Aug. 31, 1965 D. G. CAMPBELL Re. 25,846

WELL PACKER APPARATUS

Original Filed June 9, 1958 3 Sheets-Sheet 1

FIG. 1.

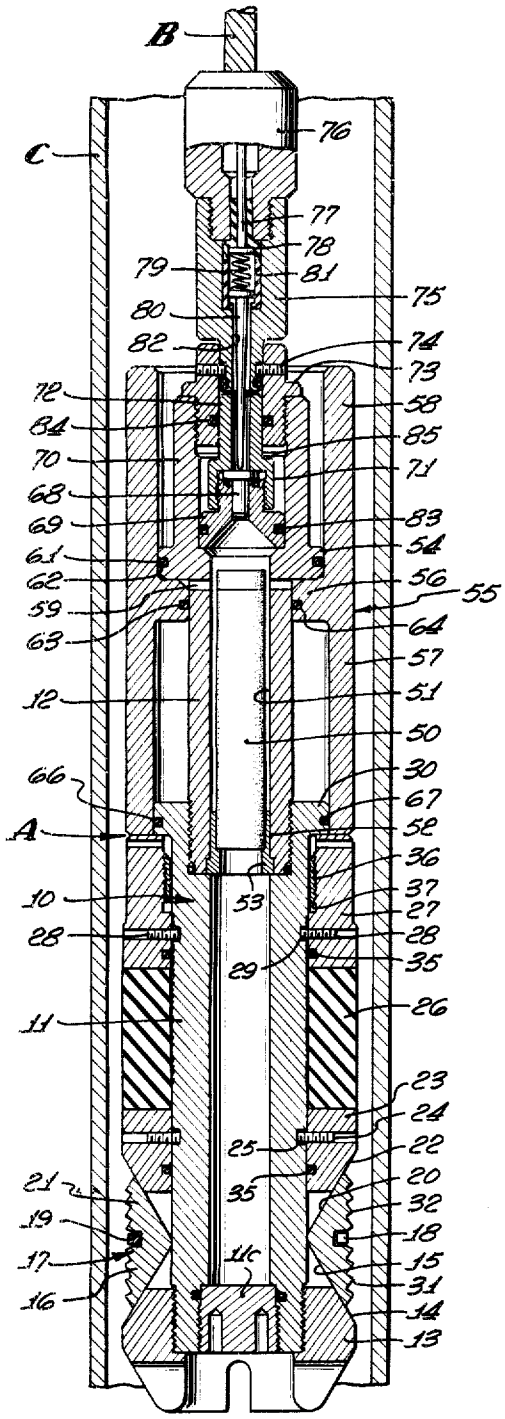
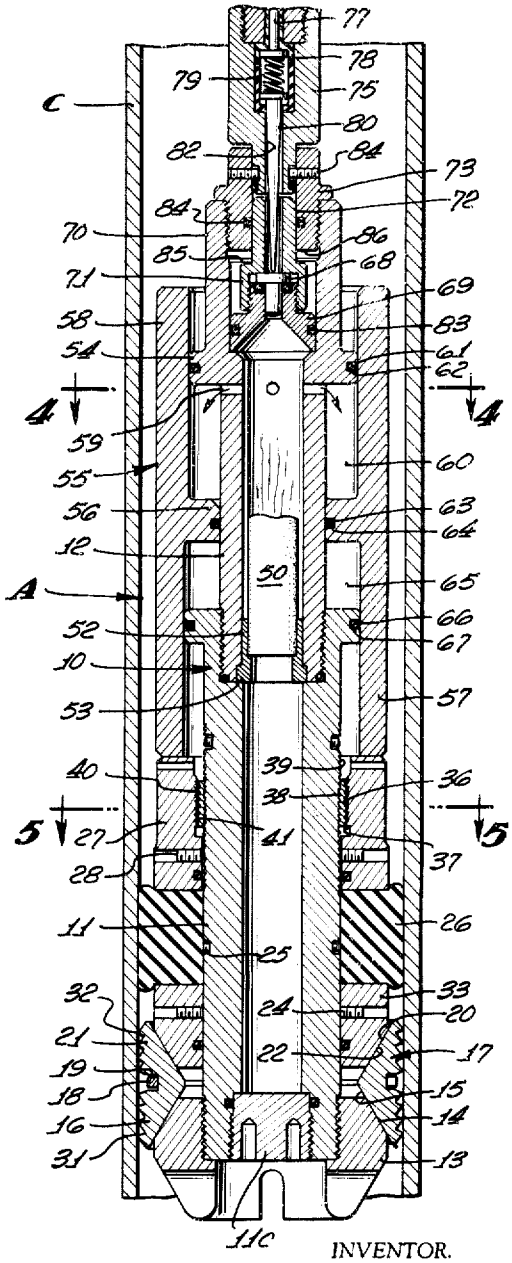


FIG. 2.



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FIG. 3.

