

Jan. 19, 1965

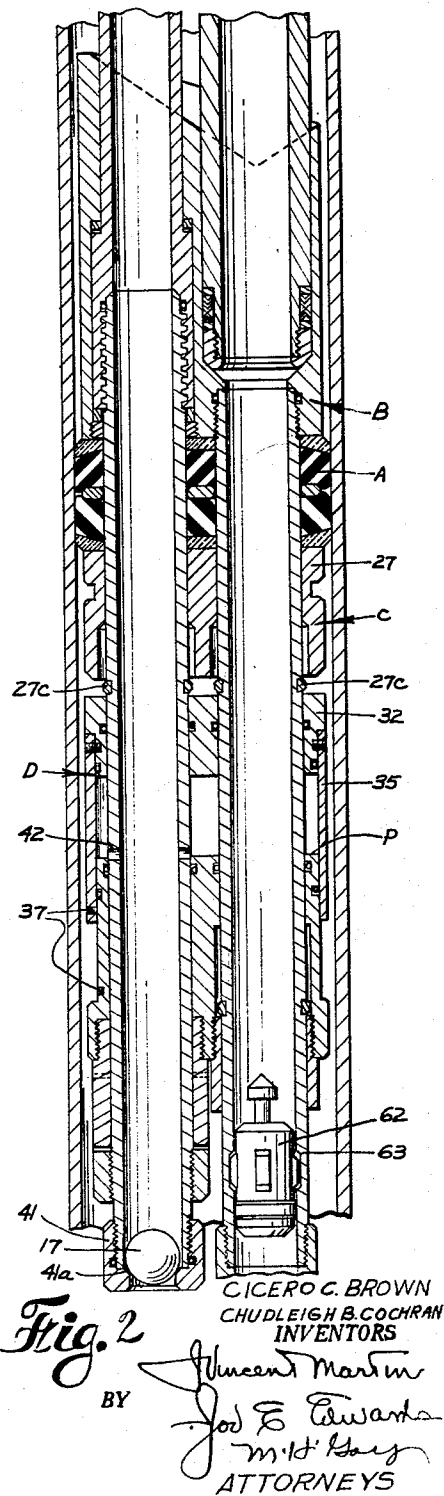
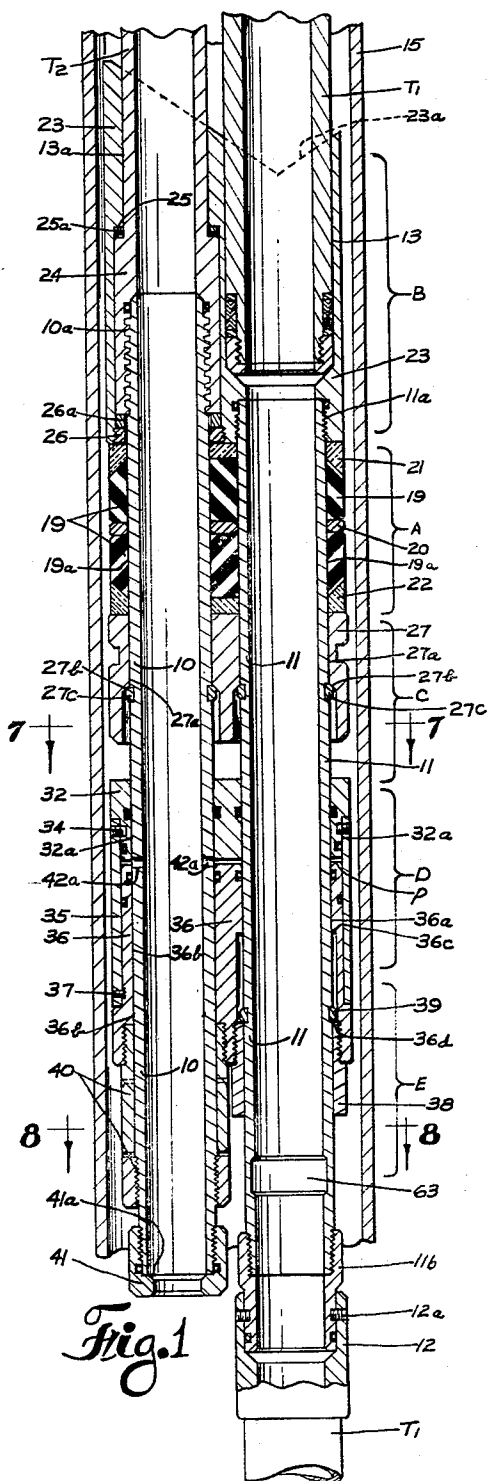
C. C. BROWN ETAL

