July 28, 1964 C. C. BROWN 3,142,338

WELL TOOLS

Filed Nov. 14, 1960 4 Sheets-Sheet 1

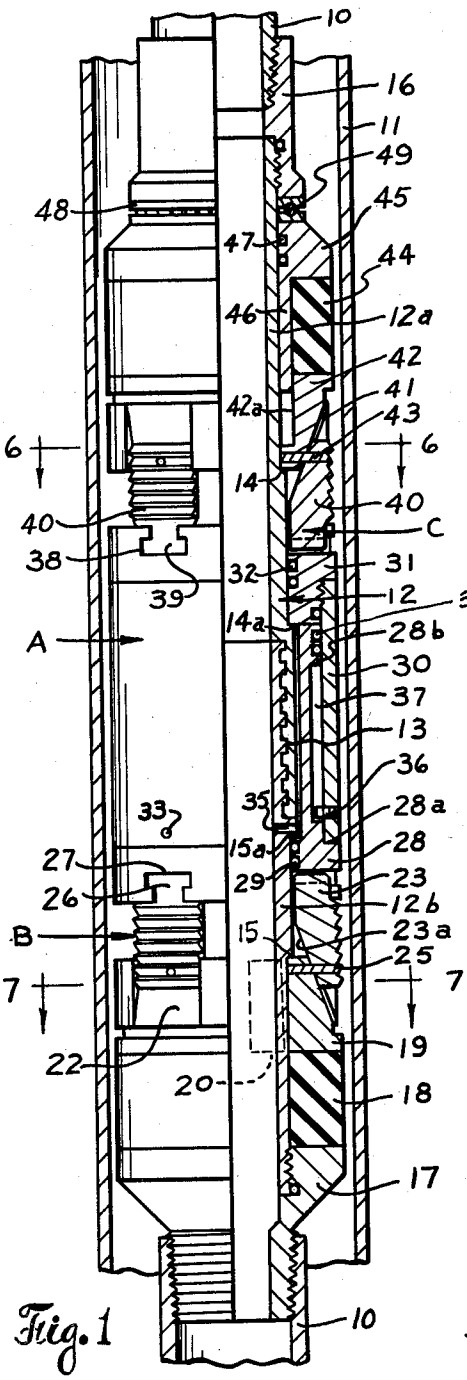

Fig. 1

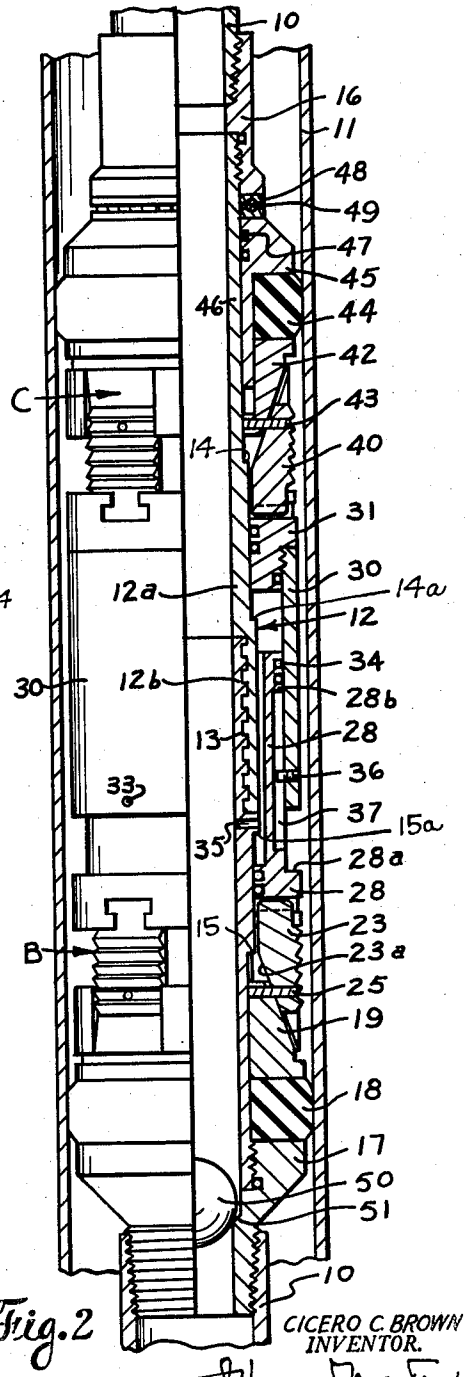

Fig. 2

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WELL TOOLS

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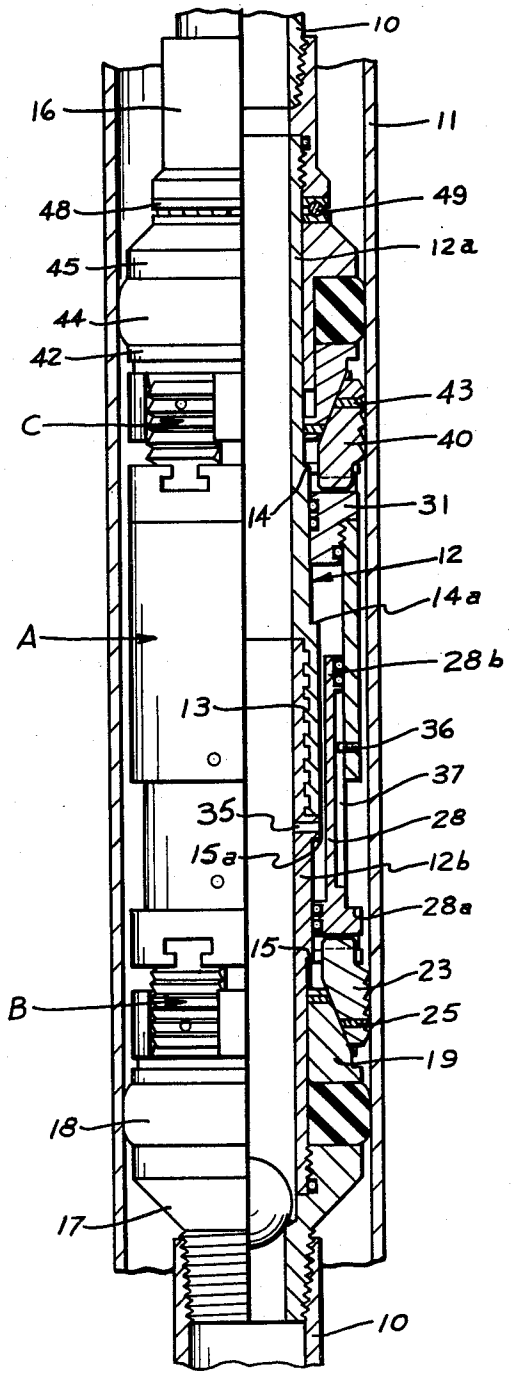