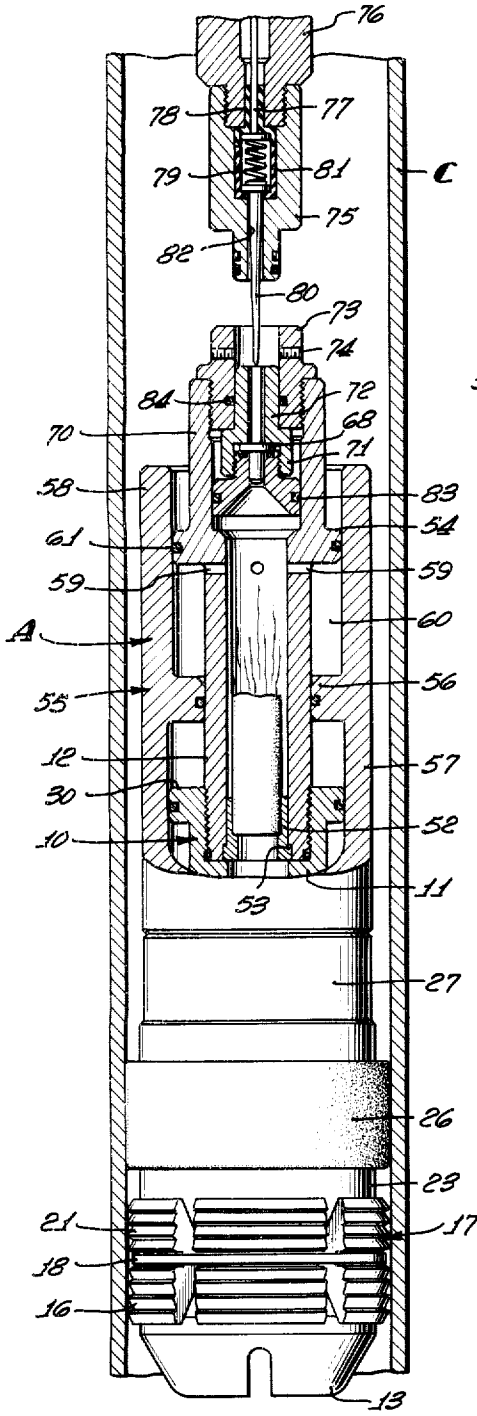


FIG. 4.

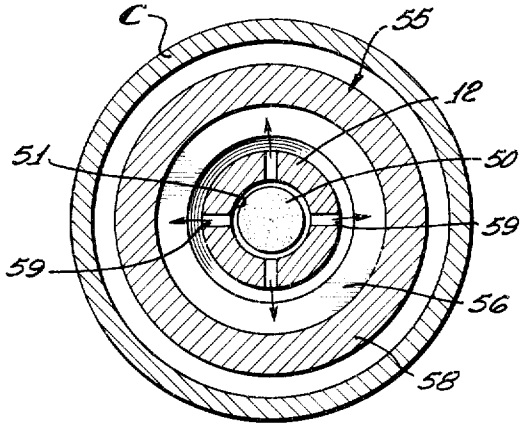
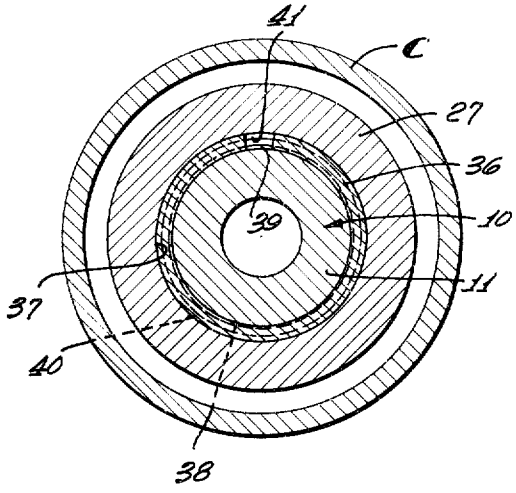


FIG. 5.



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FIG. 6.