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WELL PACKER APPARATUS

Filed Jan. 19, 1962

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WELL PACKER APPARATUS

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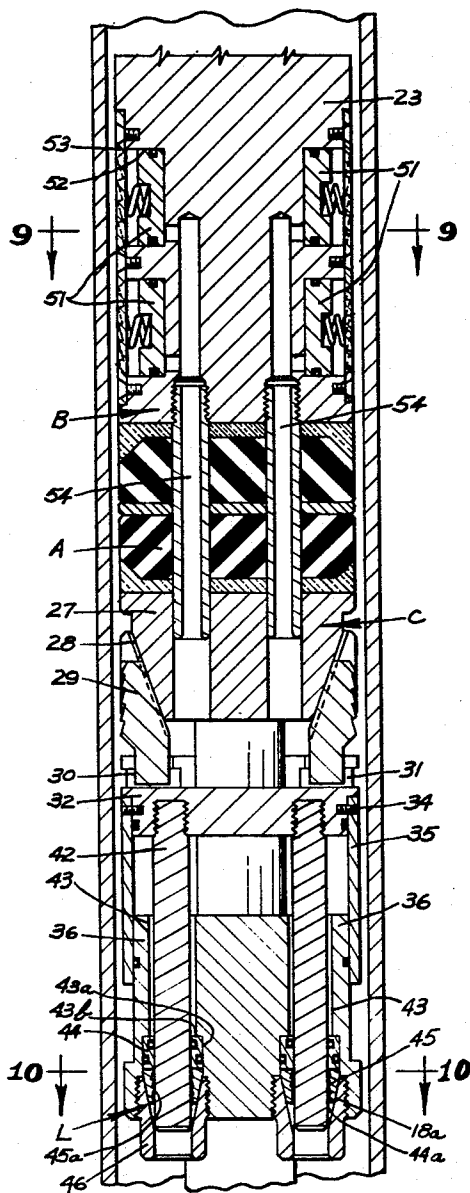
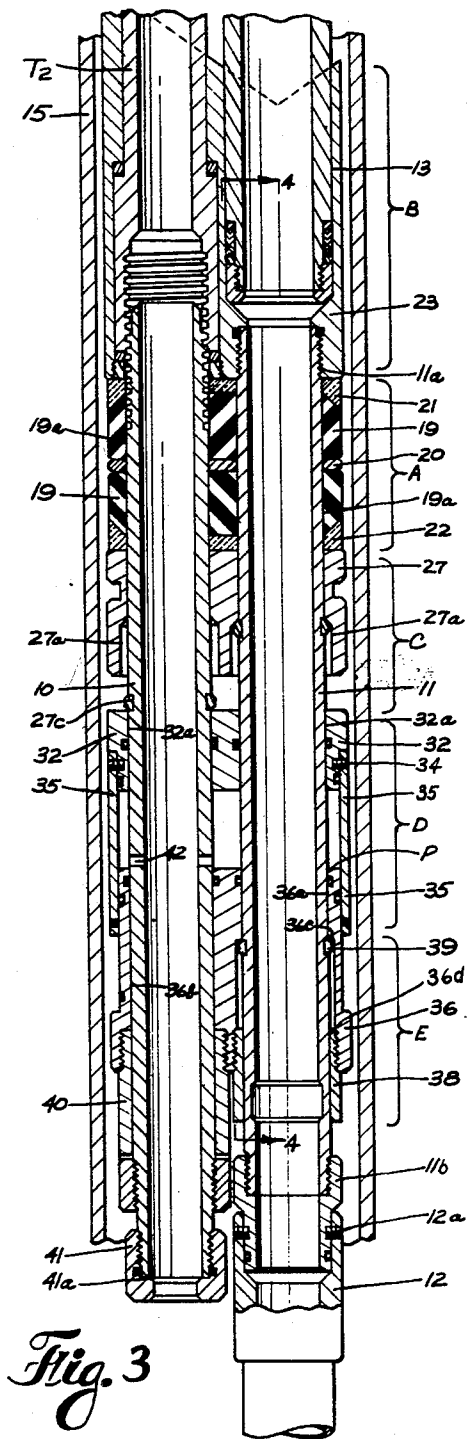


Fig. 4

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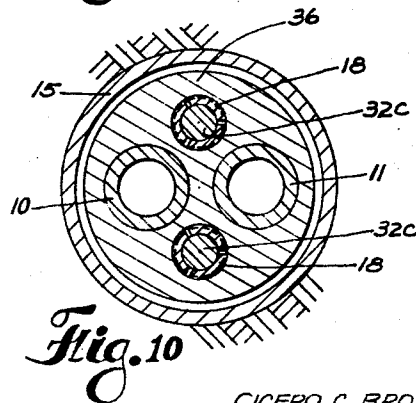
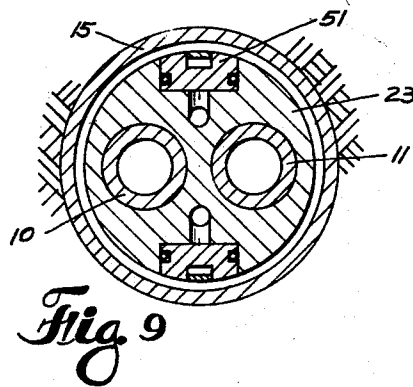
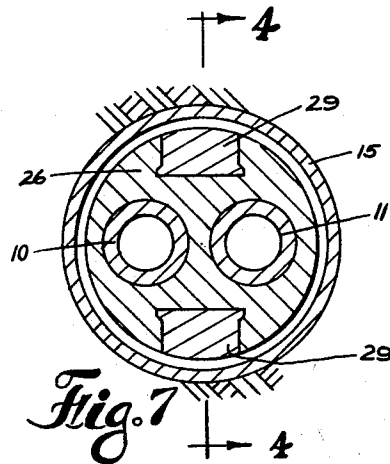
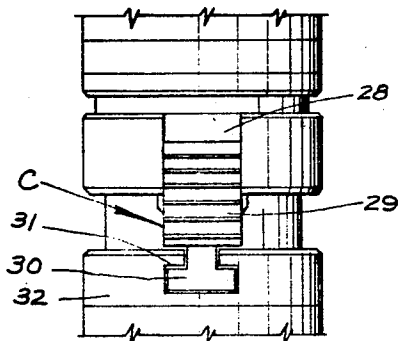
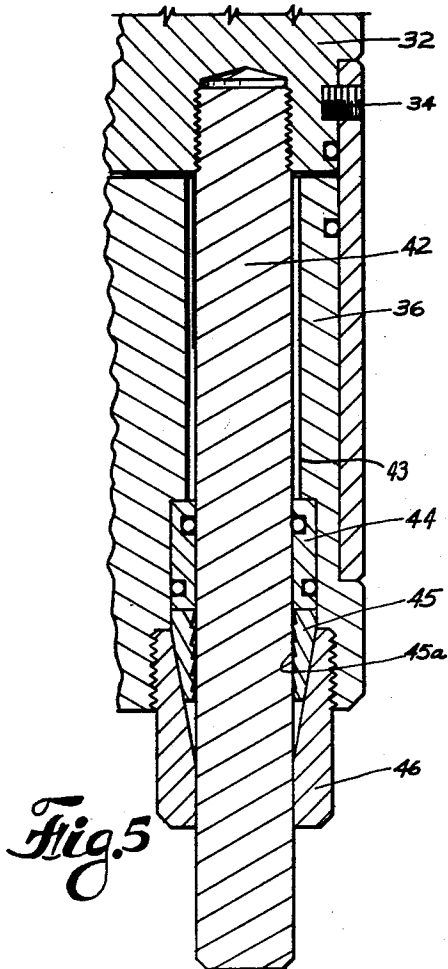
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WELL PACKER APPARATUS