Fig. 3

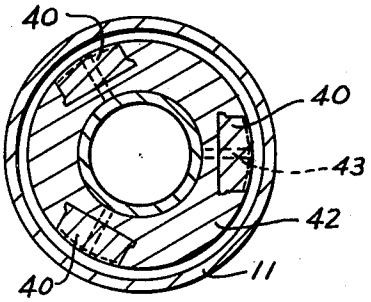

Fig. 6

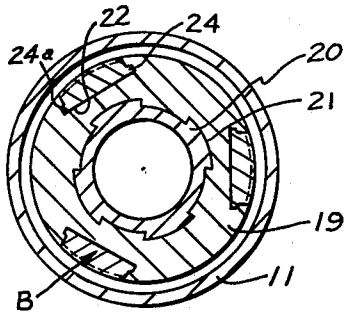

Fig. 7

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WELL TOOLS

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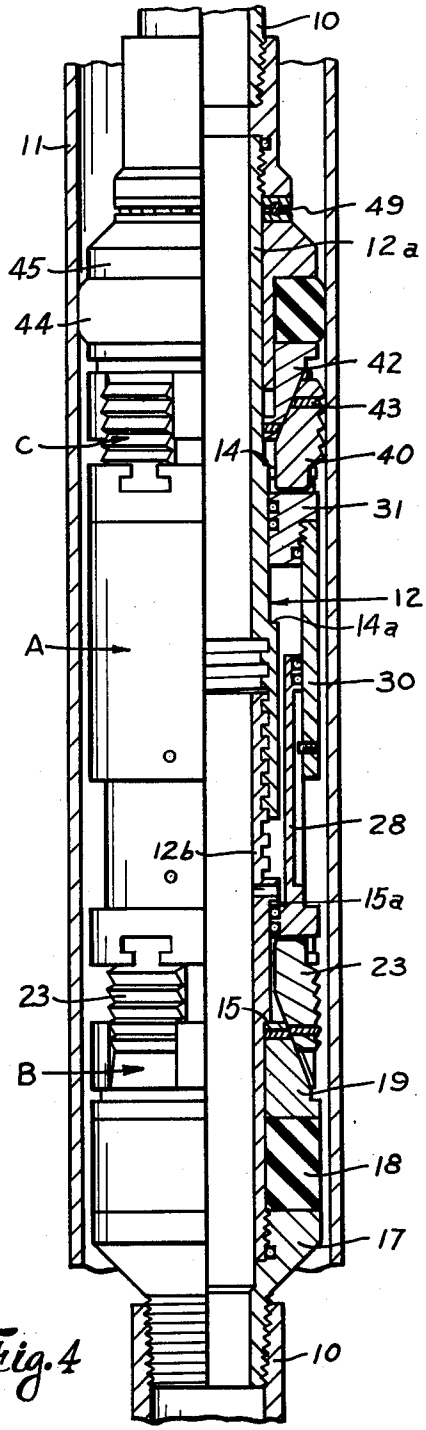