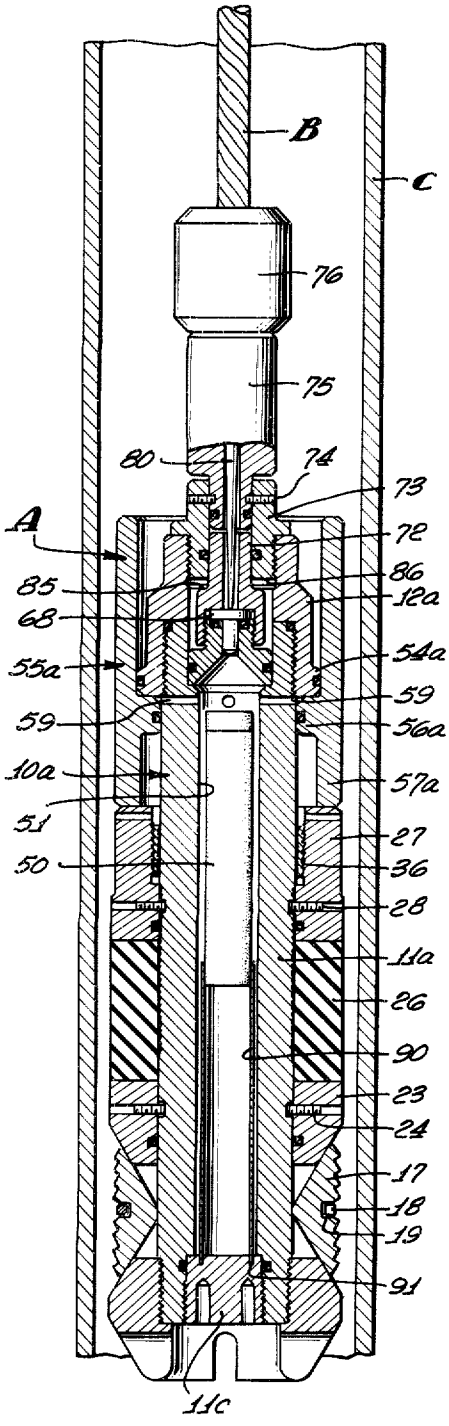
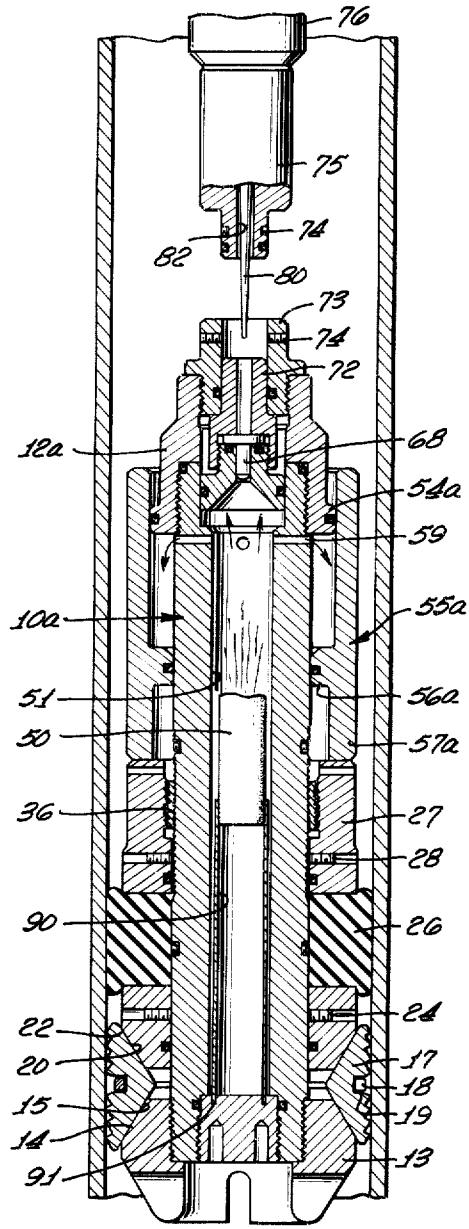


FIG. 7.



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United States Patent Office

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25,846

WELL PACKER APPARATUS

Don G. Campbell, Downey, Calif., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Original No. 3,055,430, dated Sept. 25, 1962, Ser. No. 740,708, June 9, 1958. Application for reissue Sept. 9, 1964, Ser. No. 406,650

17 Claims. (Cl. 166—122)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

The present invention relates to subsurface well apparatus, and more particularly to well packers adapted to be set in well bores.

An object of the present invention is to provide an improved well packer adapted to be anchored in packed-off condition in a well bore.

Another object of the invention is to provide a well packer containing its own source of energy for setting the packer in a well bore, the packer being relatively short and compact, economical to manufacture, and capable of withstanding relatively high pressures.

A further object of the invention is to provide a well packer adapted to be lowered in a well bore on a wire line, and containing its own source of energy for setting the packer in the well bore and for releasing the wire line therefrom, the well packer being compact and of strong and sturdy construction, enabling it to withstand comparatively large forces encountered in a well bore.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail for the purpose of illustrating the general principles of the invention; but is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIG. 1 is a longitudinal section through an embodiment of the invention, with certain of its parts initially in a retracted position;

FIG. 2 is a view similar to FIG. 1 showing the well packer anchored in packed-off condition in the well bore;

FIG. 3 is a view corresponding to FIGS. 1 and 2, with a portion of the well packer shown in side elevation, the packer being anchored in packed-off condition in the well bore and the running-in string released therefrom;

FIG. 4 is an enlarged cross-section taken along the line 4—4 on FIG. 2;

FIG. 5 is an enlarged cross-section taken along the line 5—5 on FIG. 2;

FIG. 6 is a longitudinal section showing another embodiment of the invention, with its parts in retracted position;

FIG. 7 is a view similar to FIG. 6, illustrating the packer anchored in packed-off condition in a well casing and the running-in string released therefrom.

As disclosed in the drawings, it is desired to lower a well packer A, such as a bridge plug, on a running-in string, such as a wire line B, to a desired point in a well casing C disposed in a well bore at which the well packer is to be anchored in packed-off condition against the well casing. After the setting operation of the well packer A in the well casing C has been completed, the wire line B is released from the well packer and can

be removed upwardly through the well bore to the top of the hole.