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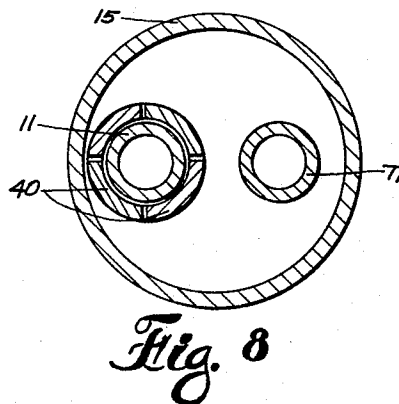
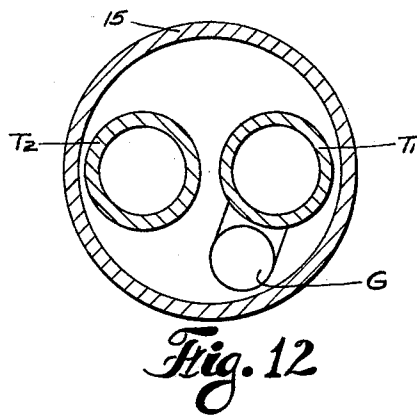
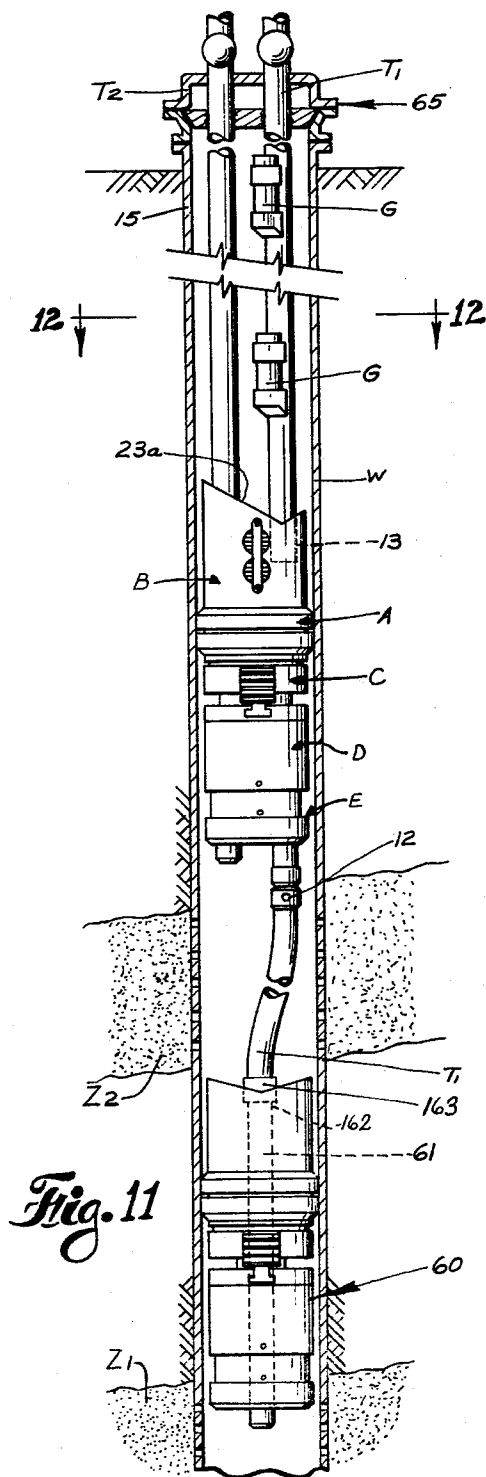
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WELL PACKER APPARATUS

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4 Sheets-Sheet 4



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1

3,166,127

WELL PACKER APPARATUS

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Filed Jan. 19, 1962, Ser. No. 167,312

18 Claims. (Cl. 166—120)

This invention relates to new and useful improvements in well packer apparatus and relates particularly to dual production well packers.

It is one object of this invention to provide a well packer adaptable for use in dual production wells which is set by the application of pressure fluid and is released by manipulation of one of the pipe strings to which it is connected.

An important object is to provide a well packer having means for moving the packing element and pipe gripping slips thereof into a set position by the application of pressure fluid, together with separate mechanical locking means for positively locking said packer in its set position, whereby the pressure fluid which set said packer may be completely relieved from said packer setting means without releasing said packer from said set position.

Another object is to provide a well packer, of the character described, which includes an improved mechanical locking means for locking the packer in set position, which mechanical locking means is acted upon, during the setting operation, by the pressure fluid which sets the packer to assure said locking means will instantaneously function upon release of said setting pressure.

A further object is to provide an improved locking assembly for a pressure fluid operated packer setting means, said assembly including a locking rod carried by one part of the setting means and a gripping member carried by another part of said setting means and so associated with the setting means that after the same is operated, it is locked against release by the locking rod and gripping member; the assembly also including a pressure responsive element coacting with the locking assembly, which element is exposed to the same pressure fluid that operates the packer setting means, whereby the coaction between the pressure responsive element and said locking assembly, during the setting operation, maintains a close contact between the locking rod and the gripping member to assure that when the setting force is relieved, the locking assembly will instantaneously act to prevent any reverse movement of the packer setting means toward an unsetting position.

A further object is to provide an improved well packer having a pair of passages extending therethrough with a tubular mandrel or section forming part of a well tubing string extending through each of said passages, said packer including an improved releasing means for releasing said packer from set position, which releasing means comprises, a screw thread system located above the packing element and operable by manipulation of one of the pipe strings, said screw thread system being so connected that unsetting and release of the well packer may be accomplished without having to impart rotation to one of the mandrels extending through the set packing element of said packer.

Another object is to provide a well packer, of the character described, which includes auxiliary pressure actuated anchoring means at its upper end together with a passage establishing communication between the anchoring means and the area below the packer when the packer is in set position, said anchoring means being isolated from and independent of pressure in the tubing string, whereby a higher pressure below the packer which would tend to displace the packer upwardly will act upon the auxiliary anchoring means to move the same into tight

2

gripping position to lock the packer against upward displacement or movement in the well bore.

Another object is to provide a dual completion well packer apparatus having connection with a pair of independent well pipe strings, and having a mechanical locking assembly coacting with the packer setting means for locking said packer setting means against unsetting; said packer being releasable by manipulation of one pipe string, whereby the other string need never be rotated, thereby making the apparatus particularly adapted for use with gas lift valves.

Another object of the invention is to provide a dual string packer of the character described, which is so constructed that one of the tubing strings attached to the packer may be removed from said packer by a straight longitudinal pull and without rotation after the packer is set and without releasing said packer from said set position.