Fig. 4

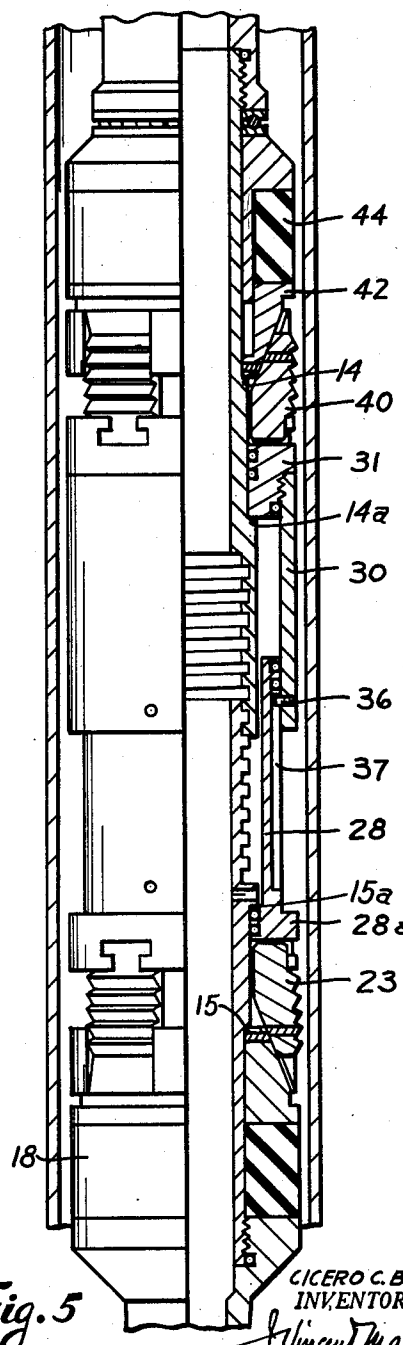

Fig. 5

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WELL TOOLS

Filed Nov. 14, 1960 4 Sheets-Sheet 4

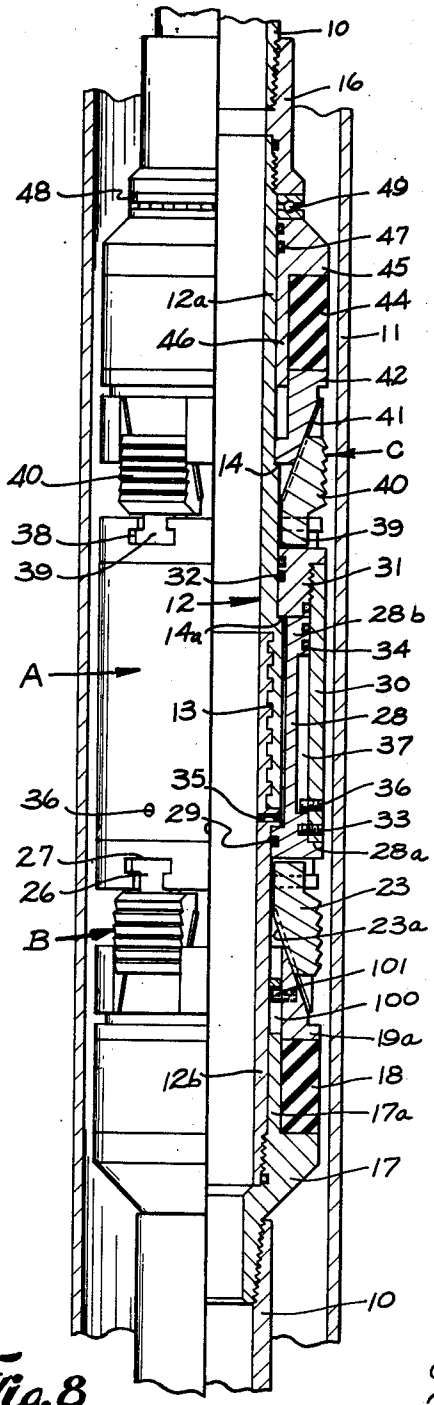

Fig. 8

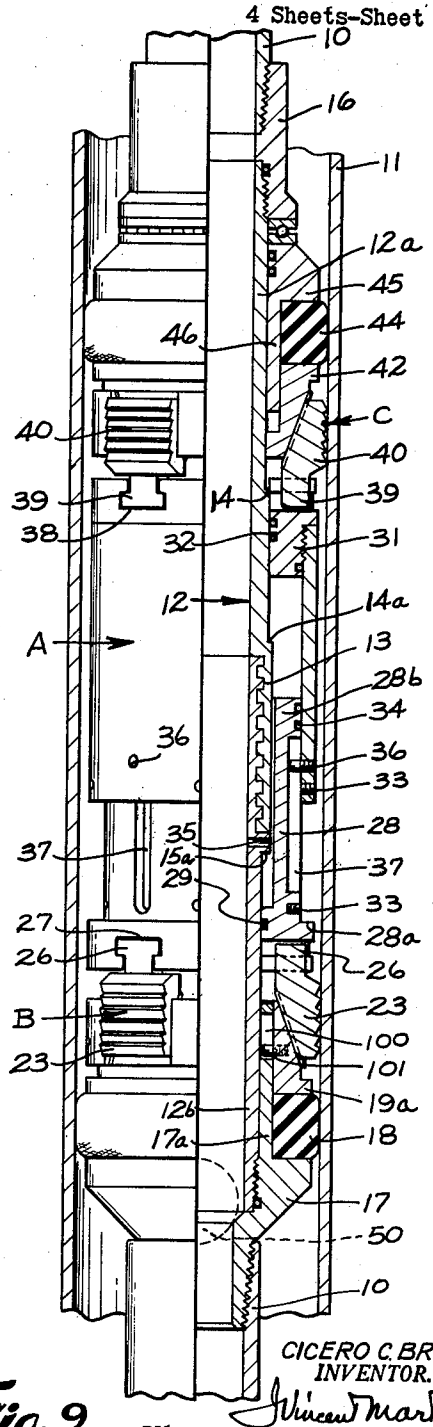

Fig. 9

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3,142,338

WELL TOOLS

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Filed Nov. 14, 1960, Ser. No. 69,118
16 Claims. (Cl. 166—120)

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

This application is filed as a continuation-in-part of my co-pending application Serial No. 784,503, filed January 2, 1959, now abandoned.

In carrying out various operations within a well bore, it is desirable to provide a well tool such as a well packer which may be set within the well bore and which, when in a set position, is locked against movement in either direction. To accomplish such locking action, two sets of gripping elements or slips are employed, one for holding the packer assembly against downward movement and the other for holding said assembly against upward movement. With the double slip arrangement, release of the packer assembly to permit its removal from the bore after it has served its function presents a problem and it has been the practice to make this type of packer permanent or nonremovable, with the result that removal can be accomplished only by drilling up all or part of the assembly which, of course, destroys the device.

It is, therefore, one object of this invention to provide a well packer assembly having means for locking the same against movement in either direction within the well bore, together with means for readily releasing the locking means to permit removal of the complete assembly from the well bore whenever such removal is desired.

Another object is to provide a well packer assembly having upper and lower gripping elements for locking the assembly against movement in either direction within a well bore, wherein said gripping elements are moved into set or gripping position by a hydraulic means and are retracted into a released or nongripping position by a mechanical means which is actuated by manipulation of the pipe string upon which the packer assembly is mounted.

An important object of the invention is to provide a well packer assembly, of the character described, wherein the gripping elements are moved into set or gripping position by the application of a suitable pressure and are constructed to remain in set position even though the pressure, which initially moved said elements to such set position, is relieved; the assembly also including normally inactive mechanical means which is adapted, upon rotation of the pipe string carrying the packer assembly, to apply mechanical pressure to the gripping element units in a direction effecting release of said gripping elements from a gripping position.

A particular object is to provide a packer assembly of the character described in which the mechanical releasing means comprises a pair of members having threaded engagement with each other and having means co-acting with the gripping slip units of the assembly, whereby upon a rotation of one of the members with respect to the other, a jacking action is produced which applies sufficient mechanical pressure to the gripping slip units to assure retraction of the gripping slips to a released position.

Other objects will hereinafter appear.

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 view partly in section and partly in elevation of a well packer constructed in accordance with the invention and illustrating the various parts in the position which they assume during lowering of the device into the well bore;

FIGURE 2 is a similar view showing the packer elements moved into initial set position and prior to setting of the gripping means;

FIGURE 3 is a similar view illustrating the packer elements and gripping means in fully set position;

FIGURE 4 is a view similar to FIGURE 1 showing the lower gripping means and packer elements retracted;

FIGURE 5 is a similar view with the various parts of the assembly in fully retracted position;

FIGURE 6 is a peripheral cross-sectional view taken on the line 6—6 of FIGURE 1;

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

FIGURE 8 is a view similar to FIGURE 1 and illustrating a slightly modified form of the invention, the parts of the tool being shown in position prior to setting of the gripping means; and

FIGURE 9 is a view similar to FIGURE 8 with the tool in fully set position.

In the drawings the letter A designates the improved well tool assembly which is adapted to be connected in a well pipe string by which the assembly may be lowered into the usual well casing **11**. The well tool assembly A is lowered to the desired elevation within the well casing and is adapted to be set therein to be locked against movement in either direction longitudinally of said casing. When desired, the lowering pipe **10** may be manipulated to effect a release of the assembly, after which the assembly may be removed from the well casing by means of said pipe **10**.

The well packer assembly includes a central tubular support or mandrel **12** which comprises an upper tubular section **12***a* and a lower tubular section **12***b*. The sections are connected together in telescoping relationship by relatively coarse threads **13** which are preferably left-hand. With such arrangement, when the lower section **12***b* is held stationary, a right-hand rotation of the upper section **12***a* will result in moving the sections axially in a direction to separate said sections. The upper section **12***a* is provided with external upwardly facing shoulders **14** and **14***a* while the section **12***b* is formed with external downwardly facing shoulders **15** and **15***a*.

The upper end of the section **12***a* of the support **12** is connected through a coupling **16** with the upper portion of the lowering pipe **10** while the lower end of the section **12***b* has connection through a coupling **17** with the lower portion of the pipe **10**. The tubular support **12** forms the main mandrel or supporting element of the complete packer assembly A.