As specifically shown[,] *in* the embodiment illustrated in FIGS. 1 to 5, inclusive, a main body **10** is provided, including a lower section **11**, which may be tubular, that is threadedly secured to an upper section **12**, which is also tubular. A plug **11c** is threaded in the lower end of the body member **11** to close the passage through the body. Threadedly secured to the lower portion of the lower body member **11** is a guide and lower expander **13** having a tapered expander surface **14** inclined in *an* upward and inward direction for coaction with companion surfaces **15** formed on the lower portions **16** of segmental slips **17** surrounding the body **10** and initially held in retracted positions with respect thereto by an encompassing split, inherently contractile snap ring **18** disposed within a circumferential groove **19** provided collectively in the segmental slips at their midportion. The segmental slips **17** also have upper tapered surfaces **20** in their upper portions **21**, which surfaces are inclined in a downward and inward direction for coaction with a companion tapered surface **22** on an upper expander **23** slidable relative to the body **10** of the tool, but initially releasably secured thereto, as by one or a plurality of shear screws **24** threaded laterally in the expander and extending into a peripheral groove **25** in the body.

Surrounding the body **10** is a packing structure of sleeve **26** which may be made of rubber or rubber-like material, the lower end of which engages the upper expander **23** and the upper end of which engages an upper abutment or setting sleeve **27** initially releasably secured to the body member **11** by one or more shear screws **28** threaded laterally in the setting sleeve **27** and received within a peripheral groove **29** in the body **11** of the tool. The upper end of this setting ring or abutment **27** is adjacent an outwardly direction flange **30** constituting the upper portion of the lower body section **11**, and which also serves as a lower piston portion of a fluid operated mechanism for setting the well packer A in the well casing C.

It is to be noted that the lower portion **16** of each slip **17** has wickers or teeth **31** facing it in upward direction, so as to anchor the well tool A against upward movement in the well casing. The upper portion **21** of each slip has wickers **32** facing in a downward direction, to engage the well casing C and prevent downward movement of the well packer A therewithin.

The slips **17** and packing **26** are expanded into engagement with the well casing by relatively moving the upper abutment or setting ring **27** downwardly and the body **10** of the tool and the lower expander member **13** upwardly. Such movement will at first effect a shearing or disruption of the sets of screws **24**, **28** holding the upper expander **23** to the body and the setting ring **27** to the body of the tool, after which the upper expander **23** will move toward the lower expander **13** causing the upper and lower expanders to relatively shift behind the slips **17** and, by virtue of the coengaging tapered surfaces **24**, **20** and **14**, **15**, shift the slips outwardly until the upper and lower wickers **32**, **31** are embedded in the wall of the well casing C. Outward expansion of the slips **17** is not prevented by the split, snap ring **18** which will merely expand as the slips expand. The split ring **18** has the purpose of holding the slips **17** in a central position when the apparatus is being run in the well casing, and also in a retracted position with respect to the body **10**.

After the slips **17** have engaged the wall of the well casing, a continuation of the downward movement of the setting ring **27** with respect to the body **10** will move such ring toward the upper expander **23**, fore-

shortening the rubber packing [sleeves] *sleeve* **26** and expanding it outwardly into sealing engagement with the wall of the well casing C and the periphery of the body **10**, preventing leakage of fluid both externally around the packing sleeve and internally thereof. If desired, as further assurance against leakage of fluid along the exterior of the body **10**, side seals **35**, such as rubber or rubber-like O rings, may be disposed in the setting ring **27** and the upper expander **23** for sealing engagement against the periphery of the body **10** of the tool.

The packer A is retained anchored in packed-off condition by preventing relative upward movement of the upper abutment and setting ring **27** along the body **10**, although downward movement relative to the body is permitted. As specifically disclosed, a split latch ring or sleeve **36** is disposed in a counterbore **37** in the setting ring **27**. This sleeve has internal ratchet teeth **38** facing in an upward direction and adapted to engage external ratchet teeth **39**, facing in a downward direction, on the periphery of the body **10**. In the event the setting ring **27** tends to move upwardly along the body **10**, or, conversely, the body **10** tends to move downwardly relative to the setting ring **27**, external cam elements **40** on the ratchet or lock ring **36** will engage companion internal cam elements **41** on the setting ring **27**, which will urge the ratchet teeth **38** inwardly and hold them in engagement with the body teeth **39**. The particulars of the lock device between the setting ring **27** and the body **10** of the tool form no part of the present invention. They may be found in the patent to John R. Baker and Martin B. Conrad, 2,647,584, patented August 4, 1953, for "Well Packer and Bridge Plugs for Well Bore."

The well packer A is set in the well casing by means of fluid pressure. The source of fluid pressure is within the well packer itself: It may be derived from a power charge or propellant **50** contained within a pressure chamber **51** in the upper body member **12**. This propellant or power charge **50** contains its own source of oxygen. When its upper portion is ignited, it will burn away progressively in a downward direction to produce a gas at a gradually increasing pressure for action upon the fluid operated portion of the tool, to set the well packer A in the well casing C.

As specifically shown in the drawings, the lower portion of the power charge **50**, which may be in stick form or contained within a suitable tube, is confined within a supporting sleeve **52** having a lower flange **53** which may be clamped between the upper and lower body sections **12**, **11** when they are screwed together. The upper portion of the body has an upper annular piston **54** along which a cylinder **55** can slide. This cylinder has a head **56** extending inwardly of a cylinder sleeve **57** and slidably engaging the upper body portion **12** below the upper piston **54**. Extending upwardly from the cylinder head **56** and slidable along the upper piston **54** is an upper cylinder skirt **58**. The lower cylinder skirt or sleeve **57** depends from the cylinder head **56** and is slidable along the lower piston or body portion **30**. This lower skirt or sleeve portion **57** is engageable with the upper end of the setting ring **27** of the well packer A.