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 well packer constructed in accordance with the invention and illustrating the packer parts in the position they assume during lowering within the well bore;

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

FIGURE 3 is a similar view illustrating the manipulation of one of the packer mandrels which effect the unsetting and release of the packer;

FIGURE 4 is an enlarged vertical sectional view of the upper portion of the packer, taken on the lines 4—4 of FIGURE 3;

FIGURE 5 is an enlarged detail view of the locking assembly which locks the packer in set position;

FIGURE 6 is a detail elevation of one of the pipe gripping slips;

FIGURE 7 is a horizontal cross-sectional view taken on the lines 7—7 of FIGURE 1;

FIGURE 8 is a cross-sectional view taken on lines 8—8 of FIGURE 1;

FIGURE 9 is a horizontal cross-sectional view taken on the lines 9—9 of FIGURE 4;

FIGURE 10 is a horizontal cross-sectional view taken along lines 10—10 of FIGURE 4;

FIGURE 11 is a diagrammatic view of the well packer set within a well bore above a second well packer to conduct well fluids from two separate formations through independent pipe strings with gas lift valves illustrated as mounted on one of the strings above the upper packer; and

FIGURE 12 is a cross-sectional view taken on the lines 12—12 of FIGURE 11.

In the drawings (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 structure 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. A first tubular support or mandrel 10 extends through one series of aligned

openings in the elements and has its upper end secured, as will be explained, within the upper head member B; its lower end projects below the lower abutment E. A second tubular support or mandrel 11 has its upper end threaded at 11a into the opening 13 in the upper head member B and extends downwardly through elements A, C, D and E to project below the packer structure; the lower end of the support 11 is coupled through a sub or nipple 11b to a safety joint connection 12, which, in turn, is connected to the lower portion of a first tubing string T1. A second tubing string T2 has its lower end connected in one of the openings 13a in the head member B. With this arrangement, the tubular supports or mandrels 10 and 11 form the main supporting members of the packer structure and said packer structure is suspended from one of the tubing strings T2.

The well packer is preferably lowered by means of the tubing string T2 and during lowering, the packing element A is in its retracted or non-sealing position with the anchoring means C being unset and the remaining parts in substantially the position shown in FIGURE 1. After the packer is in position within the well casing 15 within the well bore, the upper portion of the tubing string T1 is lowered into position and is inserted within the upper end of the opening 13 formed in the head member B to communicate with the tubular support 11 and the lower portion of string T1. When the packer is to be set, a closure or ball 17 (FIGURE 2) is dropped downwardly through the second tubing string T2 to close the lower end of the bore of the mandrel 10 and, thereafter, fluid is conducted to the hydraulically-actuated means D which, as will be explained, functions to set the anchoring means C and to deform the packing element A into sealing position with the well pipe 15. The position of the parts when the packer and anchoring means are in set position is illustrated in FIGURE 2.

To maintain the packing element and the anchoring means in set position, a locking assembly generally indicated at L (FIGURE 4) is associated with the anchoring means and functions to prevent release of the anchoring means and unsetting of the packing element even though the hydraulic pressure which initially actuates the hydraulically-actuated means D is relieved. The release of the anchoring means and unsetting of the packer to permit its removal from the well pipe is accomplished by manipulation of tubing string T2, as will be hereinafter explained in detail.

Referring to the particular construction of the various elements, the packing element A may take any desired form and as illustrated includes two generally cylindrical bodies 19 of rubber or other elastic material spaced from each other by a spacing ring 20. The upper and lower ends of the packing bodies are confined by anti-extrusion end rings 21 and 22 which are constructed of a soft metal, such as lead, and which are deformed radially outwardly when the packer is in set position. Said packing bodies have parallel openings 19a extending therethrough which form part of the longitudinal passages through which the mandrels 10 and 11 extend.

The upper abutment or head member B consists of a solid metallic body 23 having the parallel openings or passageways 13 and 13a extending therethrough; the openings 13 and 13a, like the openings 19a in the packing element, form part of the longitudinal passages through which the mandrels extend. As noted, the tubular support or mandrel 11 is secured to the upper abutment B by the thread 11a so that any movement of the upper abutment B will result in a similar movement of said tubular support. The extreme upper end of the abutment body is inclined or tapered as indicated at 23a and this taper or inclination, as shown in FIGURE 11, is for the purpose of guiding the lower end of the upper portion of the tubing string T1 into the passage 13 of said abutment.

The other tubing string T2 has an enlarged portion 24

which is confined between a shoulder 25 in the passage 13a of the abutment body 23 and a ring nut 26 which is threaded into the lower end of said passage; suitable annular bearings 25a and 26a are interposed between the extremities of the enlarged portion 24 and the shoulder 25 and ring nut 26 respectively. The bore of the enlarged portion of tubing string T2 has a coarse threaded connection 10a with the upper end of the tubular support or mandrel 10. The threads of the connection 10a are preferably left hand threads, whereby longitudinal movement of the tubing string T2 with respect to the mandrel 10 may be accomplished by right hand rotation of said string T2 relative to said mandrel.

Immediately below and abutting the lower end of the packing element A is the anchoring means C which is more clearly shown in FIGURE 4. This anchoring means includes an expander cone 27, the upper end of which is engaged by the lower end of the packing element A. Vertical openings 27a are formed in the cone (FIGURE 1) and such openings are aligned with the openings 19a in the packing element and the passageways 13 and 13a in the upper abutment to provide the longitudinal passages through which the mandrels 10 and 11 extend. Each opening 27a in the expander cone 27 is counter-bored (FIGURES 1 and 2) to form an annular shoulder 27b which is adapted to engage a snap ring 27c; the snap rings are mounted on the exterior surfaces of the tubular supports or mandrels 10 and 11. During lowering of the packer into the well, the snap rings provide a shoulder supporting the expander cone, packing element and upper abutment upon said mandrels 10 and 11.

The external surface of the expander cone 27 is formed with inclined slip-expanding surfaces 28 which coast with pipe gripping slips 29. The lower ends of the slips are each formed with a T-shaped connection 30 which engages within a T-shaped slot 31 (FIGURE 6) provided in the upper end of a slip-carrier block 32. The block has parallel longitudinal openings 32a which are aligned with the similar parallel openings in the expander cone, packing element and upper abutment and through which the supports 10 and 11 extend. When the slip carrier block 32 is moved upwardly on said tubular supports 10 and 11, the pipe gripping slips 29 are moved upwardly with respect to the inclined surfaces 28 of the expander cone 26 and this results in a radially outward movement of said slips. Thus, upward movement of the slip-carrier 32 will effect an expansion of the slips 29 into pipe-gripping position.