A lower sleeve-like packer element **18** surrounds the lower end of the support **12** and rests upon the upper end of the coupling **17**. The packer element is constructed of rubber, rubber compound or other elastic material and when in a normal undistorted position, has its external surface spaced from the wall or bore of the well casing **11**. A lower gripping means or unit B is located immediately above the packer element **18** and such unit includes an annular expander **19**, the lower end of which is supported upon the packer element **18**. As shown in FIGURE 1, the expander element **19** is disposed below the external downwardly facing shoulder **15** on the lower section **12***b* of the support **12**. To prevent rotation of the expander **19** with respect to the section **12***b*, said section is formed with longitudinal splines **20** (FIGURE 7) which engage recesses **21** provided in the bore of the expander **19**. The longitudinal extent of each spline **20** is indicated by the dotted lines in FIGURE 1. At spaced

radial points, the expander **19** is formed with inclined expander surfaces **22** and as illustrated three such surfaces are provided.

Co-acting with the inclined expander surfaces **22** are a plurality of gripping elements or slips **23**. Each slip has an inclined inner surface **23***a* which engages and rides upon the inclined expander surfaces **22** of the expander **19**. Outward movement of each gripping slip with respect to the co-acting surface which it engages is prevented by longitudinal ribs **24** formed on each slip member; said ribs engage retaining grooves **24***a* provided in the expander **19** (FIGURE 7). It will be evident that longitudinal movement of the slips relative to the expander in a direction which will move the slips downwardly will result in a radially outward movement of the gripping slips. Each gripping slip is normally retained in its raised position with respect to the expander **19** by a shear pin **25**.

The upper end of each gripping slip **23** is formed with a T-shaped hanger **26** which is adapted to engage within a T-shaped slot **27** formed in the lower end of an annular piston sleeve **28**. The piston sleeve **28** surrounds the tubular support **12** and with the assembly in fully retracted position, as shown in FIGURE 1, said sleeve surrounds the threaded joint **13** between the sections **12***a* and **12***b* of the support **12**. Suitable sealing rings **29** seal between the external surface of the section **12***b* and the bore of the piston sleeve **28**.

A tubular cylinder **30** encircles the piston sleeve **28** and has its lower end normally supported upon an external flange **28***a* formed on the piston sleeve. The upper end of the cylinder has a cylinder head **31** threaded therein and the bore of this head is sealed with the external surface of the section **12***a* of the support by suitable sealing rings **32**. It is noted that the cylinder head **31** surrounds the tubular section **12***a* above the upwardly facing shoulder **14***a* whereby when the parts are in the position of FIGURE 1, the cylinder head is supported upon said shoulder; at this time the lower end of the cylinder **30** is resting on the flange **28***a*. The parts may be retained in this position by means of a shear pin **33** which extends through the wall of the cylinder **30** and which has its inner end engaged with the piston sleeve just above the flange **28***a*. The upper end of the piston sleeve has a piston element **28***b* which has sealing engagement with the wall of the cylinder **30** by means of suitable sealing rings **34**.

With the piston sleeve **28** and the cylinder **30** in the position of FIGURE 1, the piston element **28***b* is in contact with the cylinder head **31**. Pressure fluid from the bore of the tubular support **12** may be introduced into the area below the cylinder head **31** through a fluid inlet port **35** which is formed in the lower section **12***b* of the support **12**. Upon the introduction of a pressure fluid, the cylinder head **31** and the cylinder are urged in an upward direction; at the same time this pressure will act downwardly upon the piston element **28***b* of the piston sleeve **28** and this will result in moving the parts from the position shown in FIGURE 1, through the position shown in FIGURE 2 and finally to the position shown in FIGURE 3.

For preventing rotation of the cylinder **30** with respect to the piston during such movement and also for limiting the movement of the cylinder relative to the piston, a plurality of guide pins **36**, one of which is shown in the drawings, are secured to the cylinder. Each pin **36** extends inwardly to engage within a complementary longitudinal groove **37** which is formed in the exterior of the piston sleeve. As the piston sleeve **28** is urged downwardly, it will apply a downward force to the gripping slips **23** and through the shear pin **25** will apply an endwise compressive force to the lower packer element **18**. This will result in a distortion of the packer element **18** into sealing contact with the wall of the well casing in the manner shown in FIGURE 2. Continued

application of downward force through the piston sleeve **28** to the slips will shear the pin **25** and, thereafter, the gripping slips **23** will move to a set position. Upon setting of the lower slips, the downward movement of the piston sleeve **28** is arrested and the full pressure within the bore of the cylinder **30** above the piston element **28***b* will act against the lower end of the cylinder head **31** to urge the cylinder head upwardly along the upper section **12***a* of the tubular support **12**.

An upper gripping slip unit C is mounted on the upper section **12***a* of the support **12** above the cylinder **30**. As clearly shown in FIGURES 1 to 5, the upper portion of the cylinder head **31** is formed with a plurality of T-shaped slots **38** which are engaged by T-shaped connectors **39** formed on the lower end of upper gripping slips **40** of said unit C. The slips **40** are of similar construction to the slips **23** except they are reversed and each slip **40** is adapted to co-act with an expander surface **41** formed in an annular expander **42**. The annular expander **42** surrounds the section **12***a* of the support **12**, being located above the second upwardly facing shoulder **14** which is formed on said section and said expander is rotatable on said support. A shear pin **43** normally connects each slip **40** with the expander **42**.

An upper packer element **44** is supported upon the expander **42** and is of similar construction to the lower packer element **18**. A confining head member **45** confines the upper end of the packer element **44** and surrounds the upper portion of the section **12***a* and has a tubular extension **46** which depends therefrom to extend downwardly through the packer element **44** and into a counter-bore **42***a* formed in the expander **42**. Suitable sealing rings **47** seal between the confining head **45** and the exterior of the support.

So that the upper section **12***a* of the tubular support **12** and the lowering pipe **10**, which is connected thereto coupling **16** may be rotated with respect to the confining head **45**, upper packer element **44**, expander **42** and slips **40**, a bearing raceway **48** having ball bearings **49** confined therein is disposed between the lower end of the coupling **16** and the upper end of the head **45**. As will be explained, the rotation of the lowering pipe of the upper section **12***a* with respect to the lower section **12***b* of the support will function to actuate the threaded connection **13** between sections **12***a* and **12***b*. Such actuation will effect a release of the gripping slips **23** and **40** after such slips have been set.