The pressure developed in the pressure chamber **51** resulting from the combustion of the power charge **50**, passes through radial ports **59**, formed through the upper body portion **12** immediately below the upper piston **54**, into an annular cylinder space **60** provided between the upper piston **54** and the cylinder head **56**. To prevent leakage of fluid from such space **60** in an upward direction, a suitable seal ring **61**, such as a rubber or rubber-like O ring, is provided in a piston ring groove **62** for slidable sealing against the inner wall of the upper cylinder skirt or sleeve portion **58**. Leakage of fluid in a downward direction from the cylinder space **60** is prevented by a suitable side seal **63**, such as a rubber or rubber-like O ring, in an internal groove **64** in the cylinder head **56** slidably and sealingly

engaging the periphery of the upper body portion **12** below the ports **59**.

It is preferred that the well bore fluid be prevented from entering the space **65** between the cylinder head **56** and the lower piston **30**. Accordingly, a suitable seal **66**, such as a rubber or rubber-like O ring is provided in a ring groove **67** in the lower piston **30**, which slidably and sealingly engages the inner wall of the lower cylinder sleeve **57**. The annular space **65** between the cylinder head **56** and the lower piston **30** originally will contain air at atmospheric pressure.

The upper end of the power charge **50** is ignited by the firing of a blank cartridge or igniter **68** contained within a gun barrel **69** disposed within the upper part **70** of the upper body member **12**. This gun barrel is threadedly attached to a breech-block or cap **71** between which the cartridge **68** is clamped in leak-proof relation, an upward extension **72** of the cap being slidable in a sub **73** threaded within the upper end of the body portion **70** of the well packer. This sub **73** is detachably secured, by means of shear screws **74**, to a firing head **75** extending within the sub, the firing head being threadedly secured onto a cable head **76** to which the wire line B is suitably secured, in a known manner, the wire line B extending to the top of the well bore.

The wire line B has an electrical conductor (not shown) therein which is electrically connected to an upper connector element **77** extending through an insulator **78** contained in the cable and firing heads **76**, **75**. The lower end of this upper connector **77** engages a conducting helical spring **79** bearing against the upper portion of a conductor pin **80**, which extends through another insulator **81** within the firing head **75**. The conductor pin **80** extends through an enlarged passage **82** in the firing head **75** and in the cap extension **72**, being spaced therefrom so as to avoid contact therewith. The spring **79** holds the lower end of the conductor pin **80** in the engagement with a contact at the upper end of the cartridge **68**. The cartridge has a filament (not shown) therein within its power charge (not shown) connected at one end to the contact and the other end to ground. Thus, when the circuit at the top of the well bore is closed it will be completed through the conductive line in the wire line B, the connector **77**, the connector spring **79**, conductor pin **80**, cartridge filament to ground, the circuit at the upper end of the well bore also being grounded.

When the circuit is completed, the heating of the filament will ignite the powder charge, and the flame emanating therefrom will ignite the upper end of the power charge **50**, which may be of the type described in United States Patent Number 2,640,547. The combustion of the power charge will generate gas at an increased pressure in the pressure chamber **51**. This gas under pressure is prevented from leaking upwardly out of the pressure chamber by providing a suitable side seal **83** on the gun barrel, such as a rubber or rubber-like O ring, sealingly engaging the inner wall of the upper body member extension **70**. Similarly, leakage of external fluid into the upper end of the body **10** along the cap **71** is prevented by a suitable side seal **84**, such as a rubber or rubber-like O ring, in the sub **73** and engaging the periphery of the cap extension **72**. The gas under pressure will pass through the ports **59** into the annular cylinder space **60** between the upper piston **54** and the cylinder head **56**, urging the cylinder head downwardly and the upper piston **54** of the body **10** upwardly. Such gas under pressure is effective in expanding the slips **17** and the packing structure **26** into engagement with the wall of the well casing.

In the use of the apparatus, the well packer A is secured to the lower end of the wire line B by means of the shear pins **74**. An upwardly directed shoulder **85** on the cap **71** is at first spaced below the lower end **86** of the sub **73**, the upper end of the cap extension **72** being adjacent the firing head **75**. The apparatus is lowered in the well casing C to the desired point at which the well packer A