The slip carrier block 32 is attached by suitable screws 34 with the upper end of a cylinder 35 which forms part of the hydraulically-actuated means D. The cylinder extends downwardly to encircle the body 36 of the lower abutment E and is sealed with the exterior of the body by an O-ring or other suitable sealing means; initially the cylinder is attached to said body by one or more shear pins 37 (FIGURES 1 and 2). The upper portion of the body 36 forms a stationary piston P which is located within the cylinder 35. The body 36 of the lower abutment has a pair of parallel passages 36a and 36b through which the supports 11 and 10 extend and suitable seals, such as O-rings, seal between the supports and the bores of said passages. The passage 36a through which the support 11 extends is counter-bored to form an upper internal shoulder 36c and a stop collar 38 is threaded into the lower end of the passage with the upper end of the collar forming a lower internal shoulder 36d. The tubular support 11 extends entirely through opening 36a of the lower abutment 36 and a snap ring 39 is secured to the support to be movable in the counterbore between the upper and lower shoulders 36c and 36d. With the parts in position as shown in FIGURE 1, the engagement of shoulder 36d with the snap ring limits upward movement of body 36 relative to the support, whereby an accidental setting of the packer is prevented during lowering.

5

The tubular support 10 extends entirely through the second passage 36b of the lower abutment and is non-rotatably connected to the body 36 of said abutment by the clutch 40 (FIGURE 8). Since one part of this clutch is secured to the support 10, said support, which as explained is connected to tubing T2, functions to support the entire packer assembly during lowering into the well. A tubular collar 41 having a reduced internal annular seat 41a is threaded onto the extreme lower end of the mandrel 10 and communicates with the area below the packer structure.

In order to introduce pressure fluid into the cylinder 35 and into the area above the stationary piston P formed by the lower abutment, a plurality of ports 42a are formed in the lower portion of the support or mandrel 10. These ports are so located that when the closure 17, which may be a ball, engages the seat 41a of collar 41, pressure fluid may be directed downwardly through the second tubing strip T2 and through the ports 42a into the cylinder above the stationary piston P. Such pressure is thus applied to act upwardly against the slip carrier 32 and said carrier moves upwardly because the piston P is held against downward movement by reason of the body 36 being supported through clutch 40 by the tubing string T2. The slip carrier 32 is, of course, suitably sealed with the wall of the cylinder and with the exterior of the tubular supports or mandrels 10 and 11. Upward movement of the slip carrier results in applying an upward force to the slips 29 to move them into gripping engagement with the well pipe and thereafter the pressure forces act downwardly on the upper end of piston P formed by the lower abutment body 36. The downward force is transmitted through collar 38, clutch 40 and mandrel 10 to the upper abutment 23 which is pulled downwardly to apply endwise force to the packing element and thereby set the same into sealing position. The set position of the packer 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 tubing string T2 and in order to maintain the packer in set position after the release of setting pressure, the locking assembly, generally indicated at L, in FIGURE 4 is provided. The assembly is located within the body of the lower abutment 36 and includes a pair of locking rods 42 which have their upper ends threaded or otherwise secured in the underside of the slip carrier block 32. As shown in FIGURE 10, the locking rods are disposed in a transverse plane which is at substantially a right angle to the plane in which the passages 36a and 36b in the lower abutment 36 are located. Each rod extends downwardly through a vertical bore 43 in the lower abutment and has its lower end projecting below said abutment. The bore 43 is of larger diameter than the rod 42 and the upper end of said bore communicates with the area between the piston P and the underside 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 43 is counterbored and enlarged at 43a to form an internal shoulder 43b and an annular piston 44 which surrounds the rod is slidable in the counterbore. Gripping elements 45 having inner buttress-type teeth 45a are disposed below the piston and the outer inclined surface of each gripping element is confined and co-acts with the inclined bore of a supporting nipple 46 which is threaded into the lower end of the bore 43. 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 36.

When pressure fluid is applied to the slip carrier block 32 to move the block upwardly and thereby set the main slips 29, the locking rods 42 are raised upwardly within their respective bores 43 in the lower abutment and move upwardly relative to the gripping elements 45.

6

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 slip carrier block 32 upwardly also acts through the bores 43 against the upper end of each piston 44 to maintain the gripping elements in contact with the rods; therefore as soon as pressure fluid acting against the slip carrier block 32 is relieved, any tendency of the block to move in a direction to release the main slips 29 is prevented because the rods 42 are locked against downward movement by the gripping elements. By varying the area of each of the annular pistons 44, the force with which each set of gripping elements 45 is urged into contact with its respective locking rod may be varied. Upon setting of the anchoring means C followed by setting of the packing element A, the locking rods function to prevent unsetting even though the setting pressure is released.

It is also pointed out that during the setting operation the various sealing rings on the slip carrier block 32, cylinder 35 and piston P must be effective to hold the pressure so that the desired upward force is imparted against the slip carrier 32 and main pipe gripping slips 29 to effect upward movement of the latter into a set position. However, after the packer has been set, the lock-down gripping elements 45 which engage the locking rods function as a mechanical gripping means and do not depend upon the trapping of a pressure fluid to prevent any reverse or downward motion of the main gripping slips or abutments toward an unsetting position. Therefore, even though certain of the seals in the hydraulic piston, cylinder and slip carrier block should be rendered ineffective by leakage, subsequent to the setting operation, it is assured that the packer will be maintained in a set position. The use of a mechanical lock-down means, as distinguished from hydraulic hold-down, is of advantage because in certain instances, particularly where a packer has remained in the well for a considerable period of time, the sealing means of the hydraulic assembly may leak or become ineffective.

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 51. As shown in FIGURE 4, a pair of buttons 51 may be mounted on each side of the assembly, with each button being slidable within a recess 52 formed in the upper abutment 23. A retaining strap 53 overlies each button and prevents complete outward displacement of each button from its recess. Each pair of hold-down buttons has its rear surface exposed to the pressure in the well pipe 15 below the set packer through a longitudinal passage 54. Each such passage extends downwardly through the packing element A and through the expander cone and communicates with the area below the packer element. If the pressure below the set packer increases, the hold-down buttons are urged into tight gripping engagement with the wall of the pipe to prevent upward displacement of the complete packer assembly. These hold-down elements are operated solely by pressure in the well bore and are not dependent upon pressure in the tubing strings T1 and T2.

For releasing the packer from its set position, the tubing string T2 is rotated to the right and since the lower abutment body 36 is held stationary by reason of the pipe gripping slips 29 engaging the well pipe 15 and because mandrel 10 is nonrotatably connected to the abutment 36 by the clutch 40, the coarse left-hand threaded connection 10a between the tubing T2 and the upper end of the mandrel 10 begins to release. The release connection 10a is located above the packing element A through which the mandrel extends but since the connection is at the upper end of said mandrel, the mandrel need not be rotated to effect release. This overcomes the objections and difficulties which are presented when a mandrel must rotate within a set seal.