Since the upper slips **40** are mounted on the cylinder head **31**, movement of the cylinder head in an upward direction will result in the application of a force through the slips **40**, shear pin **43** and to the lower end of the upper packer element **44**. Because the upper end of the element **44** is confined by the head **45** and its contact with the coupling **16**, this application of force will result in setting the upper packer as shown in FIGURE 2. Continued application of force will shear the pins **43** and effect a setting of the upper slips.

In the operation of the apparatus, the parts are assembled as shown in FIGURE 1 with the tubular support **12** connected in the lowering pipe **10**. The upper packer element **44** is supported upon the upper expander **42** which, in turn, rests upon the external shoulder **14** formed on the upper section **12***a* of the support. The gripping slips **40** of the upper gripping slip unit C are connected to the upper expander **42** by the shear pins **43** and are thereby maintained in a retracted position.

The cylinder **30** and its head **31** are supported upon the external shoulder **14***a* of the support, as shown in FIGURE 1, and the piston sleeve **28** has its piston element **28***b* in abutting relationship to the underside of the cylinder head. The lower end of the piston sleeve **28** rests on the lower slips which are connected through shear pins **25** to the lower expander **19** and thus the piston sleeve and cylinder are held in the position shown in FIGURE 1. If desired, the additional shear pin **33**

may be employed to assist in maintaining said piston sleeve and cylinder in this position.

It is noted that at this time the threaded connection **13** between the sections **12***a* and **12***b* of the tubular support **12** is fully made up as illustrated in FIGURE 1 and this disposes the downwardly facing external shoulder **15***a* on the lower section **12***b* in contact with an internal shoulder formed at the lower end of the bore of the piston sleeve **28**. The upper end of the expander **19** is in contact with the external downwardly facing shoulder **15** on the section **12***b* and the lower packer element **18**, which is below the expander **25**, is, of course, in its relaxed or undistorted position.

With the parts in the position shown in FIGURE 1, the assembly A is lowered to the proper position within the well casing and when it is desired to set the packer elements of said assembly and the gripping slip units thereof, a closure, which may be in the form of a ball **50**, is dropped downwardly through the lowering pipe. This ball passes downwardly through the bore of the tubular support **12** and engages an annular seat **51** which is formed in the lower coupling **17** to close downward flow of fluid through the lowering pipe and bore of the support **12**. It is, of course, evident that other types of closures may be employed. After the ball **50** is in position as shown in FIGURE 2, a pressure is built up within the lowering pipe and the bore of the support **12** and this pressure may pass through the radial port **35** into the annular space between the exterior of the support **12** and the bore of the piston sleeve **28**. As this pressure builds up within this area, a force is applied against the underside of the cylinder head **31** and at the same time a downward force is applied against the upper end of the piston element **28***b* so that the pressure tends to move the cylinder head and piston element apart. The shear pin **33**, which connects the cylinder **30** and piston sleeve **28**, is of lesser strength than the shear pins **25** and **43** which connect the slips **23** and **40** to their respective expanders.

As sufficient pressure builds up within the cylinder, the pin **33** is sheared and this permits an upward movement of the cylinder with respect to the piston element **28***b* and the piston sleeve **28**. Actually, there will be movement in both directions, that is, the cylinder will move upwardly and the piston sleeve will move downwardly. By reason of the strength of the shear pins **25**, the downward motion of the piston sleeve **28** will apply a force through the slips **23**, shear pin **25** and expander **19** to the upper end of the lower packer element **18** whereby said element is distorted radially outwardly into a sealing engagement with the casing **11**. At the same time, the upward movement of the cylinder head **31** will transmit an upward force through the upper slips **40**, shear pin **43** and expander **42** to apply an endwise force to the upper packer element **44**, thereby resulting in a radially outward movement of the upper packer element into sealing engagement with the wall of the casing **11**. This position of the parts is illustrated in FIGURE 2 where the packer elements **18** and **44** have been moved into sealing position but the gripping slips have not yet been engaged.

After the sealing elements have been engaged in the manner above described, the continued application of pressure will apply sufficient force to the piston sleeve **28** and the cylinder to shear the pins **25** of the lower slips and the pins **43** of the upper slips. When this occurs, the slips **23** may move downwardly relative to the lower expander and into gripping engagement with the wall of the well casing **11**. Also, the upper slips **40** may move upwardly with respect to their expander **42** to also move into gripping position. The packer is then in fully set position and it will be evident that any pressure from below the device will act to more firmly engage the lower slips **23**; any pressure from above the device will merely act to more firmly engage the upper slips **40**. The apparatus is thus locked within the well bore against movement in either direction and the pressure within the interior of the sleeve may be relieved and said slips will remain in their set position.

When it is desired to release the packer, it is only necessary to impart a rotation to the upper portion of the lowering pipe **10** and such rotation is imparted to the upper section **12***a* of the support **12**. As has been explained, the lower section **12***b* of the tubular support has a spline connection with the lower expander **19** and by reason of this connection **20**, **21** and the engagement of the slips with the wall of the casing, the lower section **12***b* is held stationary. Thus, the upper section **12***a* of the support may rotate with respect to the lower section and as it does so, the threads **13** which connect the sections cause a longitudinal movement of the sections with respect to each other in the manner shown in FIGURE 4.

As the sections **12***a* and **12***b* move apart by reason of the relatively coarse threads which, as pointed out, are preferably left-hand so that a right-hand rotation of the pipe **10** may be employed, the lower section **12***b* will move downwardly relative to the upper section **12***a*, which latter section is initially held stationary because the weight of the lowering pipe **10** above the assembly is acting downwardly on the upper expander and is resisting upward movement of said upper expander. As the lower section moves downwardly, the downwardly facing shoulder **15** engages the upper end of the expander, as illustrated in FIGURE 4, and applies a downward force to the expander to release the lower slips from engagement with the pipe.

As the parts reach the position shown in FIGURE 4, the pin **36** on the cylinder **30** has not reached the limit of the slot **37** in the piston **28** and continued rotation of the section **12***a* will cause a continued downward movement of section **12***b* until pin **36** engages the shoulder **28***b* formed at the upper end of slot **37**. It is pointed out that the continued extension of the sections **12***a* and **12***b* in order to move pin **36** to the limit of its slot is possible even after the lower slips have been released because so long as the upper slips and packer are still engaged, the lower section **12***b* is held against rotation by reason of the connection between the keyed lower expander **19** and the upper slips, which connection is made through the cylinder **30**, piston sleeve **28** and slips **23**.