is to be set therein (FIG. 1). When this location is reached the circuit to the igniter **68** is completed to fire the latter. The flame emanating from the cartridge will ignite the upper end of the power charge or propellant **50**, a fluid pressure then being developed within the pressure chamber **51** as the result of the combustion of propellant. This gas under pressure acts upwardly on the gun barrel **69** urging it upwardly within the body **10** and causing it to urge the firing head **75** upwardly out of the sub **73**. However, such movement is resisted by the shear screws **74** which have a much greater shear value than the shear screws **28, 24** holding the setting ring **27** and the upper expander **23** to the body **10** of the tool. The gas under pressure passes through the ports **59** into the annular cylinder space **60**, shifting the cylinder **55** downwardly and acting in an upward direction on the piston **54** to relatively urge the body **10** upwardly. When the pressure of the burning propellant **50** increases sufficiently to overcome the force of the shear screws **28, 24** holding the setting ring **27** and upper expander **23** to the body **10** of the tool, such screws are disrupted, the cylinder **55** then moving the setting ring **27** downwardly of the body **10**, and the body relatively upwardly of the setting ring, to move the expanders **23, 13** toward one another and urge the slips **17** outwardly into anchoring engagement with the wall of the well casing C. Continued increase in the pressure developed within the chamber **51** and in the cylinder space **60** urges the upper abutment or setting ring **27** towards the upper expander **26** to foreshorten the packing sleeve **26** and expand it outwardly into sealing engagement with the wall of the well casing C and the periphery of the body **10**. Such pressure will also be exerted through the packing sleeve **26** upon the upper expander **23**, to move it firmly behind the slips **17** and embed the slip wickers **31, 32** into the well casing, the same forces acting in an upward direction on the body **10** of the tool to cause the lower expander **13** to be urged upwardly behind the slips **17** and embed the wickers more firmly into the wall of the well casing. The ratchet sleeve **36** will move down along the body ratchet teeth **39** freely as the setting ring **27** moves downwardly of the body, but will preclude return movement of the setting ring **27** along the body **10** (FIG. 2).

As burning of the power charge or propellant **50** proceeds, the pressure of the gases developed will increase further, to more firmly set the packing sleeve **26** against the well casing and the slips **17** in the wall of the well casing. When the pressure increases sufficiently, it acts in upward direction on the gun barrel **69** and through the extension **72** on the firing head **75** to overcome the strength of the shear screws **74** and disrupt the latter, which will disconnect the firing head **75** from the sub **73** (FIG. 3). When the shear screws **74** are disrupted, the gun barrel **69** and cap **71** can only move a slight distance, determined by engagement of the cap shoulder **85** with the lower end **86** of the sub **73**. The firing head **75** is now free from the body **10** of the well packer, and the wire line B can be elevated, to elevate the firing head **75** and the elements contained therewithin with it and remove them from the well casing.

After the shear screws **74** have been disrupted and the firing head **75** released from the well packer A, the pressure can continue to increase, as a result of the continued combustion of the power charge **50**, and can more firmly set the well packer A in packed-off condition in the well casing. Eventually a maximum pressure will be reached upon complete burning of the power charge, but subsequent cooling of the gases produced thereby will decrease the pressure. However, the packing **26** and slips **17** will remain set with maximum force against the well casing B, because of the locking action of the lock sleeve **36** between the setting ring **27** and the body **10** of the tool.

It is preferred that the full pressure developed within the tool be available for setting the apparatus in the well bore, and that none of this pressure be required to overcome the hydrostatic head of the fluid in the well casing B. To accomplish this purpose, the cylinder **55** is pressure-balanced, by causing the lower cylinder sleeve **57** to slide along the lower piston **30** in leakproof fashion with respect thereto. This prevents the well bore fluid from entering the confined space **65** between the cylinder head **56** and the lower piston **30**. The upper and lower pistons **54, 30** have the same external diameter, which is also true of the internal diameter of the upper cylinder sleeve **58** and the lower cylinder sleeve **57**. As a result, the end area of the upper cylinder sleeve **58** is equal to the end area of the lower cylinder sleeve **57**, providing a balanced area condition, or no differential area over which the hydrostatic head of the well bore will tend to shift the cylinder **55** in one direction or the other.

The embodiment of the invention illustrated in FIGS. 6 and 7 is essentially the same as shown in FIGS. 1 to 5, inclusive. The specific form of the packer body **10a** is slightly different in that the lower section **11a** is threadedly secured to and within an upper body portion **12a** having the upper piston **54a**. The power charge or propellant **50** is held within the upper end of a supporting sleeve **90**, as by being pressed therewithin, this supporting sleeve, in turn, fitting closely within an end groove **91** in the plug **11c** threaded secured in the lower end of the body **11a** and closing the passage in the body. The ports **59** are provided through the lower body portion **11a** immediately below the upper piston **54a**.

The body **10a** does not have a lower piston, and for that reason a lower cylinder skirt is not slidable along such a head. In other words, the cylinder **55a** is not balanced against the hydrostatic head of fluid, which must be overcome by the pressure developed within the packer apparatus. The cylinder sleeve **57a** engages the setting ring **27** of the well packer. For that matter, the apparatus can be shortened somewhat by eliminating the cylinder sleeve **57a** and having the cylinder head **56a** engage the upper end of the setting sleeve **27**.

The apparatus disclosed in FIGS. 6 and 7 operates in the same manner as the other form of invention. Completion of the circuit to the igniter **68** causes the flame emanating therefrom to ignite the upper end of the power charge or propellant **50**. The developed gases will pass through the ports **59** and act downwardly on the cylinder head **56a**, forcing the cylinder **55a** in a downward direction and acting through the piston **54a** on the body **10a** to urge the latter in an upward direction. When sufficient force has been developed, the shear screws **24, 28** will be disrupted and the cylinder and setting ring **27** moved downwardly relative to the body **10a** to expand the slips **17** into anchoring engagement with the wall of the well casing and the packing sleeve **26** into sealing engagement with the casing wall. When the pressure developed in the tool exceeds the strength of the shear screws **74** holding the firing head **75** to the body sub **73**, the gun barrel will disrupt such screws, its upward movement within the body being limited by engagement of the cap shoulder **85** with the lower end **86** of the sub. The wire line B, cable head **76**, firing head **75**, and the electrical conductive elements connected directly thereto can then be removed from the well casing C. Pressure can continue to be generated in the packer body **10a** to effect a firmer setting of the slips **17** and the packing sleeve **26** against the wall of the well casing.