As the coarse threads of the connection 10a continue

to unscrew, there is a downward force applied to the mandrel 10; however, when the packer was set, the slip carrier block 32 moved up to engage the snap ring 27c on said mandrel (FIGURE 2) and because the slip carrier is still anchored to the well pipe, downward movement of mandrel 10 is initially prevented. Further rotation of the tubing string T2 resulting in further unscrewing of the coarse threaded connection 10a applies an upward force through bearing 25a and shoulder 25 to the upper abutment body 23, thereby moving this abutment body upwardly to relieve the endwise force on the packing element A. It is pointed out that upward movement of the upper abutment, together with upward movement of the second mandrel 11 is permitted because the second mandrel has its snap rings 39 and 27c movable within limits with respect to the lower abutment body 36 and the expander cone 27, respectively.

Rotation of tubing T2 continues until the upper abutment body 23 has moved up far enough to release the packing element and by this time the snap ring 27c has moved up against shoulder 27b in the expander cone, whereby subsequent rotation of tubing T2 will jack the mandrel 11 upwardly to actually pull the expander cone from between the slip members. When the packing element is released to break its seal with the well pipe, pressures above and below the packer structure are equalized, which equalizes pressure across the holddown buttons to release their grip from the well pipe. The packer is thus completely released and the packer parts are in the position shown in FIGURE 3. At this time, the snap ring 39 on mandrel 11 has engaged the upper shoulder 36c in the bore of the lower abutment body 36 and functions to suspend the lower abutment body, as well as the slip carrier block 32 and cylinder 35 therefrom; this suspension limits the downward movement of the slip carrier block relative to the expander cone and prevents the slips 29 from moving out of their dovetail guide grooves in said cone. A subsequent straight upward pull on the packer fractures a shear pin 12a in the safety joint 12 at the lower end of the mandrel and permits the packer structure to be retrieved from the well by means of the tubing T2.

In summarizing the operation, the packer structure is connected with the tubing string T2 and is lowered into the well pipe with the parts in the position shown in FIGURE 1. A closure or ball 17 is dropped through the second string T2 to engage the seat 41a in the collar 41 at the lower end of the mandrel 10. During the lowering operation, the expander cone 27, packing element A and upper abutment B are supported by the snap rings 27c which are mounted on the mandrels 10 and 11. The cylinder 35 is releasably latched in its lowered position relative to the lower abutment body 36 by the shear pins 37.

Following the positioning of the closure ball 17 on the seat 41a of collar 41 at the lower end of mandrel 10, pressure fluid is conducted downwardly through tubing string T2. This pressure passes through the ports 42a into the cylinder 35 between the piston P formed by the upper end of abutment body 36 and the slip carrier block 32, whereby an upward force is applied to the slip carrier and to the cylinder. Such upward force shears the pin 37 allowing upward movement of cylinder 35 and slip carrier block 32 which moves the slips 29 upwardly on the expander cone and into engagement with the well pipe. As soon as the slips are set, the pressure force is applied in a downward direction on piston P which is, in fact, the lower abutment body 36 and through collar 38 and clutch 40 this downward force is transmitted to mandrel 10 which pulls the upper abutment downwardly to apply endwise force to the packing element A and thereby set the same.

As the slip carrier is first moved upwardly by the pressure, the locking rods 42 of the locking assembly are moved upwardly relative to the gripping elements 45. Also, as mandrel 10 is pulled downwardly to set the packing element, the gripping members 45 are moved further

downwardly relative to said locking rods so that the net effect during the setting operation is that the gripping members 45 move downwardly relative to the locking rods. As soon as pressure is relieved after both the anchoring means and packing element have been set, the gripping elements prevent any downward movement of the locking rods 42 relative to said members and thereby hold the packer in its set position. Being a purely mechanical locking means, the locking rods and gripping members 45 do not depend upon the continued application of fluid pressure and, therefore, even if some of the seals in the assembly should be rendered ineffective, a positive lock of the packer structure in its set position is obtained.

In releasing the packer, it is only necessary to rotate the tubing T2 in a direction to the right so as to unscrew the left-hand threads of the connection 10a. As explained, this results in an upward movement of the upper abutment B to unseat the packing element, after which continued rotation results in a releasing of the anchoring means by pulling the expander from between the gripping slips. It is noted that the upward movement which releases the anchoring means is an upward movement of the expander cone and even though the locking means L remains in its gripping position, this does not interfere with the release of the anchoring means. After the anchoring means is released, a straight upward pull shears the pin 12a of the safety joint 12 and the packer may be removed from the well.

The packer structure is particularly adaptable for use in a dual production well where it is desired to run gas lift valves on the string T1 which is commonly called the long string because it extends from the surface to the lower zone. In such a situation, the string T1 cannot be rotated at any time and yet the string must be easily retrievable without effecting the setting of the packer in order that the valves may be serviced.

In FIGURE 11, a schematic illustration of the improved packer where gas lift valves are employed is shown. The well bore W traverses two production formations or zones Z1 and Z2 and a lower packer generally indicated at 60 is set between the two zones. This packer may be a wire line packer or any other packer now generally used in the field and is provided with a bore 61 having a seat 162 at its upper end.

The packer of this invention has the lower portion of the tubing string T1 connected therewith through the safety joint 12 and such lower portion may have an enlargement 163 for engaging the seat 162 in the lower packer. The tubing T2 is connected to the packer constructed in accordance with this invention and said packer and the lower portion of the string T1 is lowered into position in the well by the tubing T2. Thereafter, the upper portion of the string T1 having the gas lift valves G mounted thereon may be lowered and then seated in the passage 13 of the upper abutment E. The well head equipment generally indicated at 65 is then mounted at the surface and the lower production zone is produced through string T1 by means of the gas lift valves. The upper zone Z2 is produced through string T2.

It will be evident that in this type of installation it is never necessary to rotate the upper portion of tubing string T1 in order to either set or release the upper packer structure. By reason of the gas lift valves being mounted on the upper portion, it is not possible to so rotate the string and the arrangement herein described makes the device particularly applicable to use with gas lift valves. It is, of course, evident that since the string T1 may be lowered into position after the packers and the tubing string T2 are in position, each of the tubing strings may be independently handled.