Following the engagement of pin **36** with shoulder **28***b*, a further downward movement of the section **12***b* upon continued rotation of section **12***a* is prevented. Therefore the continued rotation will result in the section **12***a* being moved upwardly against the weight of the tubing which has up to this time been resisting its upward movement and, therefore, the upper section **12***a* moves upwardly until the packing element **44** is relaxed and the upwardly facing shoulder **14** engages the under side of the upper cone **42**. Obviously, the further upward movement of section **12***a* after shoulder **14** has engaged the upper expander results in pulling the cone from under the upper slip to complete the release of the upper slips **40**. At this time both the lower and upper slips are released. It is of course necessary that the length of the threaded connection between the sections **12***a* and **12***b* be of sufficient length to accomplish the foregoing functions.

The action of the mechanical releasing means is illustrated in FIGURES 4 and 5. In FIGURE 4 the lower expander has been moved downwardly relative to slips **23** to release said slips while the upper expander is still engaged with the slips **40** and is holding the upper slips in gripping position. However, by the time the parts reach the position of FIGURE 5, the pin **36** has traversed the full length of the slot **37** and the upper shoulder **14** on section **12***a* has engaged the upper cone with the result that an upward movement of the upper expander with respect to the slips has been effected to release said slips; when the shoulder **14***a* engages the underside of the cylinder head **31**, further movement of the sections

12*a* and 12*b* cannot occur. However, by this time both upper and lower slips as well as the packing elements 18 and 44 have been retracted and the device may be removed from the well casing by merely lifting and removing the pipe 10 from said bore.

In the form of the invention shown in FIGURES 1 through 7 and as above described, the lower gripping slips 23 are initially connected to the expander cone 19 by the shear pin 25 while the upper gripping slips 40 are initially connected to the expander cone 42 by the shear pins 43. The shear pins 25 and 43 may, as has been noted, be of greater strength than the shear pin 33 which initially connects the piston sleeve 28 with the cylinder 30. However, actual practice has shown that it is not necessary for the shear pins 25 and 43 to be of greater strength than the shear pin 33. The pins 25 and 43 may be of substantially the same strength as pin 33 or in some instances could be of lesser strength. Also pins 25 and 43 could be adjusted to shear prior to the time that the packing elements 18 and 44 are fully expanded.

Where pins 25 and 43 are arranged to shear prior to full expansion of the packing elements 18 and 44, the operation would be as follows: upon the cylinder 30 and piston sleeve 28 moving outwardly from each other by reason of fluid pressure, shearing of pins 25 and 43 would occur before total setting of packing elements 18 and 44. In such instance, the slips 23 would begin to ride downwardly on the inclined surface of expander 19 and upon engaging the wall of the casing 11 would continue to be urged downwardly along said wall. This downward movement would be permitted because the shape of the teeth of slips 23 is such that gripping action is affected only when the slips 23 are moved upwardly. As slips 23 slide downwardly along the wall of casing 11, a force is transmitted through the co-acting surfaces of said slips and the co-acting surfaces of the expander 19 so that the expansion of the lower packing element 18 would be completed.

The action of the upper slips 40 would be the same as above described, that is, after shearing of the pin 43, slips 40 would move upwardly on the cone and would then ride upwardly on the wall of the casing. During such upward movement, sufficient force would be transmitted to the upper packing element 44 to complete setting of said upper packer. The parts would finally assume the position of FIGURE 3 when the device is in fully set position.

Not only is it possible to vary the strength of the shear pins 25 and 43 but such pins can be entirely omitted and such arrangement is illustrated in FIGURES 8 and 9. In these figures, like numerals have been applied to similar parts and the form shown is substantially the same as the first form. This form includes the main mandrel 12, a lower slip assembly B, a lower packing element 18, an upper slip assembly C and an upper packing element 44. The shear pins 25 and 43 of the first form which initially connect the slips to their respective expanders are omitted.

In the form shown in FIGURES 8 and 9, the lower expander is modified in that an annular expander 19*a* is substituted for the expander 19. The expander 19*a* rests upon the upper end of the lower packing element 18 and has its outer inclined surface co-acting with the inner inclined surface 23*a* of the slips 23. Instead of connecting with the main mandrel through a spline connection, as in FIGURE 1, the expander 19*a* has connection with a tubular extension 17*a* provided on the lower coupling 17. The extension 17*a* is formed with a slot 100 and a pin 101 which is secured in the expander 19*a* extends into and is movable within said slot. The pin 101 and slot 100 set up a nonrotative connection between the lower expander 19*a* and main mandrel 12, such connection being completed through the coupling 17 and the lower section 12*b* of said main mandrel; however, the expander may undergo limited axial movement with respect to the mandrel in accordance with the length of the slot 100. The pin and slot connection perform the same function as the spline connection 20 (FIGURE 7) of the first form in that the lower expander is nonrotatable with respect to the mandrel while allowing limited axial movement of the mandrel and expander relative to each other. When employing the pin and slot connection, it is possible to omit the external shoulder 15 on the mandrel section 12*b*, which shoulder functions to confine upward movement of expander 19 on said section.

The operation of the modified form of the invention is substantially the same as that heretofore described. With the parts in the position of FIGURE 8 during lowering of the well tool, the cylinder head 31 of cylinder 30 is supported on the shoulder 14*a* of the main mandrel 12. The upper gripping slips 40 are supported upon said cylinder head while the lower slips are suspended therefrom. Since the packing elements 44 and 18 are relaxed, their respective expanders 42 and 19*a* are in a position with the slips 23 and 40 retracted (FIGURE 8).

Upon dropping of the ball 50 indicated in dotted lines in FIGURE 9 and the application of pressure through the port 35, the piston sleeve 28 and the cylinder 30 are extended. This movement urges the slips 40 upwardly with respect to the expander 42 and at the same time urges the slips 23 downwardly with respect to the expander 19*a*. As the upper slips move into engagement with the wall of the casing 11, said slips will thereafter ride upwardly on the casing wall to transmit a force through the expander sufficient to deform the upper packing element 44 into sealing position. This action takes place because of the particular shape of the teeth of slips 40 which allows upward sliding movement of the slips along the wall while preventing reverse or downward movement of said slips.

At the same time the lower slips 23 are moved downwardly into contact with the casing wall after which they will slide along said wall in a downward direction to transmit sufficient force through the expander 19*a* and against the lower packing element 18 to expand the latter. The shape of the teeth on the slips 23 allows downward sliding movement of these slips while preventing any reverse or upward motion thereof. As the lower expander 19*a* moves downwardly, the pin 101 travels within slot 100. The fully set position of the tool is shown in FIGURE 9.

Release of the tool shown in FIGURES 8 and 9 is effected in the same manner as the release of the first form. The upper section 12*a* of the main mandrel 12 is rotated relative to the lower section 12*b* and since the lower section is nonrotatably connected through coupling 17 with the lower expander 19*a*, the lower section 12*b* is held against rotation. As the sections are rotated relative to each other, the threads 13 effect a longitudinal movement of said sections, whereby the shoulder 14 moves beneath the upper expander 40 and the pin 101 is engaged by the upper limit of the slot 100.