It is to be noted that the packers are short and compact, and are yet of sturdy construction. Their various portions are made of readily drillable materials, such as cast iron, which permits a well packer to be disintegrated by a drilling bit after it has served its purpose in the well casing. The fact that the well packer is relatively short will result in its disintegration by the drill bit in a much shorter period of time than would otherwise be required, effecting large economies through the saving in rig time.

The well packer is capable of withstanding very high pressures imposed thereon from above the well packer, or which may be imposed thereon from below the well packer. The slips **17** anchor the well packer against movement in both directions within the well casing, the packing sleeve remaining sealed off against pressure in both directions in the well casing, preventing leakage of fluids thereby.

The inventor claims:

1. In a well packer: a body having a passage; slips disposed around said body; a lower expander below said slips permanently fixed to said body and engageable with said slips; an upper expander above said slips slidable along said body and engageable with said slips; packing means around said body above said upper expander; an annular piston secured to said body; an annular cylinder slidable along said piston and body and engageable with said packing means; said body having a port below said piston through which fluid under pressure within said body passage can be directed into said cylinder, said piston and body together having a resultant transverse surface facing downwardly and said cylinder having a resultant transverse surface facing upwardly, whereby said fluid under pressure acts on both transverse surfaces to shift said cylinder downwardly and said body upwardly to urge said packing means and second expander toward said first expander and expand said packing means and slips outwardly.

2. In a well tool: a body having a passage; means for securing said body to a running-in string for lowering the well tool in a well bore; normally retracted means on said body; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder engageable with said normally retracted means and including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said normally retracted means; *said body, head, other of said pistons, and the sleeve portion slidable along said other of said piston together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of the fluid under pressure in said body passage.*

3. In a well tool: a body having a passage; means for securing said body to a running-in string for lowering the well tool in a well bore; normally retracted means on said body; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder engageable with said normally retracted means and including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder between said head and one of said piston to shift said head toward the other of said pistons to expand said normally retracted means; the cross-sectional areas of said sleeve portions being substantially equal to each other; *said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of the fluid under pressure in said body passage.*

4. In a well tool: a body having a passage; slips disposed around said body; expander means for shifting said slips laterally outward; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder for shifting said slips and expander means longitudinally relative to each other, said cylinder including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; said cylinder terminating at the ends of said sleeve portions; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said slips; *said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of the fluid under pressure in said body passage.*

5. In a well packer: a body having a passage; slips disposed around said body; a first expander fixed to said body and engageable with said slips; a second expander slidable relative to said body and engageable with said slips; packing means around said body engageable with said second expander; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder for shifting said packing means and second expander toward said first expander to expand said packing means and slips outwardly, said annular cylinder including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; said cylinder terminating at the ends of said sleeve portions; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said slips and packing means.

6. In a well packer: a body having a passage; slips disposed around said body; a first expander fixed to said body and engageable with said slips; a second expander slidable relative to said body and engageable with said slips; packing means around said body engageable with said second expander; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder for shifting said packing means and second expander toward said first expander to expand said packing means and slips outwardly, said annular cylinder including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; said cylinder terminating at the ends of said sleeve portions; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said slips and packing means; the cross-sectional areas of said sleeve portions being substantially equal to each other.

7. In subsurface well apparatus: a body; slips disposed around said body; a first expander fixed to said body and engageable with said slips; a second expander slidable relative to said body and engageable with said slips; packing means around said body engageable with said second expander; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder for shifting said packing means and second expander toward said first expander to expand said packing means and slips laterally outwardly, said cylinder including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; said cylinder termi-

nating at the ends of said sleeve portions; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body can be directed into said cylinder between said head and one of said pistons; a combustible charge within said body; and means for initiating combustion of said charge to produce gas under pressure for passage through said port into said cylinder; *said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of said gas under pressure.*

8. In subsurface well apparatus: a body; slips disposed around said body; a first expander fixed to said body and engageable with said slips; a second expander slidable relative to said body and engageable with said slips; packing means around said body engageable with said second expander; a first annular piston secured to said body; a second annular piston secured to said body; an annular cylinder for shifting said packing means and second expander toward said first expander to expand said packing means and slips laterally outwardly, said cylinder including a head slidable along said body between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; said cylinder terminating at the ends of said sleeve portions; sealing means for preventing leakage between said head and body and between said pistons and sleeve portions; said body having a port through which fluid under pressure within said body can be directed into said cylinder between said head and one of said pistons; means including a detachable connection for securing said body to a running-in string for lowering said body in a well bore; a combustible charge within said body; means for initiating combustion of said charge to produce gas under pressure for passage through said port into said cylinder; *said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of said gas under pressure*; and fluid pressure actuated means subject to and actuated by gas under pressure produced by said charge for releasing said detachable connection.

