping members into pipe engaging position and also moves the elastic packing element into sealing engagement with the pipe wall,

a first tubing string including an upper section and a lower section which are connected together by a threaded connection,

the lower portion of said upper section having a rotatable connection with the upper end of the packer assembly,

the lower section of the first tubing extending downwardly through the elastic packing element of the packer assembly and projecting below said assembly,

a second tubing string engageable with the packer assembly and communicating with the tubular support thereof,

means establishing communication between the tubular support and the pressure operated setting means whereby fluid under pressure may be conducted to the setting means to actuate the same,

said threaded connection between the upper and lower sections of the first tubing string being operable by a rotation of the upper section relative to the lower section,

rotation of the upper section of the first tubing string with respect to the packer assembly being permitted by the rotatable connection between these parts, and

the lower section of said first tubing string requiring no rotative movement relative to the packer assembly to allow the upper section of said string and the packer assembly to be completely disconnected from said lower section.

12. A well packer as set forth in claim 11, wherein the threaded connection between the tubing string and support comprises relatively coarse safety-joint type threads which are left-hand threads so that relative longitudinal movement of the string and support and subsequent separation is accomplished by rotation said tubing string in a direction to the right.

References Cited by the Examiner

UNITED STATES PATENTS

2,893,492	7/1959	Brown	166—121
2,903,066	9/1959	Brown	166—46
3,083,767	4/1963	Brown	166—120

CHARLES E. O'CONNELL, *Primary Examiner*,

BENJAMIN HERSH, *Examiner*.