Although it may be that one or the other of the expanders is released first, the continued rotation of the section 12*a* relative to section 12*b* results in a jacking action which moves each of the expanders from beneath its respective slips, whereby the parts are returned to the position of FIGURE 8. In such position, the upper and lower slips and their adjacent packing elements are fully released and the tool may be removed from the well bore.

It is pointed out that the well packer assembly is relatively simple in construction and provides upper and lower gripping means which will function to lock the assembly within the well bore against movement in either direction to provide a permanent-type packer. The gripping means is initially moved into a set position by the application of fluid pressure and is maintained in such position by the pressures acting against the packer elements. Therefore, even though the setting pressure within the cylinder is relieved, the packer elements and the gripping slip units

remain in set position. Subsequently, when it is desired to release the gripping means, it is only necessary to manipulate the lowering pipe and effect a mechanical release of both the upper and lower slips whereby the entire assembly may be removed from the well bore.

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 tool assembly including, a tubular support adapted to be connected in a well pipe string and lowered in a well bore, an upper gripping means mounted on the support and movable into gripping position to lock the assembly against movement in one direction within the well bore, a lower gripping means mounted on the support and movable into gripping position to lock the assembly against movement in the other direction within said well bore, a hydraulically-actuated part mounted on the support and engageable with the upper gripping means to move said gripping means into gripping position when said part is actuated, a second hydraulically-actuated part mounted on the support and engageable with the lower gripping means to move said lower gripping means into gripping position when said part is actuated, the tubular support having means for conducting pressure fluid from the tubular support to the hydraulically-actuated parts to operate the same and thereby move the upper and lower gripping means into gripping position, and normally inactive means forming part of the tubular support adapted when actuated to engage and co-act with the upper and lower gripping means for retracting said upper and lower gripping means to permit removal of the complete assembly from the well bore, said normally inactive means being actuated by manipulation and movement of the pipe.

2. A well tool assembly including a tubular support adapted to be connected in a well pipe string and lowered in a well bore, an upper gripping means mounted on the support and movable into gripping position to lock the assembly against movement in one direction within the well bore, a lower gripping means mounted on the support and movable into a gripping position to lock the assembly against movement in the other direction within said well bore, a hydraulically-actuated part mounted on the support and engageable with the upper gripping means to move said gripping means into gripping position when said part is actuated, a second hydraulically-actuated part mounted on the support and engageable with the lower gripping means to move said lower gripping means into gripping position when said part is actuated, the tubular support having means for conducting pressure fluid from the tubular support to the hydraulically-actuated parts to operate the same and thereby move the upper and lower gripping means into gripping position, a pair of force-applying sections forming part of said tubular support, said sections being in telescoping relationship to each other and being normally in a first retracted position, means actuated by a manipulation and movement of the well pipe string to which the tubular support is connected for moving the force-applying sections to a second extended position, and means on said sections engaging and co-acting with the upper and lower gripping means when said sections are moved to extended position to release said gripping means from gripping position whereby the entire assembly may be removed from the well bore.

3. A well tool assembly as set forth in claim 2, wherein the force-applying sections comprise tubular members which are connected together in telescoping relationship by relatively coarse threads, said threads functioning to move the members to extended position upon rotation of one of said members relative to the other, and means directly connecting one of the members to the well pipe string, whereby rotation of said string effects a movement of the members to an extended position.

4. A well tool as set forth in claim 1, together with releasable means associated with the upper gripping means to normally maintain the same in retracted position, and additional releasable means associated with the lower gripping means for maintaining the lower gripping means in retracted position, said releasable means for both the upper and lower gripping means being released upon a predetermined application of pressure to the hydraulicaly-actuated parts whereby said pressure first releases the releasable means and thereafter moves the gripping means into gripping position.

5. A well tool assembly including, a tubular support adapted to be connected in a well pipe string and lowered in a well bore, an upper gripping means mounted on the support and movable into a gripping position to lock the assembly against movement in one direction within the well bore, a lower gripping means mounted on the support and movable into the gripping position to lock the assembly against movement in the other direction within said well bore, hydraulically-actuated means on said support between the upper and lower gripping means and having a connection with said gripping means, whereby operation of said hydraulically-actuated means moves said gripping means into gripping position, the tubular support having means for conducting pressure fluid from the bore of the well pipe to which the support is connected to said hydraulically-actuated means to operate the same and thereby move the upper and lower gripping means into gripping position, and normally inactive means forming part of the tubular support adapted when actuated to engage and co-act with the upper and lower gripping means for retracting the upper and lower gripping means to permit removal of the complete assembly from the well bore, said normally inactive means being actuated by manipulation and movement of the pipe.

6. A well tool assembly including, a tubular support adapted to be connected in a well pipe string and lowered in a well bore, an upper gripping means mounted on the support and movable into gripping position to lock the assembly against movement in one direction with the well bore, a lower gripping means mounted on the support and movable into a gripping position to lock the assembly against movement in the other direction within said well bore, a hydraulically-actuated part mounted on the support and engageable with the upper gripping means to move said gripping means into gripping position when said part is actuated, a second hydraulically-actuated part mounted on the support and engageable with the lower gripping means to move said lower gripping means into gripping position when said part is actuated, the tubular support having means for conducting pressure fluid from the tubular support to the hydraulically-actuated parts to operate the same and thereby move the upper and lower gripping means into gripping position, the tubular support including an upper member and a lower member telescoping said upper member and having threaded engagement therewith, one of the members of said support being rotatively coupled to the upper gripping means and the other of said members being mounted to rotate with respect to the other gripping means, whereby relative rotation of said members causes movement of the members in an axial direction with respect to each other, said members being normally in a first position in substantially fully telescoped position, relative rotation of the members extending said members to a second extended position, and means on the upper and lower members co-acting with the upper and lower gripping means when said members are moved to extended position to release the gripping means from gripping position whereby the entire assembly may be removed from the well bore.

7. A well tool assembly including, a tubular support adapted to be connected in a well pipe string and lowered

into a well bore, said support comprising an upper tubular section and a lower tubular section, means connecting the upper and lower sections in telescoping relationship to each other and normally maintaining the sections in a first fully telescoped position, said connecting means being operable by manipulation of the pipe string to which the support is connected for moving the sections axially with respect to each other to a second extended position, upper gripping means rotatively mounted on the upper section of the support, lower gripping means nonrotatively mounted on the lower section of the support, hydraulically-actuated means having parts coacting with the upper and lower gripping means to move the same into gripping position when said hydraulically-actuated means is actuated, the tubular support having means for conducting pressure fluid from the bore of the support to operate said hydraulically-actuated means and thereby set said upper and lower gripping means, means on the upper section of the support engageable with the upper gripping means to release the same from set position, and means on the lower section of said support engageable with the lower gripping means to release the same from said position, said means being engageable with said upper and lower gripping slips when the sections are moved to an extended position.