9. In a well tool: a body having a passage; slips disposed around said body; a lower expander below said slips permanently fixed to said body and engageable with said slips; an upper expander slidable downwardly relative to said body and engageable with said slips; packing means around said body above and engageable with said upper expander; an annular piston secured to said body; an annular cylinder slidable along said piston and body and engageable with said packing means; said body having a port through which fluid under pressure within said body passage can be directed into said cylinder, said piston and body together having a resultant transverse surface facing downwardly and said cylinder having a resultant transverse surface facing upwardly, whereby said fluid under pressure acts on both transverse surfaces to shift said cylinder downwardly and said body upwardly to shift said packing means and second expander downwardly toward said first expander to expand said packing means and slips outwardly; a combustible charge within said body; and means for initiating combustion of said charge to produce gas under pressure for passage through said port into said cylinder.

10. In a well tool: body means; means for securing said body means in a running-in string for lowering the well tool in a well bore; normally retracted means on said body means; a first annular piston secured to said body means; a second annular piston secured to said body means; an annular cylinder engageable with said normally retracted means and including a head slidable along said body means between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said normally retracted means; said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of said fluid pressure in said cylinder.

11. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; normally retracted means on said body means; an upper annular piston above said normally retracted means and secured to said body means; a lower annular piston above said normally retracted means and secured to said body means; an annular cylinder above and engageable with said normally retracted means and including a head slidable along said body means between said pistons and upper and lower sleeve portions slidable along said upper and lower pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and upper piston to shift said head toward said lower piston to expand said normally retracted means; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in said cylinder.

12. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; normally retracted means on said body means; a first annular piston secured to said body means; a second annular piston secured to said body means; an annular cylinder engageable with said normally retracted means and including a head slidable along said body means between said pistons and first and second sleeve portions slidable along said first and second pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to expand said normally retracted means; said body, head, other of said pistons, and the sleeve portion slidable along said other of said pistons together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action on said head of said fluid pressure in said cylinder; the cross-sectional areas of said sleeve portions being substantially equal to each other whereby fluid in the well bore externally of the well tool does not tend to shift said cylinder upwardly or downwardly along said body means.

13. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; normally retracted means on said body means; an upper annular piston above said normally retracted means and secured to said body means; a lower annular piston above said normally retracted means and secured to said body means; an annular cylinder above and engageable with said normally retracted means and including a head slidable along said body means between said pistons and upper and lower sleeve portions slidable along said upper and lower pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and upper

piston to shift said head toward said lower piston to expand said normally retracted means; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in such cylinder; the cross-sectional areas of said sleeve portions being substantially equal to each other whereby fluid in the well bore externally of the well tool does not tend to shift said cylinder upwardly or downwardly along said body means.

14. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; slips disposed around said body means; expander means for shifting said slips laterally outwardly; a first annular piston secured to said body means; a second annular piston secured to said body means; an annular cylinder for shifting said slips and expander means longitudinally relative to each other, said cylinder including a head slidable along said body means between said pistons and first and second sleeve portions slidable along the first and second pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and one of said pistons to shift said head toward the other of said pistons to shift said slips laterally outward; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in said cylinder.

15. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; slips disposed around said body means; expander means for shifting said slips laterally outward; an upper annular piston above said slips and expander means and secured to said body means; a lower annular piston above said slips and expander means and secured to said body means; an annular cylinder for shifting said slips and expander means longitudinally relative to each other, said cylinder including a head slidable along said body means between said pistons and upper and lower sleeve portions slidable along said upper and lower pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and upper piston to shift said head toward said lower piston to shift said slips laterally outward; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in said cylinder.

16. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; slips disposed around said body means; expander means for shifting said slips laterally outward; an upper annular piston above said slips and expander means and secured to said body means; a lower annular piston above said slips and expander means and secured to said body means; an annular cylinder for

shifting said slips and expander means longitudinally relative to each other, said cylinder including a head slidable along said body means between said pistons and upper and lower sleeve portions slidable along said upper and lower pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and upper piston to shift said head toward said lower piston to shift said slips laterally outward; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in said cylinder; the cross-sectional areas of said sleeve portions being substantially equal to each other whereby fluid in the well bore externally of the well tool does not tend to shift said cylinder upwardly or downwardly along said body means.

17. In a well tool: body means; means for securing said body means to a running-in string for lowering the well tool in a well bore; normally retracted means on said body means; an upper annular piston above said normally retracted means and secured to said body means; a lower annular piston above said normally retracted means and secured to said body means; an annular cylinder above and engageable with said normally retracted means and including a head slidable along said body means between said pistons and upper and lower sleeve portions slidable along said upper and lower pistons, respectively; sealing means for preventing leakage between said head and body means and between said pistons and sleeve portions; and means providing a fluid pressure in said cylinder between said head and upper piston to shift said head toward said lower piston to expand said normally retracted means; said fluid pressure providing means including a passageway in said body means communicating with said cylinder between said head and upper piston; said body, head, lower piston, and lower sleeve portion together providing a confined space into which well bore fluid cannot enter to prevent such well bore fluid from acting on said head in opposition to the action of said fluid pressure in said cylinder.

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