From the foregoing, it will be seen that a dual production packer is provided which may be set by hydraulic pressure and which may be released by manipulation of one of the tubing strings. Of importance to the present invention is the locking assembly L which includes the

annular pistons 43 which utilize the hydraulic force, which is moving the pipe-gripping slips upwardly, to act against the mechanical gripping members 45 to assure their close contact with the exterior of the locking rods 42 during the setting operation. This means that immediately that the hydraulic force is relieved, the gripping members 45 are in position and firmly grip the external surface of locking rods 42 to prevent any reverse or downward movement of the gripping slips as well as upward movement of upper abutment B. Also of importance to the invention is the location of the releasing mechanism whereby it is not necessary to rotate or manipulate a mandrel through the set packing A which is often difficult. The release is effected simply by manipulating the tubing string T2.

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

What we claim is:

1. A well packer apparatus lowerable within a well pipe including,
 - a tubular support,
 - an elastic packing mounted on the support,
 - an anchoring means on the support below the packing element and including outwardly movable pipe-gripping members for engaging said well pipe,
 - fluid pressure operated setting means on the support below the anchoring means,
 - means connecting the fluid pressure operated means with said anchoring means,
 - additional means including the tubular support connecting the fluid pressure operated setting means with the packing element, whereby actuation of the 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 well tubing string having threaded connection with the upper end of the tubular support for lowering the packer into the well pipe,
 - means establishing communication between the tubing string and the setting means whereby fluid under pressure is conducted to the setting means to actuate the same,
 - and a mechanical locking means associated with the setting means for locking said setting means in the position to which it has moved during setting the anchoring means and packing element, whereby the pressure which actuated said setting means may be released and the mechanical locking means will maintain the anchoring means and the packing element in their set position.
2. A well packer apparatus as set forth in claim 1, wherein said locking means comprises,
 - a locking rod secured to one part of the setting means,
 - and a gripping member carried by another part of said setting means,
 - said locking rod and gripping member being constructed to allow movement of said parts of the setting means relative to each other in a direction to set the anchoring means and packing element while preventing movement of said parts relative to each other in an opposite direction.
3. A well packer apparatus as set forth in claim 1, wherein said locking means comprises,
 - a locking rod secured to one part of the setting means,
 - and a gripping member carried by another part of said setting means,
 - said locking rod and gripping member being constructed to allow movement of said parts of the setting means relative to each other in a direction to set the anchoring means and packing element while

- preventing movement of said parts relative to each other in an opposite direction,
 - a pressure responsive element engaging the gripping member of said locking means,
 - means communicating the pressure responsive element with the fluid under pressure which is utilized to actuate the setting means, whereby during actuation of the setting means a pressure force is applied to said pressure-responsive element and to the gripping member in a direction to maintain said gripping member in close contact with the locking rod to assure instantaneous gripping engagement between said rod and said gripping member upon release of the pressure fluid which actuates the setting means.
4. A well packer apparatus lowerable within a well pipe including,
 - a first tubular support,
 - a second tubular support,
 - an upper abutment having connection with the upper ends of the supports,
 - an elastic packing element slideably mounted on the supports and having its upper end confined by the upper abutment,
 - anchoring means on the supports below the packing elements and including an expander which engages and confines the lower end of said packing element, said anchoring means also including radially movable gripping slips engageable with the well pipe,
 - fluid pressure operated setting means comprising a piston secured to the lower end of one of the supports and a cylinder secured to the gripping slips of the anchoring means, whereby actuation of the setting means effects a relative movement of piston and cylinder to first move the gripping slips into pipe gripping position and to subsequently apply an endwise force to the packing element through downward movement of said one tubular support and upper abutment with respect to the packing element,
 - means communicating one of said supports with said fluid pressure operated setting means so that fluid pressure may be conducted to said setting means to actuate the same,
 - a tubing string threadedly connected to the first of said supports and confined against longitudinal movement within the upper abutments, whereby rotation of said tubing following setting of the anchoring means and packing element will move the upper abutment and the second support upwardly to relieve the endwise force on the packing element to unset the same,
 - and means on the second support and engageable with the expander of the anchoring means upon subsequent upward movement of the second support to move the expander relative to the gripping slips to release the same.
 5. A well packer apparatus as set forth in claim 4, wherein
 - the upper abutment has a passageway communicating with said second support,
 - and a second tubing string lowerable into the well pipe after the first string and well packer are positioned therein and having its lower end insertable into said passageway.
 6. A well packer apparatus as set forth in claim 4, together with a mechanical locking means associated with the fluid pressure operated setting means for locking said setting means in the position to which it has moved when the anchoring means and packing element were set, whereby the pressure which actuated said setting means may be released and the mechanical locking means will maintain the anchoring means and the packing element in their set position.
 7. A well packer apparatus as set forth in claim 4, together with a mechanical locking means associated

11

with the fluid pressure operated setting means for locking said setting means in the position to which it has moved when the anchoring means and packing element were set, whereby the pressure which actuated said setting means may be released and the mechanical locking means will maintain the anchoring means and the packing element in their set position,

said upper abutment having a passageway communicating with the second support,

and a second tubing string lowerable into the pipe after the first string and well packer are positioned therein and having its lower end insertable into said passageway.

8. A well packer apparatus as set forth in claim 4, together with a mechanical locking means associated with the fluid pressure operated setting means for locking said setting means in the position to which it has moved during setting of said anchoring means and packing element,

said mechanical locking means comprising a locking rod and a gripping member adapted to engage said locking rod to prevent movement of the rod in one direction relative to the gripping member,

said locking rod and gripping member being connected one to the cylinder and the other to the piston of the setting means whereby movement of said piston and cylinder relative to each other in a direction to set the anchoring means is permitted while movement of said piston and cylinder in an opposite direction is prevented.

9. A well packer apparatus as set forth in claim 8, together with a pressure responsive element engaging the gripping member of said locking means,

means communicating the pressure responsive element with the fluid under pressure which is utilized to actuate the setting means, whereby during actuation of the setting means a pressure force is applied to said pressure responsive element and to the gripping member in a direction to maintain said gripping member in close contact with the locking rod to assure instantaneous gripping engagement between said rod and said gripping member upon release of the pressure fluid which actuates the setting means.