8. A well tool assembly as set forth in claim 1, together with an upper packer element disposed above and in contact with the upper gripping means, means confining that end of said packer element which is remote from the gripping means whereby when the upper gripping means is moved into gripping position the packer element is deformed into sealing position, a lower packer element disposed below and in contact with the lower gripping means, and means confining that end of said lower packer element which is remote from the lower gripping means whereby when the lower gripping means is moved into gripping position the lower packer element is deformed into sealing position.

9. A well tool assembly as set forth in claim 5, together with an upper packer element disposed above and in contact with the upper gripping means, means confining that end of said packer element which is remote from the gripping means whereby when the upper gripping means is moved into gripping position the packer element is deformed into sealing position, a lower packer element disposed below and in contact with the lower gripping means, and means confining that end of said packer element which is remote from the gripping means whereby when the lower gripping means is moved into gripping position the lower packer element is deformed into sealing position.

10. A well tool assembly including, a tubular support adapted to be connected in a well pipe string and lowered into a well bore, said support comprising an upper tubular section and a lower tubular section, means connecting the upper and lower sections in telescoping relationship to each other, and normally maintaining the sections in a first fully telescoped position, said connecting means being operable by manipulation of the pipe string to which the support is connected for moving the sections axially with respect to each other to a second extended position, a lower gripping slip unit carried by the lower section of the tubular support, said lower gripping slip unit comprising an expander, means for nonrotatively mounting the expander on said section and gripping slips co-acting with the expander whereby relative movement of said slips and said expander moves the gripping slips outwardly into gripping position, an upper gripping slip unit mounted on the upper section of the tubular support, said gripping slip unit comprising an expander surrounding the upper section of the support, means for rotatively mounting the expander on said upper section and gripping slips co-acting with the expander whereby relative movement between the slips and expander displaces said slips into gripping position, hydraulically-actuated means surrounding the support and located between the upper and lower gripping slip unit, the tubular support having means for conducting a pressure fluid to the hydraulically-actuated means to operate the same and apply a force to the gripping slip units to effect relative movement of the slips with respect to their expanders and thereby set the same, means on the lower section of the support engageable with the expander of the lower gripping slip unit to release the gripping slips thereof from gripping position, and means on the upper section of said support engageable with the expander of the upper gripping slip unit to release the gripping slips thereof from gripping position said means being engageable with said upper and lower expanders when the sections are moved to an extended position.

11. A well tool assembly as set forth in claim 10 wherein the hydraulically-actuated means comprises a cylinder and a tubular piston movable within the cylinder, with both piston and cylinder surrounding the support, said cylinder and said piston being moveable relative to each other upon the application of hydraulic pressure and having their extremities engaged with the gripping slips of the upper and lower gripping slip units, whereby said gripping slips are moved with respect to their expanders to displace the gripping slips into gripping position.

12. A well tool assembly as set forth in claim 10 together with an upper packer element adjacent the upper gripping slip unit and a lower packer element adjacent the lower gripping slip unit, and means confining that end of each packer element which is remote from the gripping slip unit adjacent that packer element for distorting the packer elements into sealing position when the gripping slips of said units are moved into gripping position.

13. A well packer assembly including, a tubular support adapted to be connected in a well pipe string and lowered into a well bore, said support comprising an upper tubular section and a lower tubular section, means connecting the upper and lower sections in telescoping relationship to each other and normally maintaining the sections in a first fully telescoped position, said connecting means being operable by manipulation of the pipe string to which the support is connected for moving the sections axially with respect to each other to a second extended position, a lower resilient packer element mounted on the lower section of the support, an annular slip expander supported on the upper end of the packer element, a plurality of gripping slips engaging the expander and adapted to be moved into gripping position when the slips are moved in one direction relative to the expander and to be retracted when moved in an opposite direction, releasable means normally connecting the slips to the expander in a retracted position, a movable annular piston surrounding the support and having its lower end connected to the gripping slips, a cylinder surrounding the annular piston and having a cylinder head at its upper end in sealing engagement with the upper section of the tubular support, said support having means conducting fluid pressure from the bore of the support into the cylinder, upper gripping slips connected to the upper end of the cylinder, an upper annular expander surrounding the upper section of the tubular support and adapted to coact with the slips to move the slips radially outwardly into gripping position when the expander and slips are moved in one direction with respect to each other and to retract said slips when the parts are moved relative to each other in an opposite direction, releasable means normally connecting the upper slips to the upper expander with the slips in a retracted position, an upper resilient packer element supported upon the upper expander, confining means carried by the upper section of the support and engaging the upper end of the upper packer element, introduction of fluid pressure into the cylinder resulting in movement

of the annular piston in a downward direction and a movement of the cylinder in an upward direction whereby a force is applied to the gripping slips and expanders to effect distortion of the upper and lower packer elements into sealing position, continued application of pressure after said packer elements have been set effecting a release of the releasable means between the slips and their respective expanders, whereby said slips are moved into a gripping position, abutment means on the upper section of the tubular support engageable with the upper expander to move the same from between the upper slips, abutment means on the lower section of the support engageable with the lower expander to move said expander from between its slips, said abutment means being engageable with said upper and lower expanders when the sections of the tubular support are moved to an extended position.

14. A well packer assembly as set forth in claim 13 together with frangible means between the cylinder and the annular piston for normally maintaining the cylinder and piston in a position which applies no force to the gripping slips of said gripping slip units.

15. The combination with a permanent type well tool assembly having an upper gripping slip unit and a lower gripping slip unit for locking the assembly against movement in either direction within a well casing, of a releasing apparatus comprising, a tubular support extending entirely through said assembly, said support comprising

an upper section and a lower section which telescope each other and which are normally in a first fully telescoped position, said sections being movable to a second extended position, the upper section being rotatable within the upper gripping slip unit and having an abutment which is spaced from said unit when the sections are in their first fully telescoped position, means nonrotatively connecting the lower section with the lower gripping unit while permitting axial movement with respect thereto, said lower section having an abutment thereon which is spaced from the lower gripping slip unit when the sections are in their first fully telescoped position, and means for moving the sections of said support to their second extended position to engage the abutments thereon with the gripping slip units to thereby effect a release of said units from gripping position.

16. The combination as set forth in claim 15, together with a lowering pipe connected to the upper section of the support, said means for moving the sections to their second extended position being operable by manipulation of said lowering pipe.

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