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

a tubular support,

an elastic packing element mounted on the support, an anchoring means on the support below the packing element and including outwardly movable pipe-gripping members for engaging a well pipe,

fluid pressure operated setting means on the support below the anchoring means,

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

additional means including the tubular support connecting the fluid pressure operated setting means with the packing element, whereby actuation of the 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 tubing string having threaded connection with said tubular support,

means establishing communication between the tubing string and the setting means whereby fluid under pressure is conducted to the setting means to actuate the same,

an abutment means engaging the upper end of the packing element and mounted on said tubing string to confine the packing element against upward movement during the setting operation,

a mechanical locking means associated with the setting means for locking said setting means in the position to which it has moved during setting the anchoring means and packing element, whereby the

12

pressure which actuated said setting means may be released and the mechanical locking means will maintain the anchoring means and the packing element in their set position,

and means for rotatably connecting the tubing string to the abutment means while confining said tubing against longitudinal movement relative thereto, whereby rotation of said tubing string without rotation of the tubular support will actuate the threaded connection and move said abutment in a direction away from the packing element to release it from set position.

11. A well packer apparatus as set forth in claim 10, wherein said locking means comprises,

a locking rod secured to one part of the setting means, and a gripping member carried by another part of said setting means,

said locking rod and gripping member being constructed to allow movement of said parts of the setting means relative to each other in a direction to set the anchoring means and packing element while preventing movement of said parts relative to each other in an opposite direction.

12. The combination with a well tool having anchoring means for anchoring the same within a well pipe, of a pressure-actuated setting means for effecting setting of said anchoring means which comprises two parts movable relative to each other, said setting means including,

a cylinder and a piston movable relative to each other, means for conducting pressure fluid into the cylinder to move the piston and cylinder relative to each other, means connecting one part of said anchoring means to the cylinder and the other part to the piston, whereby movement of the cylinder and piston relative to each other in one direction will set said anchoring means,

a locking rod,

a gripping member engageable with said rod, the locking rod and gripping member being secured one to the cylinder and the other to the piston,

said gripping member having means constructed to permit movement of the rod and member in the direction which these parts move when the piston and cylinder move to set the anchoring means,

said means of said gripping member preventing relative movement of said rod and gripping member in an opposite direction which would permit movement of the piston and cylinder relative to each other in a direction to unset the anchoring means, whereby said locking rod and gripping member mechanically lock the piston and cylinder to prevent unsetting of the anchoring means.

13. The combination set forth in claim 12, together with a pressure-responsive means engaging the gripping member and having one side exposed to the pressure fluid which is conducted to the piston and cylinder to actuate the same, said last-named pressure-responsive means urging said gripping member into firm contact with the locking rod during actuation of said piston and cylinder, whereby upon release of the pressure fluid within the cylinder which may result in said piston and cylinder moving in an opposite direction to unset the anchoring means, said gripping member immediately grips said locking rod to lock the piston and cylinder against such movement to thereby instantaneously lock the anchoring means against unsetting.

14. The combination with a well tool having anchoring means including two parts movable relative to each other for anchoring the same within a well pipe, of a pressure-actuated setting means for effecting setting of said anchoring means, said setting means including,

a cylinder and a piston movable relative to each other, means for conducting pressure fluid into the cylinder to move the piston and cylinder relative to each other, means connecting one part of said anchor-

13

ing means to the cylinder and the other part to the piston, whereby movement of the cylinder and piston relative to each other in one direction will set said anchoring means,

a pair of locking rods having their upper portions secured to the cylinder to be movable therewith,

a gripping member for each rod engageable with the rod and secured to the piston for movement with the piston,

each gripping member having means constructed to permit movement of the rod and member in the direction which these parts move when the piston and cylinder move to set the anchoring means,

said means of each gripping member preventing relative movement of its rod and the gripping member in an opposite direction which would permit movement of the piston and cylinder relative to each other in a direction to unset the anchoring means whereby said locking rod and gripping member mechanically lock the piston and cylinder to prevent unsetting of the anchoring means.

15. The combination set forth in claim 14, together with,

a pressure responsive means surrounding each rod and engaging the gripping member associated with that rod,

means communicating one side of each pressure responsive means with the pressure fluid which is conducted to the piston and cylinder to actuate the same, whereby such pressure acts against each pressure responsive means to urge the gripping member into firm contact with its locking rod during actuation of said piston and cylinder,

release of the setting pressure fluid which may result in said piston and cylinder moving in a direction to unset the anchoring means, also releasing the fluid acting upon each pressure responsive means whereby each gripping member may immediately grip its locking rod to thereby lock the piston and cylinder against movement in a direction which would unset the anchoring means.

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

a first tubular support,

a second tubular support,

an upper abutment having connection with the upper ends of the supports,

an elastic packing element slideably mounted on the supports and having its upper end confined by the upper abutment,

anchoring means on the supports below the packing elements and including an expander which engages and confines the lower end of said packing element,

14

said anchoring means also including radially movable gripping slips engageable with the well pipe,

fluid pressure operated setting means comprising a piston secured to the lower end of one of the supports and a cylinder secured to the gripping slips of the anchoring means, whereby actuation of the setting means effects a relative movement of piston and cylinder to first move the gripping slips into pipe gripping position and to subsequently apply an endwise force to the packing element through downward movement of said one tubular support and upper abutment with respect to the packing element,

means communicating one of said supports with said fluid pressure operated setting means so that fluid pressure may be conducted to said setting means to actuate the same,

the first tubular support having its upper end projecting upwardly above the packer and into a passage in the upper abutment,

a tubing string having its lower end portion extending into the passage of the upper abutment,

means within said passage engageable with said tubing string for rotatably mounting the string within the passage while preventing longitudinal movement of the string with respect to the upper abutment,

and a threaded connection between the lower end portion of the tubing string and the projecting end of the first tubular support whereby after the anchoring means and packing element are set, a rotation of the tubing string relative to the stationary first support will effect an upward movement of the abutment to release the endwise setting force upon the packing element to retract it from sealing position.

17. A well packer apparatus as set forth in claim 16 wherein the threaded connection between the tubing string and the first tubular support comprises left-hand threads, whereby release of the packing element is accomplished by right-hand rotation of said tubing string.

18. A well packer apparatus as set forth in claim 16 together with means on the second tubular support and engageable with the expander of the anchoring means when the upper abutment and second support are moved upwardly by reason of rotation of the tubing string, whereby the expander is moved upwardly relative to the gripping slips to release the same.

References Cited in the file of this patent

UNITED STATES PATENTS

2,903,066	Brown	Sept. 8, 1959
2,946,384	Brown	July 26, 1960
2,999,544	Conrad et al.	Sept. 12, 1961
3,045,754	Myers	July 24, 1962
3,080,923	Brown	Mar. 12, 1963